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The Real Effects of Mandatory Dissemination of Non-Financial Information through Financial Reports

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The Real Effects of Mandatory Dissemination of Non-Financial Information through Financial Reports

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Abstract: We examine the real effects of mandatory, non-financial disclosures, which require SEC-registered mine owners to disseminate their mine-safety records through their financial reports. These safety records are already publicly available elsewhere, which allows us to examine the incremental effects of disseminating information through financial reports. Comparing mines owned by SEC-registered issuers to those mines that are not, we document that including safety records in financial reports decreases mining-related citations and injuries by 11 and 13 percent, respectively, and reduces labor productivity by approximately 0.9 percent. Additional evidence suggests that increased dissemination, rather than unobservable factors associated with regulatory intervention, drive these effects. We also provide evidence that feedback effects from equity markets are a potential mechanism through which the dissemination of information leads to real effects. Overall, our results illustrate that disseminating non-financial information through financial reports can have real effects—even if the content of that disclosure is already publicly available.

Keywords: Information dissemination, real effects, financial reporting, Dodd-Frank Act, mine safety, corporate social responsibility.

JEL Classification: D03, G14, G18, G38, I18, J28, K22, K32, L71, L72, M41, M48

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1. Introduction

In the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (the "Dodd-Frank Act"), policymakers made an unprecedented move towards using securities regulation to address issues unrelated to the Securities and Exchange Commission's (SEC) core mission of protecting investors and maintaining the fair and efficient functioning of financial markets (Lynn 2011). Sections 1502 and 1503 of the Dodd-Frank Act require financial statement disclosures of non-financial information regarding purchases of war minerals from Congo and mine health and safety performance.[1] In this paper, we examine the real effects of the mandatory dissemination of mine-safety disclosures ("MSD") through the financial reports of the 151 SEC-registered firms whose ownership of a U.S. mine make them subject to Section 1503 of the Dodd-Frank legislation.[2] That the information disseminated through MSD is already publicly available on the Mine Safety and Health Administration's (MSHA) website is a key feature of our setting that allows us to isolate and provide insights into the dissemination role of financial reporting. Understanding the consequences of information dissemination is critical because it is one of the primary functions of financial reporting, yet its real effects are not well understood (Leuz and Wysocki 2016).

Section 1503 of the Dodd-Frank Act requires the disclosure of citations for violations of mine safety regulations both periodically in mine owners' financial reports (i.e., Forms 10K and 10Q) and immediately upon the receipt of an imminent danger order (IDO) through a Form 8K release. The implicit argument advocates of MSD make is that information disseminated through financial reports has implications that it does not have when disclosed only on the MSHA's

[1] We use the term "non-financial" to reflect the fact that the primary objectives of these provisions are to affect non-financial outcomes (e.g., improving safety).
[2] We define "real effects" as situations in which the disclosing person or reporting entity changes its behavior in a way that affects resource allocation as a result of the disclosure mandate.

website. However, it is unclear whether the information included in MSD is news to investors or other interested parties. One reason including this information in financial reports could be incrementally useful is because financial reports aggregate mine-level information to the firm level and broadcast it to a wide range of interested parties, which significantly reduces the costs of assessing mine owners' safety performance. Lower acquisition costs could in turn increase public awareness of the firms that own mines with poor safety records, making it easier to attribute responsibility to these firms' managers and owners and more difficult for them to plausibly deny their awareness of unsafe work conditions. Even if some, relatively sophisticated, investors, such as institutions, are already aware of the MSHA disclosures, as less sophisticated parties become aware of safety issues, the costs of investing in or operating a firm with a poor safety record could increase (e.g., through heightened disapproval of firms with poor safety records).

If MSD increases awareness of mines with poor safety records, one potential mechanism through which it could provide an incentive for managers to improve mine safety is feedback effects from equity markets.[3] MSD could affect equity valuations by bringing attention to information that helps investors assess future cash flows or allocate assets based on their non-cash-flow-based preferences. Cash flow effects could occur, for example, through fines or mine closures. Non-cash-flow-based preferences could lead investors to require higher returns for financing the operations of firms that engage in activities that conflict with those preferences, such as maintaining relatively unsafe working conditions (e.g., Fama and French 2007; Friedman and Heinle 2015). If managers' utility functions incorporate the value of the firm, and MSD

[3] In our setting, we use the term "feedback effects" to describe scenarios where the firm's dissemination of information affects (or is anticipated to affect) security prices, which in turn lead a manager to alter her behavior. Such effects could occur either because managers learn from changes in security prices (e.g., about investors' preferences over safety) or because of the mitigation of agency costs, where managers do not learn from prices per se, but rather are forced to internalize the long-term cash flow effects of poor safety (see Section 3).

affects investor demand for the firm's securities, then MSD will provide an incentive to alter resource allocation decisions to improve safety. Ultimately, whether the dissemination of non-financial information through financial reports has real effects or is altogether irrelevant is an empirical question.

Using data obtained directly from the MSHA, we first assess the effect of MSD on the incidence rate of citations for violations of mine safety regulations, which are the primary subject of MSD. For these analyses, we employ a difference-in-differences design that compares changes in citations issued to mines owned by SEC registrants ("MSD mines") and mines owned by non-SEC registrants ("non-MSD mines") following the effective date of Dodd-Frank. We control for flexible time trends and static, mine-level differences by including both year and mine fixed effects. Using both ordinary least squares (OLS) and Poisson regressions, and measuring incidence rates over one- and two-year periods, we document a decrease in citations per inspection hour of approximately 11% for MSD mines relative to non-MSD mines. Among MSD mines, we find no evidence of an increase in non-disseminated citations, which is consistent with MSD increasing compliance with mine safety regulations rather than changing inspector behavior (e.g., a higher likelihood of downgrading severe to less severe citations).

Next, we analyze the effect of MSD on injury rates. An implicit assumption of the Dodd-Frank reporting requirements, which focus almost exclusively on the dissemination of citations for safety violations, is that a decrease in citations will translate into a reduction in injuries. However, the link between compliance with mine safety regulations and actual safety improvements is debatable (e.g., Ruffennach 2002; Gowrisankaran et al. 2015). Using the same methodology as in the citation analysis, and consistent with a meaningful improvement in safety, we document a 13 percent decrease in injuries for MSD mines relative to non-MSD mines.

While the above results suggest that MSD has substantial benefits, it is unlikely that the observed safety improvements are costless. Gowrisankaran et al. (2015) posit that mines produce a joint output of safety and mineral production, which suggests that an increase in safety could lead to lower mineral production per hour worked. We examine this tradeoff by testing whether productivity in coal mines, where we have reliable measures of production and labor quantities, changes around the adoption of MSD. Using a difference-in-differences research design, we find evidence of a significant reduction in labor productivity for MSD mines relative to non-MSD mines following the implementation of MSD. The observed decline translates into increased labor costs of approximately 0.9 percent of total revenue.

A critical assumption of our identification strategy is that the trends in mine safety and productivity for MSD mines and non-MSD mines would have been the same in the absence of MSD (i.e., the parallel trends assumption). We confirm the validity of this assumption by mapping out the counterfactual treatment effect of MSD in the pre-MSD period (from 2000 to the second quarter of 2010) and showing that there are no significant differences between MSD mines and non-MSD mines for any of our outcome variables in the pre-MSD period.

Even with similar pre-treatment trends, unobservable events leading to the MSD regulation (e.g., public outrage following mining disasters) that differentially affect MSD mines and non-MSD mines could potentially confound our inferences. To address this possibility, we first demonstrate that there is no difference in the reactions of MSD mines and non-MSD mines to another major regulatory event (the 2006 MINER Act) that pertains to all mines and was triggered by events similar to those that led to MSD. Additionally, we match MSD mines and non-MSD mines on observable characteristics and show that the impact on the estimated treatment effect is small, which indicates that any potential selection on unobservables would have to be large to affect our inferences (Altonji et al. 2005). Finally, to assess the influence of macroeconomic shocks, we demonstrate that the timing of the 2008 financial crisis and the subsequent recovery do not line up with the pattern of our estimated treatment effects around MSD and that the treatment does not vary with owners' financial constraints. Taken together, the results of our analyses indicate that MSD has real effects on mine safety and productivity.

We next explore feedback effects from equity markets and, in particular, decreases in investor demand for firms with poor safety records, as a potential mechanism through which MSD could create an incentive for managers to improve safety. We assess the effects of MSD on investor demand by examining short-window stock returns and changes in the ownership of mutual funds (who are subject to greater scrutiny than other types of investors, such as individuals or hedge funds) following MSD-8K filings. We find that the release of an MSD-8K filing is, on average (at the median), associated with a negative return of 41 (20) basis points and that mutual funds significantly decrease their holdings in quarters with MSD-8K releases relative to those without. The decline in ownership is most pronounced for funds with explicitly stated preferences for "socially responsible investment" (SRI), which suggests that non-cash-flow-based preferences contribute to the observed decline in investor demand for unsafe mines. For both returns and mutual fund holdings, we find that the negative response to a safety citation is significantly larger when it is disseminated through an 8K filing *in addition to* being disclosed on the MSHA's website.

Our paper contributes to the existing literature by documenting real effects of disseminating non-financial information through financial reports. Although information dissemination is one of the primary functions of financial reporting, its real effects are not well understood (Leuz and Wysocki 2016). Prior work examining the real effects of disclosure focuses on settings where the disclosed information is not publicly available elsewhere (e.g., Jin and Leslie 2003). The information disseminated through MSD is already available online, which allows us to isolate and provide insights into the dissemination role of financial reports.

Our paper also highlights the role of capital market responses to the dissemination of information through financial reports as a mechanism that can alter managerial incentives and precipitate real changes. Prior literature shows that investors' limited attention (Merton 1987; Barber et al. 2005; Barber and Odean 2008), dissemination (Rogers, et al. 2015), and non-cash-flow-based preferences (e.g., Fama and French 2007; Hong and Kacperczyk 2009; Hong and Kostovetsky 2012; Friedman and Heinle 2015) can affect security prices. Our findings suggest that information disseminated through financial reports can focus investor attention and highlight socially undesirable activities leading to feedback effects from the capital markets that can alter managers' behavior and have real effects.

Given the increasing trend toward regulating non-financial disclosures, understanding the real effects of these regulations is increasingly important. For example, the European Union (EU) recently mandated significant new non-financial disclosures related to firms' environmental, social, and governance performance. Grewal et al. (2015) find negative market reactions to the announcement of the EU regulation, which suggests that on average such disclosures are costly to investors. Our focus is on whether the non-financial disclosures accomplish their objectives, rather than their potential cost to shareholders. Given that we find an improvement in safety, one could argue that MSD accomplishes its objective. However, we also observe a decline in productivity, so it is important to note that the improvement in safety is not without costs. Ultimately, the desirability of non-financial disclosure policies depends on the tradeoff between safety improvements and their associated costs.

2. Institutional Background

The mining industry is both an economically important and historically unsafe sector of the U.S. economy. In 2014, the mining industry contributed $225.1 billion to GDP and nearly two million jobs to the U.S. economy (NMA 2014). Since 1900, more than 100,000 workers have died and many more have been injured in U.S. mines (MSHA 2014). Although mining is no longer among the ten most dangerous jobs in the U.S. (based on fatalities), it remains one of the most heavily regulated sectors in terms of employee health and safety. As is often the case with policy interventions, catastrophic events frequently trigger mine-safety regulation (Ruffennach 2002). For instance, Congress established the MSHA in 1977 following the Sunshine Mine fire that killed 91 workers. In January 2006, two accidents in West Virginia killed 14 workers, which prompted Congress to pass the Mine Improvement and New Emergency Response (MINER) Act of 2006 (CNN 2010).

Although safety has improved in recent decades, mine disasters remain common. From 2000 to 2014, Gowrisankaran et al. (2015) identify five mining accidents as disasters based on the number of fatalities—the most recent being the Upper Big Branch disaster that killed twenty-nine miners in West Virginia on April 5, 2010. As in the past, the latest tragedy prompted regulatory intervention. However, rather than simply increasing the resources used to inspect mines or the fines for violating health and safety standards, policy-makers turned to securities regulation. Following the common congressional practice of tacking off-topic provisions onto laws, West Virginia Senator Jay Rockefeller IV introduced MSD into the Dodd-Frank Act, which primarily focuses on regulations intended to reform the financial services sector. MSD is clearly intended to address safety issues rather than aid investors in assessing financial performance (Lynn 2011), and Rockefeller IV explicitly motivated MSD in that way:

> *"Currently, there is no requirement to publicly disclose safety records* [sic]*, which has allowed companies to operate without critical checks and balances. West Virginia suffered a terrible loss recently at the Upper Big Branch mine and we owe it to our miners and their families to do more to make mine safety a top priority."* (Senator John D. Rockefeller IV, Press Release May 07, 2010)

Given that MSD regulation is an endogenous response to the Upper Big Branch mining disaster, one of our main identification challenges is to separate the effect of the dissemination of information through MSD from the forces that led to the passage of the MSD regulation (e.g., public outrage over the Upper Big Branch mining disaster). We address this issue in Section 4.3.

The use of transparency as a policy instrument in the context of mine safety follows a recent trend in regulation where lawmakers take an informational approach to solve complex regulatory challenges and rely on market forces to impose penalties for socially undesirable behaviors (Fung et al. 2007). Yet, whereas transparency initiatives in other areas have mandated the disclosure of information that was not previously publicly available elsewhere—such as charge prices in healthcare (Christensen et al. 2015) or hygiene scores in restaurants (Jin and Leslie 2003)—in response to the Upper Big Branch disaster, policymakers used securities regulation to disseminate already-publicly-available safety records.

Under MSD, operators are required to disclose severe citations for violations of the Federal Mine Safety and Health Act of 1977 (the Mine Act), proposed penalties, legal actions, and fatalities. In Appendix A, we describe these disclosure requirements in further detail. Under the Mine Act, the MSHA is required to inspect surface mines at least twice a year and underground mines at least four times a year. If inspectors identify violations of safety and health standards, they issue citations or orders, which may carry monetary penalties or, in some cases, result in mine closures.

Since 2000, the MSHA has made publicly available on its website a mine-level database on inspections, violations, and injuries.[4] The required disclosures under the Dodd-Frank Act are drawn directly from this database.[5] That is, the regulation requires dissemination through financial reports of information that is already publicly available. However, prior to Dodd-Frank, firms did not disclose their mine-safety records in their financial reports and it was not completely straightforward for outsiders to construct these records from the MSHA database.[6]

Dodd-Frank Section 1503(a) requires the disclosure of firms' mine safety records in their periodic reports (10Qs and 10Ks for domestic issuers and 20Fs and 40Fs for foreign issuers). Section 1503(b) of the Act requires mine owners to file a current report on Form 8K within four business days of receiving an imminent danger order (IDO).[7] The requirement for 8K disclosure of IDOs reflects the fact that these orders are more serious than other types of citations.[8] While firms are required to include all of the 8K information in their periodic reports, the 8Ks serve as a timelier channel relative to the 10K and 10Q—however, the MSHA typically discloses the results of its inspections on its website within twenty-four hours, making it a timelier source than any financial report. In Appendix A, we provide a typical example of an MSD-related 8K and 10K filing and a screenshot from the MSHA website.

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[4] An assessment of Internet web traffic suggests that MSHA.gov is not a commonly visited website (it ranks #54,506 among all U.S. websites), even compared to other websites of similar governmental agencies (e.g., OSHA.gov ranks #25,687, DOL.gov ranks #16,027, CDC.gov ranks #3,139). See http://www.similarweb.com/website/msha.gov (accessed in November 2015) for details.

[5] The SEC estimates that MSD compliance costs are low because the information is available to issuers on the MSHA website by the time firms need to prepare their periodic reports (Release Nos. 33-9286; 34-66019; File No. S7-41-10).

[6] To verify that firms did not make similar mine-safety-related disclosures prior to Dodd-Frank, we conducted the search described in Appendix B for 2009, a year before the passage of Dodd-Frank, and found no evidence of any comprehensive disclosure of citations for violations of the Mine Act.

[7] The SEC does not require foreign private issuers to file 8Ks and hence they are not subject to this part of Dodd-Frank.

[8] Issuers must also file an 8K when a firm receives a written notice for a Pattern of Violations (POV). However, because POVs are relatively infrequent in practice (there is only one in our 8K sample), we refer to those events that trigger the filing of an 8K as IDOs.

Importantly, there is no materiality threshold for any of the required mine-safety disclosures under Dodd-Frank. Issuers must report safety records even if their omission is unlikely to influence the economic decisions of financial statement users. The departure from the general accounting convention of only requiring disclosure of material information likely reflects that the purpose of MSD is to improve mine safety rather than protect investors.

Table 1 provides descriptive statistics for the 151 issuers subject to MSD.[9] The average issuer subject to MSD owns about 24 mines. Relative to the average issuer in *Compustat*, MSD firms are slightly larger, with an average book value of total assets of $14B (the *Compustat* average is $12B). Mining is the most frequent primary industry sector of MSD issuers (33%), but disclosers also come from five (of nine) other industries—indicating that MSD applies to a broad range of industries, not just firms in the mining sector.[10]

3. Conceptual Framework

In this section, we discuss how the public dissemination of safety information can provide an incentive for managers to improve mine safety. One possibility is that the firm's dissemination of mine-safety records affects security prices. If the manager's utility function incorporates firm value, changes in securities prices could create a feedback effect that leads the manager of the firm to alter her resource allocation decisions. Mine safety information could affect securities prices through (at least) two channels—1) through its direct implications for cash flows, and/or 2) because some investors require higher returns for financing activities that conflict with their non-cash-flow-based preferences.

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[9] We include only firms that own mines in this sample (i.e., we exclude firms that work only as contractors). Contractors are not involved in operating the mine and therefore have less influence on the safety of the mine. See Appendix B for further details on how we identify issuers subject to Section 1503 of Dodd-Frank and announcements of IDOs on Form 8K.

[10] Berkshire Hathaway Inc. is an example of an issuer that is subject to Section 1503 of Dodd-Frank but does not have its primary activities in mining. Berkshire Hathaway Inc. is subject to the regulation due to its ownership of MidAmerican Energy, which owns 89.9% of Pacific Corp., which owns several mines.

Information on safety may be useful for investors in estimating firm value because safety violations can directly decrease cash flows through fines and shutdowns. For example, in 2011, the MSHA levied over $152 million in fines (MSHA 2012). Beyond any direct effects of fines or shutdowns, current information on mine safety is likely to be useful in assessing future safety performance, meaning MSD could lead investors to revise their expectations of future cash flows. One reason MSD might not change managers' incentives to invest in safety is that, even before MSD, investors would eventually observe the cash flow implications of firm safety (i.e., when cash flows are disclosed in the financial statements). However, if the horizon over which managers' seek to optimize firm value is shorter than that of investors, and MSD accelerates investors' discovery of safety issues, then MSD could affect managers' incentives by causing them to internalize the long-run cash flow implications of safety issues.

Information on safety could also affect firm value if a significant proportion of investors prefer owning firms with strong safety records for reasons independent of the cash flow implications of those safety records. If a firm conducts activities in opposition to a social norm that dictates investors' non-cash-flow-based preferences, revelation of this activity will likely decrease the demand of investors who dislike this activity, which in turn could affect the firm's stock price (Fama and French 2007). Friedman and Heinle (2015) build on Fama and French (2007) to model the asset pricing implications of corporate social responsibility (CSR), which, given the subject of MSD, is directly relevant in our setting. Their model predicts that, given a sufficient number of investors with non-cash-flow-based preferences, the market will price CSR disclosures.[11]

[11] Prior research provides several empirical examples of such non-cash-flow-based preferences and their effect on investment choice. Cohen (2009) shows that loyalty leads employees to overweight company stock in their portfolio allocations. Hong and Kacperczyk (2009) show that socially-conscious institutional investors avoid "sin" stocks (e.g., tobacco, alcohol, and gaming). Hong and Kostovetsky (2012) show that investors' values affect their

While the above arguments are fully consistent with a neoclassical framework, MSD could also affect safety through mechanisms other than firm value, such as increasing the reputational, or shaming, costs managers face from the public revelation that they operate a firm with poor safety conditions. For example, Dyck et al. (2008) examine the role of western media coverage in reforming corporate governance in Russia and find that increased coverage in the Anglo-American press increases the probability of reform. Dyck et al. (2008) find no effect when the Russian media covers the same governance violations and argue that this suggests shaming and the revelation of misbehavior to an audience likely to condemn the action as a likely mechanism. In the case of MSD, managers or directors could feel personally shamed by an increased public awareness of safety violations and try to improve safety performance to mitigate this sentiment.

Regardless of the mechanism through which the dissemination of safety information affects safety, what creates tension in our setting is that the content of the MSD disclosures is already publicly available through the MSHA's webpage. For MSD to affect managers' incentives to invest in safety, it must increase awareness of firms' mine safety records among some interested parties.

One potential reason why MSD could increase awareness is that the information on the MSHA website is costly to acquire and aggregate. For example, the mine owner in the MSHA database is often a subsidiary or joint venture partner whose connection to the parent, SEC-filing company, may be difficult to ascertain. In addition, prior to MSD, the complete list of mines

investment decisions. The home bias literature (e.g., French and Poterba, 1991; Karolyi and Stulz, 2003) shows that investors overweight their allocations of stocks from their own country. In each of the aforementioned studies, investor preferences appear to affect asset prices, presumably because some investors have disutility for financing activities of which they do not approve. This literature suggests that investor preferences for owning companies with strong records of employee safety could affect the price of stocks satisfying or violating this preference beyond any direct monetary effect of owning unsafe mines.

owned by an SEC filer was not readily available and would have required costly aggregation (and perhaps even direct communication with the firm) to compile.

An additional (non-mutually exclusive) possibility is that investors may simply be inattentive to, or unaware of, the MSHA disclosures (e.g., Merton 1987; Barber and Odean 2008). For example, Barber et al. (2005) show that attention-grabbing information, such as marketing and advertising, significantly affect the purchase decisions of mutual fund investors. Rogers et al. (2015) find causal evidence that dissemination affects stock prices. If investors are inattentive and do not use the MSHA website, then the dissemination of firms' safety records through financial reports could direct investors' attention to this information.

One reason to be skeptical that inattention and acquisition costs play a role in this setting is that sophisticated investors have considerable resources and are less likely to be constrained by cognitive processing limitations. Yet, even for sophisticated investors that are familiar with mines' safety records, as less sophisticated parties also become aware of safety violations, the costs of investing in a firm that owns a mine perceived to be unsafe may increase after MSD. For example, the increased awareness that an institutional investor owns a company with a poor safety record could lead to heightened public disapproval of their investment decisions—particularly if third parties, such as the news media, scrutinize the investor's portfolio holdings (as may be the case, for example, with university endowments, public pensions, or mutual funds). This opposition could manifest through not contributing to the fund (or institutions that own it) or by fomenting protests against the investment in unsafe mines. Lower costs of becoming aware of investments in firms with poor safety records could also reduce the ability of fund managers to plausibly deny their awareness of unsafe work conditions, heightening the risks of ownership.

The dissemination of firms' mine-safety records through financial reports could decrease information acquisition costs and increase awareness in several ways. SEC-required disclosures on Forms 8K, 10Q, and 10K are effectively the billboards of the financial community. Because financial reports are so widely disseminated and have such low incremental acquisition costs, after MSD, investors, financial analysts, and the news media that follow SEC filings are more likely to become aware of violations of the Mine Act—even if they are not explicitly looking for them. The information presented is also more comparable across firms and aggregates mine-level data to the operator level so that affiliation with the owners is more transparent. In addition, by including safety disclosures in firms' periodic financial reports, MSD effectively forces top management to sign off on their safety records quarterly when they certify their financial reports. This process could direct management's attention toward safety performance and how their own firm compares to its peers.

Ultimately, whether the mandatory dissemination of non-financial information in financial reports has real effects, or is altogether irrelevant, is an empirical question. Our goal in this paper is to assess the existence and magnitude of any such effects.

4. Empirical Evidence

We organize our empirical analyses as follows: first, we investigate the real effects of MSD by examining changes in safety citations, mining-related injuries, and productivity for mines subject to MSD relative to those that are not. We then explore the impact of MSD on capital markets as a potential mechanism for any observed real effects.

4.1 Implications of MSD for mine safety

In this section, we assess the effect of MSD on the incidence rates of citations for violations of the Mine Act and mining-related injuries. Our empirical strategy relies on the institutional fact that only SEC-registered firms are subject to Dodd-Frank and, hence, only mines owned by SEC-registered firms have their safety records included in financial reports. We use a standard difference-in-differences framework where non-MSD mines (owned by non-SEC-registered firms) are the control group. Our baseline model, suppressing year and mine subscripts, is:

$$Citations\ or\ Injuries = \beta_0 + \beta_1 MSD + \sum \beta_i Fixed\ Effects + \varepsilon \tag{1}$$

The dependent variable is either the incidence rate of citations per inspection hour (*Citations*) or injuries per 200,000 hours worked (*Injuries*). *MSD*, the variable of interest, is an indicator coded as one after a mine's safety information is included in a financial report. We include year fixed effects to control for changes over time in safety technology and regulations other than Dodd-Frank, which likely affect both MSD mines and non-MSD mines equally. We include mine fixed effects to control for differences in production technologies and other static factors among mines. The mine fixed effects control for all sources of time invariant risk at each mine, including the generally higher risk levels in coal mines relative to non-coal mines (Gowrisankaran et al. 2015). In this specification, we identify the effect of MSD from changes in incidence rates around the entry-into-force date of Dodd-Frank for MSD mines relative to non-MSD mines. We estimate block-bootstrapped standard errors at the mine-owner level.

We first estimate the baseline model using a standard OLS regression, where we measure incidence rates over both one- and two-year periods. Although measuring incidence rates over one year is consistent with the length of the 10K reporting period, it is a relatively short interval over which to measure infrequent outcomes such as citations and injuries. To mitigate this concern, we also estimate the regression using incidence rates measured over two years. Yet, even when measured over two-years, the infrequency of citations and injuries still results in a high density of observations at zero. An OLS regression will not sufficiently account for this concentration of observations, which could lead to biased estimates of the treatment effect (e.g., Wooldridge 2002). To address this issue, we also run the baseline specification using a Poisson regression.[12]

The Poisson probability distribution captures the infrequent and discrete nature of citations and injuries and is widely used to model similar events (e.g., Rose 1990; Li et al. 2012). In the Poisson specification, the dependent variable is the count of citations or injuries. We use inspection and work hours as exposure variables—meaning the interpretation of the estimated coefficient on *MSD* is comparable to the OLS specification.[13] We report average treatment effects for both the OLS and Poisson regressions where incidence rates are measured over one- and two-year periods, but, because it conceptually best addresses low incidence rates, our preferred specification is the Poisson regression with incidence rates measured over two-years.

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[12] Although the Poisson model has the advantage that it explicitly captures the infrequent and discrete nature of citations and injuries, Poisson regression also has some limitations, including: 1) it assumes that the conditional mean equals the conditional variance of the distribution (violations of this assumption are known as over-dispersion), and 2) it assumes the independence of incidents over time. Regarding the first concern, we follow Rose (1990) and Hausman (1984) to test whether over-dispersion is a problem. We base the test for over-dispersion on a regression of the log of the estimated variance of the residuals for each mine (σ^2) on the log of the conditional mean for each mine: $(\lambda) : \log(\sigma^2) = \beta_0 + \beta_1 \log(\lambda)$. As we find that the magnitude of β_1 is close to one, there is no indication that overdispersion is a problem in our specification. Regarding the second concern, the independence of events over time, we augment the baseline Poisson models by including the lagged dependent variable in the regression and find that it has no effect on the *MSD* coefficient in any of our primary analyses. Another issue is that the Poisson regression is estimated using maximum likelihood, which requires a relatively large number of observations to achieve consistent estimates (i.e., the incidental parameters problem). Because our regression model includes mine fixed effects and only twelve years of data over which to estimate these effects in the annual analysis (six periods for the two-year analysis) this is a potential concern. We assess the magnitude of the bias this issue creates using a jackknife procedure (dropping each period in turn) and find that the bias is less than 5%.

[13] In count models, such as Poisson, the fact that counts can be made over different exposure periods (e.g., the number of mine hours worked) is accounted for by including the log of the exposure period variable on the right hand side of the model with the coefficient constrained to be one. One potential concern with scaling by the number of inspection hours in the citation analysis, or in the case of the Poisson specification, including inspection hours as an exposure variable, is the possibility that changes in inspection hours for disclosed relative to non-MSD mines could drive the observed decline in citations. To mitigate this concern, first, we alternatively include the log of inspection hours as a control variable (with an unconstrained coefficient) rather than scaling by inspection hours (or including inspection hours as the exposure variable) and find very similar results. Second, we alternatively scale by (or include as an exposure variable) mine hours worked, rather than inspection hours, and find very similar results.

We obtain mine-level data from the *U.S. Department of Labor MSHA Open Government Data* website. The website compiles an array of datasets that provide information concerning health and safety for mining operations located in the U.S. We use the *Inspection*, *Violation*, and *Accident/Injuries* databases. We obtain data on mine hours worked from the *CDC Address/Employment (AE)* database. We restrict our analyses to active mines. Following prior research (e.g., Gowrisankaran et al. 2015), we further restrict the analyses of injuries to mine-years with at least five full-time employees (i.e., more than 10,000 hours worked) to reduce the influence of very small mines. In both sets of analyses, our sample includes observations from 2002 to 2013. In the OLS regressions, we truncate the top 1% of incident rates. We do not truncate the incidence rates in the Poisson regression because this specification is essentially a log-linear model, which can effectively deal with outliers without truncation.[14]

We determine which mines in the MSHA databases are disclosed in financial reports (and therefore are in our treatment sample) through a comprehensive search of all relevant filings in the SEC's *Edgar* database. We provide a detailed description of this data collection procedure in Appendix B. Our control sample consists of all non-MSD mines available in the MSHA databases (i.e., those not identified as MSD mines through the *Edgar* search).

4.1.1 Implications of MSD for compliance with the Mine Act

In this section, we present results for our analysis of the effect of MSD on citations for violations of the Mine Act. We define the incidence rate for citations as the number of citations per inspection hour (or, in sensitivity tests, hours worked). We condition on inspection hours because violations of the Mine Act are unobservable unless the mine receives a citation, which depends on having an inspection. In cross-sectional tests, we also separate citations into severe

[14] In the Poisson regression, truncation could serve as a way to address over-dispersion (Saffari et al., 2011). In untabulated analyses, we repeat our baseline Poisson specifications using the same 1% truncation and find similar results (see also footnote #12).

and not-severe citations. We define *Severe Citations*, for both MSD mines and non-MSD mines, as those citations classified by the MSHA as "S&S" (severe and significant) violations. We define all other citations as *Not-Severe Citations*. MSD does not require firms to disclose non-S&S citations.

Table 2 Panel A provides descriptive statistics for the variables used in the citation analysis. After excluding inactive mines and truncating the top 1% of citations per inspection hour, the dataset contains 2,726 MSD mines and 23,533 non-MSD mines. The incidence rate of citations is similar across both types of mines. For MSD (non-MSD) mines, on average, one inspection hour results in 0.08 (0.10) citations and approximately one quarter of these are *Severe Citations*. Minimum, median, and maximum values are also similar. Overall, the descriptive statistics indicate that MSD mines and non-MSD mines are similar in terms of the citations they receive before conditioning on MSD.[15]

We present results for the estimated average effect of MSD on the incidence of citations in Table 3. In Columns (1) and (3), we estimate the baseline specification using OLS measuring *Citations* over one- and two-year periods, respectively. In both specifications, the coefficient on *MSD* is negative and significant (-0.011 and -0.009, respectively). The estimated coefficients imply a reduction in *Citations* of between 11% and 13%.[16] In Table 3 Columns (2) and (4), we estimate the baseline specification using Poisson regressions over one- and two-year periods, respectively.[17] For both specifications, the coefficient on *MSD* is negative and significant (-0.112 and -0.113, respectively) and the estimated magnitudes imply a reduction in *Citations* of 11%.

[15] We provide further evidence on covariate balance between MSD and non-MSD mines in connection with the matching analysis in Appendix C.

[16] To calculate the economic magnitude of the estimated effect we compare the coefficient on *MSD* to the mean incidence rate of citations for MSD mines prior to MSD.

[17] The number of observations differs in the Poisson specifications because Poisson estimation eliminates observations which have zero outcomes across the entire sample period.

Overall, the estimates for the average effect of MSD in Table 3 are consistent across specifications and indicate a significant reduction in the incidence of citations for MSD mines relative to non-MSD mines subsequent to Dodd-Frank.

An important caveat makes it difficult to unambiguously interpret the results from the citation analysis—it is not clear whether the observed reduction in citations is attributable to increased compliance with the Mine Act or changes in MSHA enforcement. Our objective is to assess whether MSD improves compliance. Ideally, we would examine actual violations of the Mine Act, rather than citations for violations. However, violations do not result in citations when they go undetected or when inspectors use the discretion available to them in the Mine Act to exercise forbearance. Jin and Leslie (2003) find that restaurant hygiene inspectors are more likely to assess hygiene scores just above the thresholds for hygiene grades after they know the grades will be disclosed to potential customers. In our setting, inspectors might consider the consequences of citing a mine for a violation before they write the citation and, because they know that the consequences are greater subsequent to MSD (i.e., a severe citation must be included in the firm's financial reports), might reduce the severity of citations to MSD mines (but not to non-MSD mines). Managers may also recognize the consequences of wider dissemination and, subsequent to MSD, spend more resources persuading inspectors to downgrade citations before they issue them (e.g., through arguments or bribes).

Table 4 Columns (1) and (2) report results separately for *Severe Citations*, which for mines subject to MSD are disseminated, and *Not-Severe Citations*, which are not disseminated. If inspectors downgrade (ignore S&S) citations in response to the MSD regime, we would expect a positive (or insignificant) coefficient on *MSD* for *Not-Severe Citations*.[18] However, we find a

[18] Alternatively, the inspector may disregard all types of violations—our analysis assumes that inspectors face costs if they ignore violations and hence will prefer to downgrade severe citations or ignore only severe citations.

negative and statistically significant coefficient on *MSD* for both *Severe* and *Not-Severe Citations*, which is consistent with MSD increasing compliance with the Mine Act. It is difficult to explain why there would be a reduction in *Not-Severe Citations* if the overall reduction in citations were attributable to inspectors downgrading severe violations to not-severe violations. Put differently, it is not clear why inspectors would have an incentive to change their behavior for citations that are not disseminated.[19]

Overall, the evidence in this section indicates that compliance with the Mine Act increased in response to MSD. However, because it is not obvious that compliance with the Mine Act will have an impact on safety (e.g., Ruffennach 2002), it is difficult to interpret these findings as providing sufficient evidence to conclude that safety has improved. For this reason, in the next section, we examine the effect of MSD on injury rates.

4.1.2 Implications of MSD for injury rates

In this section, we present results for our analysis of the effect of MSD on injury rates. MSD focuses on the dissemination of Mine Act compliance records. Yet, a reduction in injury rates was clearly the ultimate policy objective (e.g., Rockefeller IV 2010).

Following mine-industry standards, we define the injury rate as the number of injuries per 200,000 employee hours worked. We include injuries that lead to an absence of at least one week, permanent disability, or a fatality. We exclude minor injuries to mitigate any effects of injury reporting bias.[20] Table 2 Panel B provides descriptive statistics for the variables used in this analysis. After excluding mine-year observations with less than 10,000 hours worked and

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[19] We do find a stronger effect for *Severe Citations* (although it is not significantly different from the coefficient on *Not-Severe Citations*), which could suggest that inspectors change their citation behavior to some extent, yet the magnitude of the shift is not sufficient to completely account for the observed change in citations.

[20] Reporting bias in injuries can occur if workers are compensated for their safety performance and for that reason choose not to report minor injuries (National Research Council 1982). Injuries that lead to at least a one week absence, permanent disability, or a fatality are unlikely to go unreported (Morantz 2013). Moreover, the penalties for misreporting or failing to report an injury are severe (including up to five years in prison), which further suggests that reporting bias is unlikely a concern for serious accidents (see http://www.msha.gov/forms/70001).

truncating the top 1% of injury rates, the dataset contains 2,168 MSD mines and 8,321 non-MSD mines. The injury rates are similar across MSD mines and non-MSD mines—there are on average 1.45 and 1.34 injuries per 200,000 hours worked, respectively. Reflecting these low incidence rates, the median injury rate is zero for both MSD mines and non-MSD mines.

Table 5 reports results for the baseline specification, where we estimate the average effect of MSD on injury rates. In Columns (1) and (3), we estimate OLS regressions measuring injury rates over one- and two-year periods, respectively. The coefficient on MSD is negative and significant in both specifications (-0.196 and -0.231, respectively). The estimated coefficients imply a reduction in injury rates for MSD mines of between 12% and 16% subsequent to MSD.[21] In Table 5 Columns (2) and (4), we estimate Poisson regressions measuring injury rates over one- and two-year periods, respectively. The coefficients on *MSD* are also negative and significant for both specifications. The coefficients of -0.130 (in both specifications) imply a 13% reduction in the incidence rate of injuries for MSD mines subsequent to MSD. Overall, the estimates for the average effect of MSD are consistent across specifications and indicate that the regulation reduced injury rates by between 12% and 16%. The estimated reduction in injury rates are close to the 11% reduction we estimate for citations in Section 4.1.1 and are consistent with substantial safety improvements.

4.2 Implications of MSD for productivity

In this section, we investigate whether a reduction in citations and injuries imposes a measurable cost on firms in terms of lower labor productivity.[22] Gowrisankaran et al. (2015)

[21] To calculate the economic magnitude we compare the estimated coefficient on *MSD* to the mean injury rate for MSD mines in the pre-MSD period.

[22] There are other ways firms could improve safety that would not necessarily affect productivity. For example, firms could elect to close their most dangerous mines in response to MSD. In an untabulated analysis, we find that the likelihood of closing a mine that is in the top decile of the injury distribution increases in the post-MSD period by 4% for MSD relative to non-MSD mines.

posit that mines produce a joint output of safety and mineral production, which suggests that an increase in safety could lead to lower mineral production per hour worked. However, if the joint production function between safety and output is not reflective of all the tradeoffs mines face, then changes in productivity may not fully capture the costs that firms incur. For example, firms may choose to invest more heavily in safety-related R&D after MSD. This will likely increase safety, but not necessarily at the expense of labor productivity. Additionally, if miners are trading safety for leisure, rather than productivity, then a stronger managerial emphasis on safety protocol could improve safety without reducing productivity (this emphasis could occur, for example, through compensation contracts).

To empirically assess whether MSD affects labor productivity, we estimate an OLS difference-in-differences specification similar to Eq. (1) using the natural log of tons of coal mined per mine hour worked (*Labor Productivity*) as the dependent variable. Again, we include year and mine fixed effects. We obtain data on coal-mine production from the CDC's *AE* database. One important difference in this analysis is that, because of data availability constraints, we are able to observe productivity only for coal mines over a shorter sample period (starting in 2006).

Table 2 Panel C presents descriptive statistics for *Productivity*. Average productivity for MSD mines relative to non-MSD mines is similar at 4.1 and 3.2 tons of coal per hour, respectively. Table 6 presents results for our analysis of the effect of MSD on productivity. Results suggest that, following the adoption of MSD, labor productivity decreased by 7.1 percent for MSD mines relative to non-MSD mines, which translates into an increase in labor costs of approximately 0.9 percent of revenues.[23] The observed reduction in labor productivity is consistent with an increased focus on safety and highlights one potential cost of MSD.

4.3 Assessing identification assumptions

The key assumption underlying our identification strategy is that MSD mines and non-MSD mines would have had similar trends in citations, injuries, and productivity absent MSD (i.e., the parallel trends assumption). The inclusion of mine-level fixed effects in our analyses preclude any time invariant differences across mines from affecting our results, but several potential concerns remain: 1) the outcome variables for MSD mines and non-MSD mines could have different trends for reasons unrelated to MSD; 2) MSD regulation is a response to the Upper Big Branch disaster that also raised public scrutiny of mine safety, which could affect public and private firms differentially; 3) public and private firms could respond differently to contemporaneous macroeconomic conditions. We conduct several additional analyses to address each of these three concerns.

First, we examine differences in the pre-regulation trends in our outcome variables between MSD mines and non-MSD mines by mapping out the counterfactual treatment effect over our sample period. To map out the effect, using our preferred specification, we replace the single *MSD* variable with separate interactions between the MSD-mine indicator and indicators for each of the two-year sample periods, except for the two-year period immediately before MSD takes effect (i.e., 2008-2009 is the benchmark period). We graphically depict these results in Figure 1 Panels A, B, and C. In all three panels, the counter-factual treatment effects in the pre-

[23] Based on assumptions of an hourly wage of $25 and an average coal price of $50 per ton the average labor cost as a proportion of revenue is 12.5% [$25 per labor hour ÷ (4 tons per hour×$50 per ton)]. To approximate the increase in labor cost relative to revenue, we multiply the reduction in productivity (7.1%) by the average labor costs as a proportion of revenue (12.5%).

regulation periods are small and statistically indistinguishable from the benchmark period, which provides support for the parallel-trends assumption.

Next, we address the concern that other factors arising in response to the Upper Big Branch disaster, such as public outrage, represent an alternative explanation for our results. This is only a concern in our empirical design if these factors differentially affect MSD and non-MSD mines—this is a possibility because of the differences in their owners (public and private firms, respectively). To assess this concern we look at responses to the MINER Act, another regulatory event that we show below shares many similarities with MSD. The MINER Act, which was adopted in July 2006 shortly following the Sago Mine disaster, applies equally to all U.S. mines regardless of whether they are owned by public or private firms (i.e., it pertains to both our treatment and control mines).

In Figure 2, we plot two proxies for public attention to mine safety, the total number of U.S. newspaper articles and Google searches referencing mine safety (both indexed at 100 at the time of the Sago Mine disaster on January 2, 2006, which has the highest value for both proxies). For both proxies, sharp spikes in attention are evident around the mining disasters preceding the MINER Act and MSD (i.e., the Sago and Upper Big Branch Mine disasters, respectively). To the extent the two proxies capture the unobservables that led to regulation (e.g., public outrage), the graph suggests that MSD and the MINER Act are similar with respect to these unobservables. Hence, we can use the MINER Act to assess whether MSD mines and non-MSD mines react similarly to the unobservables that preceded MSD. In each graph where we map out the counterfactual treatment effect (i.e., Figure 1 Panels A, B, and C), we also indicate the timing of the adoption of the MINER Act. We find no evidence of a differential response to the MINER

Act, which suggests that MSD mines and non-MSD mines respond similarly to the unobservables that precede regulation.

Next, we address the concern that public (MSD-filing) and private (non-MSD-filing) firms respond differently to changes in macroeconomic conditions around the time of the adoption of Dodd-Frank. Given their access to the public capital markets, public firms might respond differently to shocks in the debt and equity markets. Figure 3 presents the trend in equity and credit market conditions over our sample period from 2002 to 2013. The graphs show that, while there are multiple shocks to both variables over our sample period, the patterns of these shocks look nothing like the estimated counterfactual treatment effects for citations, injuries, or productivity (see Figure 1). Figure 1 does reveal a significant deterioration in credit conditions in 2008-2009. One potential concern this raises is that, because they are less able to access equity financing, financing constraints lead privately-owned mines to differentially reduce their investment in safety.

We conduct two additional (untabulated) analyses to address this concern. First, we find that the observed decline in citations and injuries for MSD relative to non-MSD mines is not driven solely by a decrease in safety investment by non-MSD mines (i.e., the majority of the effect comes from an increase in safety for MSD mines). Second, for MSD-mines, we partition the sample based on the extent of financing constraints a firm faces using both the mean and median values of the Rajan and Zingales (1998) measure of financing constraints. We find no evidence of economically or statistically significant cross-sectional variation in the effect of MSD on citations or injuries based on the extent of financing constraints. Overall, these analyses suggest that, although macroeconomic conditions may well affect mine safety, they do not appear to differentially affect SEC-registrants' and non-SEC-registrants' safety investments over our sample period.

An alternative way to address the non-random assignment to the treatment group in our sample is to match on observable mine characteristics. This approach directly addresses selection on observables, and, to the extent observable and unobservable mine characteristics are related, provides a way to gauge the magnitude of any potential selection effect (Altonji et al. 2005). In Appendix C, we compare observable characteristics in our sample of MSD mines and non-MSD mines and find that they differ along two dimensions, mine size (based on hours worked) and mine type (coal versus non-coal and surface versus underground). We match on these two characteristics and find that matching has little effect on the estimated treatment effect (see Appendix C). This suggests that, to affect our inferences, any potential selection on unobservable mine characteristics would have to have little correlation with size and mine type (which seems unlikely) or be large in magnitude to fully explain the estimated treatment effect.

Finally, a potential concern with our results is that the observed improvement in safety could be attributable to public firms selling their most citation- and accident-prone mines to private firms. In an untabulated analysis, we find descriptive evidence that public firms do not sell their most dangerous mines (defined as mines in the top decile of the citation distribution) to private firms at a higher frequency in the post-MSD period. Empirically, changes in mine ownership, in our sample, are infrequent.

4.4 MSD and feedback effects from the capital markets

Our objective in this paper is to examine the real effects of disseminating non-financial information through financial reports. However, it is also important to understand the mechanisms through which MSD affects mine safety. Investor responses in the capital markets could create a feedback effect where firms' dissemination of information affects their allocation of resources to safety (Kanodia and Sapra, 2016; Leuz and Wysocki, 2016). If the awareness of poor safety performance reduces investor demand for the firm's securities (and correspondingly firm value) and managers' utility functions incorporate this decline in value, then the dissemination of safety information will give managers an incentive to undertake real actions to improve their safety records. We assess the capital-market effects of MSD by examining both short-window stock returns and changes in mutual fund ownership following MSD-8K filings.

4.4.1 Market reactions to announcements of mine-safety violations

We conduct our market reaction tests using a standard event study methodology and compute the average (and median) cumulative abnormal return (*CAR*) in the two-day window beginning on the filing date of the 8K on the SEC's Edgar website.[24] We collect a comprehensive list of all 8K filings from the SEC's *Edgar* database, which consists of 206 unique 8K filings (as described in Appendix B). As indicated in Table 1, 8K filings are relatively infrequent—with an average of only 1.35 per firm over the four-year period from 2010 to 2014. While approximately 75% of issuers subject to the regulation do not release any 8Ks (114 out of 151), a smaller number of firms file 8Ks frequently (e.g., the maximum is 35).[25] We use stock price data from the *Center for Research in Security Prices* (*CRSP*) and market-adjust the returns by subtracting the corresponding two-day return on the *CRSP* equal-weighted index.[26] We exclude from our analysis any 8K filings that overlap (on day *t* or day *t+1*) with firms' *Compustat* earnings announcement dates. To control for extreme returns (which are less likely to

[24] We use a two-day return window, which includes the filing date and the subsequent trading day, because some filings occur after regular trading hours.
[25] One firm in our sample (Alpha Natural Resources) has more than twice as many 8K filings (35) as the next most frequently filing firm. To reduce the influence of this firm, we eliminate 8Ks for this firm that exceed the number received for any other firm (i.e., Alpha Natural Resources 17^{th}-35^{th} 8K filings).
[26] Results are very similar if we instead market-adjust using the *CRSP* value-weighted return index or the S&P 500 index return.

be driven by the 8K filings), we truncate returns at the top and bottom 1%.[27] We present the results for this analysis in Table 7 Panel A. As indicated in Column (1) (Column (2)), the average (median) two-day *CAR* following the 8K release is -0.41% (-0.20%) and is significant at the 10% level.

Next, in Table 7 Panel B, we examine the event-window returns based on whether the mine mentioned in the MSD-8K is a coal or non-coal mine.[28] As noted by Gowrisankaran et al. (2015), coal mining is primarily conducted underground and is likely to be more dangerous than other types of mining. Moreover, given that coal mines are likely to be susceptible to high-fatality disasters that attract significant media attention (e.g., the Upper Big Branch explosion), we expect that the mine safety records of coal mines receive more scrutiny than those of other types of mines. For these reasons, we expect the market reactions to 8K filings to be larger for coal mines than non-coal mines. Consistent with this prediction, in Column (1) (Column (3)), we find that the average (median) two-day *CAR* following the 8K filings for coal mines is -0.77% (-0.70%) and is significant at the 5% level (1% level). On the contrary, in Column (2) (Column (4)), the average (median) two-day *CAR* following the 8K filing for non-coal mines is -0.14% (-0.13%) and is not statistically different from zero. The difference in medians between coal and non-coal mines is statistically significant at the 10% level.[29]

If MSD increases investors' awareness of potential mine-safety issues of which they were not previously aware, then we expect the largest revision in firm value to occur following the first MSD-8K release. For firms that file multiple MSD-8Ks, we investigate the magnitude of the

[27] Throughout the price reaction analyses, our inferences are consistent if we do not truncate returns.

[28] We determine whether a particular 8K filing pertains to a coal or non-coal mine by obtaining the name of the mine directly from the 8K itself and matching that name to the mine's MSHA Id in the MSHA database. Because we are unable to successfully match all mines from the 8K filings (in some instances the name of the violating mine is not disclosed), the sample size for this analysis is smaller than for the analysis in Table 7 Panel A.

[29] Consistent with these results, in untabulated analyses, we find that the magnitude of the decline in the incidence rates for citations and injuries following MSD is also larger for (but not limited to) coal mines.

price reaction for the first 8K filing compared to all subsequent 8K filings. Table 8 Panel A presents results for this analysis. Column (1) shows that the average (median) market reaction to a firm's first 8K release is -2.02% (-1.80%). The average (median) response for all subsequent 8Ks is -0.55% (-0.54%). For both mean and median returns, the market reaction to the first 8K is significantly different from that of subsequent 8Ks at the 10% level.[30]

To assess whether the documented decline in firm value is unique to MSD, or whether similar declines occur when the MSHA posts IDOs on their website, we examine the response to the disclosure of an IDO in the pre- and post-MSD periods. In the pre-MSD period, IDOs are disclosed only on the MSHA's webpage. In the post-MSD period, the MSHA posts IDOs on their website and firms disseminate them through an 8K release. If the MSD-8K disclosures increase investor awareness of mine-safety issues, we expect to observe a larger response to IDOs issued in the post-MSD period. To insure that the window contains both the IDO posting on the MSHA's website and the 8K release in the post-MSD period, we calculate CARs over a five-trading-day window following the issue date of the IDO. Our sample of pre-MSD website IDOs consists of 551 unique postings and an average of 3.65 per firm over our sample period.

Table 8 Panel B reports results for this analysis. In the pre-MSD period, the five-day mean and median CARs following an IDO posting are close to, and not statistically different from, zero. In the post-MSD period, consistent with an increase in investor awareness, the average (median) five-day CAR is -0.70% (-0.81%) and is significantly different from zero at the

[30] Comparing the responses to MSD-8K filings across mining-industry and non-mining-industry firms is another potential way to assess whether MSD increases investor awareness (see Table 1 for details on the industry composition of our sample). Investors in a firm whose core business is not mining (e.g., Berkshire Hathaway) might be less aware that the firm owns a mine(s) and for this reason react more strongly to the announcement of a safety violation. Alternatively, the implications of a safety violation could be greater for firms whose core business is mining. We find that market reactions are generally stronger for firms in the mining industry (untabulated).

10% (5%) level. The difference in the mean (median) pre- and post-period market reactions of 0.83% (1.15%) is statistically significant at the 10% (5%) level.[31]

4.4.2 Changes in mutual fund ownership around the announcement of mine-safety violations

As an alternative approach to assessing the plausibility of feedback from the capital markets as a mechanism for the observed real effects, we examine whether investors likely to be sensitive to workplace safety issues alter their ownership positions in response to the disclosure (and/or dissemination) of negative information about firm safety. Because mutual funds' holdings are publicly observable, and thus subject to greater scrutiny than the holdings of other types of investors (e.g., individuals or hedge funds), they are likely more sensitive to safety issues (e.g., Hong and Kacperczyk 2009). Accordingly, we expect the release of negative information about a firm's safety record (through an MSHA website disclosure of an IDO and/or the dissemination of the IDO through an 8K filing) to decrease mutual fund investors' demand for the stocks of firms that own mines with safety issues. Among mutual funds, in recent years, there has been an increase in the number of funds dedicated to "socially responsible investing" (SRI) (Hong and Kostovetsky 2012). Many of these funds avoid (or underweight relative to the market portfolio) investments in firms that engage in socially sensitive activities such as alcohol, gaming, defense, or offer poor working conditions. We expect the demand of SRI mutual funds to be more sensitive to the disclosure and dissemination of IDOs than other types of funds.

Using the *Thomson Reuters Mutual Funds* database, we identify mutual fund holdings for 111 of the 151 firms subject to MSD for the period from 2002-2013. The average firm has mutual fund ownership of approximately 31% of shares outstanding. Following Hong and Kostovetsky (2012), we classify mutual funds' SRI status based on their inclusion in an index

[31] One limitation of this analysis is that it cannot speak to whether, in the pre-MSD period, investors react to mine-safety disclosures over longer windows (i.e., more than five days). However, in an analysis over a longer window, it would be difficult to separate the effect of the mine-safety disclosures from other events.

maintained by *The Forum for Sustainable and Responsible Investment* (*USSIF*).[32] From this list, we are able to identify 46 SRI funds that own shares in at least one of the firms subject to MSD. The average firm has total SRI ownership (across all SRI funds) of approximately 0.3% of shares outstanding. While the small number of funds that identify as SRI leads to a relatively small average total SRI ownership, the average individual SRI fund's position is comparable to that of other types of mutual funds (0.034% versus 0.041% of shares outstanding, respectively).

We assess mutual fund sensitivity to mine safety by examining each fund's percentage change in holdings from the end of the quarter prior to the announcement of an IDO to the end of the subsequent quarter by estimating the following OLS regression at the fund-firm and year-quarter level (suppressing fund-firm and year-quarter subscripts):

$$\begin{aligned}\%\Delta Holdings \ &= \beta_0 + \beta_1 IDO \ + \beta_2 MSD \times IDO + \beta_3 SRI \times IDO + \beta_4 MSD \times SRI \times IDO \\ &+ \sum \beta_i Fixed \ Effects + \varepsilon\end{aligned} \quad (2)$$

$\%\Delta Holdings$ is the percentage change in holdings for fund i in firm j from $quarter_{t-1}$ to $quarter_{t+1}$. *IDO* is an indicator coded as one if a firm receives an IDO in a given $quarter_t$. *MSD* is an indicator coded as one if an IDO is disclosed on both the MSHA's website and disseminated through an 8K (i.e., in the post-Dodd-Frank period). *SRI* is an indicator coded as one if a fund identifies as socially responsible. We include year-quarter fixed effects to control for any potential trends in ownership and allow these coefficients to vary across SRI and non-SRI investors. We include mutual fund fixed effects to control for differences in trading behavior and investment preferences across funds. We trim the top 1% of $\%\Delta Holdings$ to control for outliers and cluster standard errors at the fund level. In this specification, we identify the effect of MSD from changes in mutual fund holdings around the entry-into-force date of Dodd-Frank for IDO quarters relative to non-IDO quarters and for SRI relative to non-SRI funds.

[32] This index is available online at http://charts.ussif.org/mfpc/. We accessed this data in August 2015.

We present the results of estimating Eq. (2) in Table 9. Consistent with a decline in mutual fund demand following poor firm safety performance, the coefficient of -0.007 on *IDO* indicates that, on average, mutual funds decrease their ownership stakes by 0.7% more in quarters when the MSHA discloses an IDO on its website relative to those quarters when it does not. The coefficient of -0.009 on *MSD*×*IDO* indicates that this sensitivity to safety issues more than doubles when the IDO is also disseminated through an 8K.

Looking at the incremental sensitivity of SRI funds to IDO releases, the coefficient on *SRI*×*IDO* of -0.045 suggests that SRI funds respond more to safety issues than other types of mutual funds. In the post-MSD period, the coefficient on *MSD*×*SRI*×*IDO* of -0.112 indicates that the incremental sensitivity of SRI funds to safety further increases when the IDO is also disseminated through an 8K. Despite the relatively large economic magnitude of these effects, neither of these coefficients is statistically different from zero, which likely reflects the small number of SRI fund-firm observations. However, the total incremental sensitivity of SRI funds in the post period (*SRI*×*IDO* + *MSD*×*SRI*×*IDO*) of -0.157 is statistically significant (p-value 0.057), and suggests that SRI mutual funds decrease their ownership stakes by 15.7% more than non-SRI mutual funds in quarters when an MSD-8K is filed. Although the documented magnitudes of these ownership changes are likely too small to fully explain the equity returns around MSD-related 8K announcements documented in Section 4.4.1, these findings indicate that those investors expected to be most sensitive to safety issues respond more to these issues after MSD.

Overall, the evidence on market reactions and mutual fund holdings suggests a decrease in investor demand for firms with poor safety records is one potential mechanism through which MSD could create an incentive for managers to increase mine safety. Further, our results suggest that the dissemination of mine-safety information through financial reports increases (at least some interested parties') awareness of mine-safety-related issues.

5. Conclusion

Increasingly, policy makers are using securities regulation to address issues beyond the SEC's core mission of protecting investors and maintaining the fair and efficient functioning of financial markets. The idea is that, once they remove the frictions that prevent information discovery, market forces can be an effective means of reducing socially undesirable behaviors. Sections 1502 and 1503 of the Dodd-Frank Act, which require financial statement disclosures of non-financial information regarding purchases of war minerals and mine safety performance, are cases in point. The objectives of these policies are noble—more than ten million people have died in Africa's Great War and every year hundreds of workers are injured or killed in U.S. mines. Yet, it is unclear whether such regulation has the power to affect wars or improve mine safety. If disseminating non-financial information through financial reports has real effects, then policy-makers could use securities regulation to address a broad set of policy issues. If not, then regulators and issuers are wasting resources on drafting and complying with such regulation.

We examine the effectiveness of these policies in the context of mandatory dissemination of mine-safety records in SEC-registered firms' financial reports. Most, if not all, of the information included in these disclosures is publicly available on the MSHA's website—this feature of the setting allows us to examine the incremental effects of disseminating this information through financial reports. Comparing mines owned by SEC-registered issuers to those mines that are not, we document that dissemination through financial statements is associated with an approximately 11 percent decrease in mining-related citations and a 13 percent decrease in injuries. We also find that the increased investment in safety leads to a decline in labor productivity, which suggests a tradeoff between safety and productivity. We show feedback effects from the capital markets are one potential mechanism through which safety information disseminated through financial reports could alter managers' decisions and have real effects. Overall, our results suggest that there are real effects of disclosing non-financial information in financial reports—even if this information is publicly available elsewhere.

It is important to note that our results are subject to some limitations. First, we cannot establish whether MSD is a socially efficient policy because we have no objective way to tradeoff its benefits (increased safety) and costs (lower productivity). Second, our results speak only to the incremental effects of disseminating non-financial information through financial reports—we cannot say what the effects of disseminating such information through other channels might be (e.g., a billboard or public service announcement). Third, although we are able to provide some evidence that feedback effects from the capital markets are a plausible mechanism for the observed real effects, we are unable to assess the importance of other mechanisms (e.g., managerial reputation). Fourth, we estimate treatment effects on the treated firms. Since the real effects of dissemination we document are likely to be (at least in part) driven by feedback effects from equity markets, our findings may not generalize to other settings (e.g., private firms).

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Appendix A: Dodd-Frank Sections 1503(a) and (b) Disclosure Requirements

Section 1503(a) of the Dodd-Frank Act describes the information that must be disclosed in periodic reports (on Forms 10Q and 10K), and includes the following: (i) violations of the Mine Act that are significant and substantial (S&S);[33] (ii) the total dollar value of proposed-penalty assessments from the MSHA under the Mine Act; (iii) the number of mining-related fatalities; (iv) pending as well as resolved legal actions before the Federal Mine Safety and Health Review Commission (FMSHRC), an independent adjudicative agency for disputes under the Mine Act; and, (v) the number of certain orders and citations that require (or may in the future require) the mine operator to immediately withdraw all personnel from an affected area of a mine such as an imminent danger order (IDO) or a written notice of a pattern of violations (POV).[34] Issuers are free to present the required information as they believe is appropriate but most follow the tabular presentation that the SEC suggests (see SEC File No. S7-41-10).

Form 8K Example: Berkshire Hathaway, Inc.

ITEM 1.04Mine Safety – Reporting of Shutdowns and Patterns of Violations

On February 4, 2014, Bridger Coal Company, a coal mining joint venture that is two-thirds owned and operated by a subsidiary of PacifiCorp, an 89.8% indirectly-owned subsidiary of Berkshire Hathaway Inc., received an imminent danger order under section 107(a) of the Federal Mine Safety and Health Act of 1977 at its underground mine located near Rock Springs, Wyoming. On February 5, 2014, Bridger Coal Company completed actions to abate the concerns, and the Federal Mine Safety and Health Administration terminated the section 107(a) order.

[33] MSHA inspectors, when writing a citation or order, determine whether a violation is significant and substantial (S&S). A violation is S&S if it "significantly and substantially contributes to the cause and effect of a coal or other mine safety or health hazard..." (MSHA Program Policy Manual Vol. 1, p. 23).

[34] An imminent danger is defined in the Mine Act as "the existence of any condition or practice in a coal or other mine, which could reasonably be expected to cause death or serious physical harm before such condition or practice can be abated." An imminent danger order requires operations to cease and miners leave the affected area until the violations have been deemed to be abated. A written notice of a pattern of violations (POV) is issued when the MSHA determines that a history of violations exist that could indicate future danger. A POV can be particularly concerning because if any violation is found within 90 days of the issuance of a POV, an order to cease operation is subsequently delivered.

Appendix A (cont.): Form 10K Example- Berkshire Hathaway, Inc.

MINE SAFETY VIOLATIONS AND OTHER LEGAL MATTER DISCLOSURES PURSUANT TO SECTION 1503(a) OF THE DODD-FRANK WALL STREET REFORM AND CONSUMER PROTECTION ACT

PacifiCorp and its subsidiaries operate coal mines and coal processing facilities and Acme Brick and its affiliates operate clay, shale and limestone excavation facilities (collectively, the “mining facilities”) that are regulated by the Federal Mine Safety and Health Administration (“MSHA”) under the Federal Mine Safety and Health Act of 1977 (the “Mine Safety Act”). MSHA inspects mining facilities on a regular basis. The total number of reportable Mine Safety Act citations, orders, assessments and legal actions for the year ended December 31, 2014 are summarized in the table below and are subject to contest and appeal. The severity and assessment of penalties may be reduced or, in some cases, dismissed through the contest and appeal process. Amounts are reported regardless of whether PacifiCorp or Acme has challenged or appealed the matter. Coal, clay and other reserves that are not yet mined and mines that are closed or idled are not included in the information below as no reportable events occurred at those locations during the year ended December 31, 2014. PacifiCorp and Acme have not received any notice of a pattern, or notice of the potential to have a pattern, of violations of mandatory health or safety standards that are of such nature as could have significantly and substantially contributed to the cause and effect of coal or other mine health or safety hazards under Section 104(e) of the Mine Safety Act during the year ended December 31, 2014.

	Mine Safety Act							Legal Actions		
Mining Facilities	**Section 104 Significant and Substantial Citations[1]**	**Section 104(b) Orders[2]**	**Section 104(d) Citations/ Orders[3]**	**Section 110(b)(2) Violations[4]**	**Section 107(a) Imminent Danger Orders[5]**	**Total Value of Proposed MSHA Assessments (in thousands)**	**Total Number of Mining Related Fatalities**	**Pending as of Last Day of Period[6]**	**Instituted During Period**	**Resolved During Period**
Coal:										
Deer Creek	12	—	—	—	—	$ 38	—	4	5	10
Bridger (surface)	3	—	2	—	—	8	—	3	3	4
Bridger (underground)	47	—	2	—	1	219	—	11	19	19
Cottonwood Preparatory Plant	—	—	—	—	—	—	—	—	—	—
Wyodak Coal Crushing Facility	—	—	—	—	—	—	—	—	—	—
Clay, shale and limestone:										
Minnesota	—	—	—	—	—	—	—	—	—	—
Malvern	1	—	—	—	—	—	—	—	—	—
Wheeler	—	—	—	—	—	—	—	—	—	—
Eureka	—	—	—	—	—	—	—	—	—	—
Fort Smith	—	—	—	—	—	—	—	—	—	—
Kanopolis	—	—	—	—	—	—	—	—	—	—
Oklahoma City	—	—	—	—	—	—	—	—	—	—
Tulsa	—	—	—	—	—	—	—	—	—	—
Denver	—	—	—	—	—	—	—	—	—	—
Bennett	—	—	—	—	—	—	—	—	—	—
Denton	—	—	—	—	—	—	—	—	—	—
Elgin	—	—	—	—	—	—	—	—	—	—
McQueeney	—	—	—	—	—	—	—	—	—	—
Garrison	—	—	—	—	—	—	—	—	—	—
Sealy	—	—	—	—	—	—	—	—	—	—
Texas Clay	—	—	—	—	—	—	—	—	—	—
Leeds	—	—	—	—	—	—	—	—	—	—
Montgomery	—	—	—	—	—	—	—	—	—	—
Lueders	2	—	—	—	—	—	—	—	—	—
Cordova	—	—	—	—	—	—	—	—	—	—

Appendix A (cont.): MSHA Website Citation Disclosure Example- Berkshire Hathaway, Inc.

Note: The following MSHA website disclosure pertains to the Jim Bridger Mine, which is a bituminous coal mine operated in Sweetwater County, Wyoming. The Jim Bridger Mine is operated by the Bridger Coal Company. Bridger Coal Company is owned jointly by PacifiCorp (two-thirds) and Idaho Power Company (one-third). Idaho Power Company is the mine operator. PacifiCorp is a wholly-owned subsidiary of the MidAmerican Energy Holdings Company (recently renamed Berkshire Hathaway Energy). MidAmerican is a wholly-owned subsidiary of Berkshire Hathaway, Inc. Those citations included in the 10-K are indicated in the far right column in bold.

Mine Data Retrieval System
as developed by PEIR

Mine Citations, Orders, and Safeguards

Current Mine Information

Mine ID:	**4800677**
Operator:	**Bridger Coal Company**
Opr. Begin Date:	**Unknown**
Mine Name:	**Jim Bridger Mine**
Current Controller:	**MidAmerican Energy Holdings Company; IDACORP**
Controller Start Date:	**Unknown**
Mine Status:	Active
Status Date:	7/1/1974
Mined Material:	Coal (Bituminous)
Type of Mine:	Surface
Location:	Sweetwater County, WY
State:	WY

Operator History for Mine ID: 4800677

Operator Name	Begin Date	End Date
Bridger Coal Company	Unknown	

How do I use this information? *Click Here*

Citations, Orders, and Safeguards

The current operator Bridger Coal Company - The starting date is Unknown

- Indicates violations pending hearings, appeals, and/or other actions.
- Indicates violations that have not yet been assessed.
- These are non-assessable.

– **Assessment Process Overview**

Note: Vacated Citations are not included in any reports on the MDRS.

Violator	Contractor ID	Citation/Order No.	Case No.	Date Issued	Final Order Date	Section of Act	Date Terminated	Citation/ Order	S & S	Standard	Proposed Penalty ($)	Citation/Order Status	Current Penalty ($)	Amount Paid To Date ($)	
Bridger Coal Company		8479259	000389966	12/16/2014		104(d) (1)	12/16/2014	C	Y	77.506	144,800.00	In Contest	144,800.00	0.00	**104(d) #1**
Bridger Coal Company		8479260	000389946	12/16/2014		104(d) (1)	12/16/2014	O	Y	77.502	66,142.00	Hearing Case Filed	66,142.00	0.00	**104(d) #2**
Bridger Coal Company		8479023	000360048	7/16/2014	6/9/2015	104(a)	7/16/2014	C	N	72.620	100.00	Closed	100.00	100.00	
Bridger Coal Company		8479021	000360048	7/15/2014	10/8/2014	104(a)	7/15/2014	C	N	77.1607(n)	100.00	Closed	100.00	100.00	
Company Owned Operations/Div of BATO	JHR	8479022	000359511	7/15/2014	9/24/2014	104(a)	7/16/2014	C	N	77.1606(c)	100.00	Closed	100.00	100.00	
LDE Corporation	D994	8479020	000359359	7/9/2014	9/24/2014	104(a)	7/9/2014	C	N	77.412(a)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8479019	000360048	7/2/2014	10/8/2014	104(a)	7/2/2014	C	Y	77.1710(g)	425.00	Closed	425.00	425.00	**104(a) #1**
Bridger Coal Company		8476755	000360048	6/26/2014	10/8/2014	104(a)	6/26/2014	C	Y	77.403-1(g)	3,143.00	Closed	3,143.00	3,143.00	**104(a) #2**
Bridger Coal Company		8476756	000360048	6/26/2014	10/8/2014	104(a)	6/26/2014	C	Y	77.1607(b)	3,143.00	Closed	3,143.00	3,143.00	**104(a) #3**
Bridger Coal Company		8479006	000355136	5/20/2014	8/6/2014	104(a)	6/16/2014	C	N	77.1606(c)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8479005	000355136	5/19/2014	8/6/2014	104(a)	5/19/2014	C	N	77.1102	100.00	Closed	100.00	100.00	
Bridger Coal Company		8479004	000355136	5/8/2014	8/6/2014	104(a)	5/19/2014	C	N	77.208(c)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8479003	000355136	5/6/2014	8/6/2014	104(a)	5/7/2014	C	N	77.1713(c)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8479002	000352208	4/23/2014	7/9/2014	104(a)	4/24/2014	C	N	77.1606(c)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8479001	000352208	4/16/2014	7/9/2014	104(a)	4/23/2014	C	N	77.1606(c)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8478698	000349511	3/4/2014	6/4/2014	104(a)	3/5/2014	C	N	50.11(b)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8478700	000349511	3/4/2014	6/4/2014	104(a)	3/5/2014	C	N	50.11(b)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8478697	000349511	3/4/2014	6/4/2014	104(a)	3/5/2014	C	N	50.20(a)	100.00	Closed	100.00	100.00	
Bridger Coal Company		8478699	000349511	3/4/2014	6/4/2014	104(a)	3/5/2014	C	N	50.11(b)	100.00	Closed	100.00	100.00	
Tekko Enterprises, Inc	A4540	8477977	000343925	1/15/2014	3/29/2014	104(a)	1/15/2014	C	N	77.502-2	100.00	Closed	100.00	100.00	
Bridger Coal Company		8477976	000344162	1/7/2014	4/3/2014	104(a)	1/7/2014	C	N	77.502-2	285.00	Closed	285.00	285.00	

Appendix B: Description of Data Collection Methodology

This appendix provides a detailed description of the methodology used to identify the firms subject to Dodd-Frank Section 1503, their 8K filings, and compile a list of the mines that they operate.

We identify mine-safety filings using *directEDGAR*, an extraction engine that facilitates text-based searches of all SEC Edgar filings. We also use *SeekEdgar*, a similar extraction engine to verify and complement the *directEDGAR* search. To capture the full sample of relevant firms, we search Form 10K (and 20F) filings using the terms "mine safety" and "section 104" (the most common type of citation). These terms allow us to identify disclosures in both the exhibits to the 10K (Exhibits 95 and 99 are commonly used) as well as in the body of the filing. We then compile a comprehensive list of the MSD mines from these filings, which we hand match to the MSHA databases based on mine names and numbers. For MSD mines that are still not matched to a mine number after this process, we use an internet search to aid in identifying mine numbers. We include only firms that operate mines in this sample (i.e., we exclude firms that work only as contractors). Contractors are not involved in operating the mine and therefore have less influence on the safety of the mine.

There were two notable complications in this process. First, companies occasionally group mines together into a common classification such as "other mines" that makes it difficult to infer the exact identities of the mines. Second, for seven firms, we were unable to match all of the MSD mines to the MSHA databases because of ambiguities in the disclosed names. In these cases, we search the company name using an MSHA database that reports the controller/operator history at each mine and included all mines under that company (as the controller) currently listed as "active." Due to the complex organizational structures of firms in our sample, this process is likely to be less accurate than directly identifying mine ID numbers within the 10K. For example, if the firms disclose mines that are operated by a subsidiary in its 10K, we run the risk of misclassifying the mine using this process (because the MSHA database would list the subsidiary as the owner).

To collect the sample of mine-safety-related Form 8K filings, we follow a very similar procedure. Specifically, we first perform *DirectEDGAR* and *SeekEdgar* searches using the term "mine safety." We match the 8Ks to *CRSP* and *Thomson Reuters' Mutual Funds* database based on CIK codes. To identify the mine to which the IDO is issued, we collect the violating mine's name from each 8K filing and hand match the name to the MSHA databases. For a small portion of the 8Ks, we are unable to match the names to the MSHA database because the name of the violating mine is not disclosed.

Appendix C: Matching Analysis

Matching on mine characteristics is an alternative way to address non-random assignment to the treatment group in our sample. In this Appendix, to further support a causal interpretation of our findings, we present the results of an analysis using coarsened exact matching (CEM) (see Blackwell et al. 2010). Matching in general, and CEM in particular, has several advantages over a multiple-regression control variable approach. First, matching analyses do not assume that the underlying relationship between the dependent and matched independent variables is linear. Second, matching addresses issues resulting from nonoverlapping distributions between the treatment and control samples (i.e., it ensures common support). Third, matching directly addresses selection on observables, and, to the extent observable and unobservable mine characteristics are related, provides a way to gauge the magnitude of any potential selection on unobservable mine characteristics (Altonji et al. 2005).

CEM is a monotonic imbalance matching approach that allows the covariate balance between the treatment and control groups to be specified ex ante. Effectively, the CEM method groups observations into distinct bins based on the selected matching variables, the size of which are determined by the researcher. Then, weights are assigned to the control observations such that the representation of the control group in each bin matches that of the treatment group. Observations in bins without both a treatment and control observation are eliminated to ensure common support.

For our analysis, we select three mine characteristics as matching variables: the average hours worked in a mine in the pre-MSD period (*Size*), whether the mine is a coal mine (*Coal*), and whether the mine is an underground mine (*Underground*). We corsen our sample into 100 CEM bins, which reflects a tradeoff between preserving observations and the ex-post similarity of the distributions of the matching variables across the treatment and control groups. We then use the weights from this coarsening in estimations of our primary specifications of Eq. (1).

Table AC1 shows the descriptive statistics for the treatment and control samples both before and after applying CEM weights. In Panels A, B, and C we present descriptive statistics for citation rates, injury rates, and labor productivity, respectively. However, because the results of the matching procedure are similar across the panels, we discuss detailed results only for Panel A.

In Panel A, prior to matching, the average *Size* of MSD-mines (the treatment group) is 76,812 work hours per year compared to 20,858 for Non-MSD-mines. After applying the CEM weights to the Non-MSD-mine sample, average *Size* increases to 69,201. Prior to applying the CEM weights, 14.5% (5.6%) of the Non-MSD-mines are coal (underground) mines compared to 30.3% (14.3%) for the MSD-mines. After applying CEM weights to Non-MSD-mines, these mines have virtually the same proportion of coal (underground) mines as MSD-mines—30.3%

(13.7%). Overall, the descriptive statistics indicate that the distribution of observable mine characteristics is more balanced after performing CEM.

Table AC2 presents the regression results for the citation rate (Panel A), injury rate (Panel A), and labor productivity (Panel B) analyses. We present results for the common support sample both with and without CEM weights. By presenting both sets of results, we are able to assess the effect of applying the CEM weights. For all three analyses, results based on the common support sample are similar to our main analyses in the paper, which indicates that the observations lost because of a lack of common support have little effect on our inferences. More importantly, when we apply the CEM weights, we observe little attenuation in the magnitude of the estimated coefficient on *MSD* in any of the three specifications. Specifically, the attenuation from both limiting the sample to common support and applying the CEM weights is 23% for citations, 6% for injuries, and 18% for productivity.

One weakness of the matching approach is that we can only ensure covariate balance on the variables we observe (i.e., size, whether the mine is a coal mine, and whether the mine is underground). However, since the attenuation in the treatment effect after matching is modest, any potential selection on unobservable mine characteristics would have to have little correlation with mine size or mine type (which seems unlikely) or be quite large in magnitude to explain all of the estimated treatment effect.

References:

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Table AC1: Matching Analysis Descriptive Statistics

Panel A: Citation Rates

	MSD-Mines			*Non-MSD-Mines*				
					No CEM Weights		*CEM Weights*	
	N (mine-years)	*Mean*	*Std. Dev.*	*N (mine-years*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Size (avg. hours 2002-2009)	23,632	76,812	129,230	137,432	20,858	52,701	69,201	131,321
Coal	23,667	0.3032	0.4597	137,839	0.1445	0.3516	0.3032	0.4596
Underground	23,667	0.1431	0.3502	137,839	0.0560	0.2300	0.1372	0.3440

Panel B: Injury Rates

	MSD-Mines			*Non-MSD-Mines*				
					No CEM Weights		*CEM Weights*	
	N (mine-years)	*Mean*	*Std. Dev.*	*N (mine-years)*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Size (avg. hours 2002-2009)	14,331	98,563	148,470	42,658	45,505	78,440	94,676	149,124
Coal	14,340	0.3231	0.4677	42,685	0.1736	0.3788	0.3231	0.4677
Underground	14,340	0.1593	0.3660	42,685	0.0817	0.2739	0.1591	0.3657

Panel C: Labor Productivity

	MSD-Mines			*Non-MSD-Mines*				
					No CEM Weights		*CEM Weights*	
	N (mine-years)	*Mean*	*Std. Dev.*	*N (mine-years)*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Size (avg. hours 2002-2009)	2,312	156,510	164,692	3,851	72,825	112,625	156,433	163,631
Coal	2,320	1.0000	0.0000	3,872	1.0000	0.0000	1.0000	0.0000
Underground	2,320	0.5621	0.4962	3,872	0.3998	0.4899	0.4384	0.4963

Notes: This table reports descriptive statistics for citation rates (Panel A), injury rates (Panel B), and labor productivity (Panel C) for mine-year observations both before and after coarsened exact matching (CEM). The sample period is from 2002 to 2013. We define *Size* as the average hours worked in the pre-period (2002-2009). *Coal* and *Underground* are binary indicators that take on the value of one if the mine is identified as a coal or underground mine, respectively. We discuss data collection procedures in Appendix B.

Table AC2: Effect of Matching on Estimated Treatment Effect

Panel A: Citation and Injury Rates

Dependent Variable: Citation or Injury Rates Measured over Two-year Periods	*Citation Rates*		*Injury Rates*	
	No CEM Weights	*CEM Weights*	*No CEM Weights*	*CEM Weights*
MSD	-0.102***	-0.083***	-0.144***	-0.122***
	(-0.022)	(-0.020)	(-0.044)	(-0.036)
Fixed Effects	Year & Mine	Year & Mine	Year & Mine	Year & Mine
Pseudo R-squared	0.542	0.579	0.577	0.59
N (mine-periods)	86,252	86,252	21,368	21,368
Number of Unique Mines	18,955	18,955	4,693	4,693

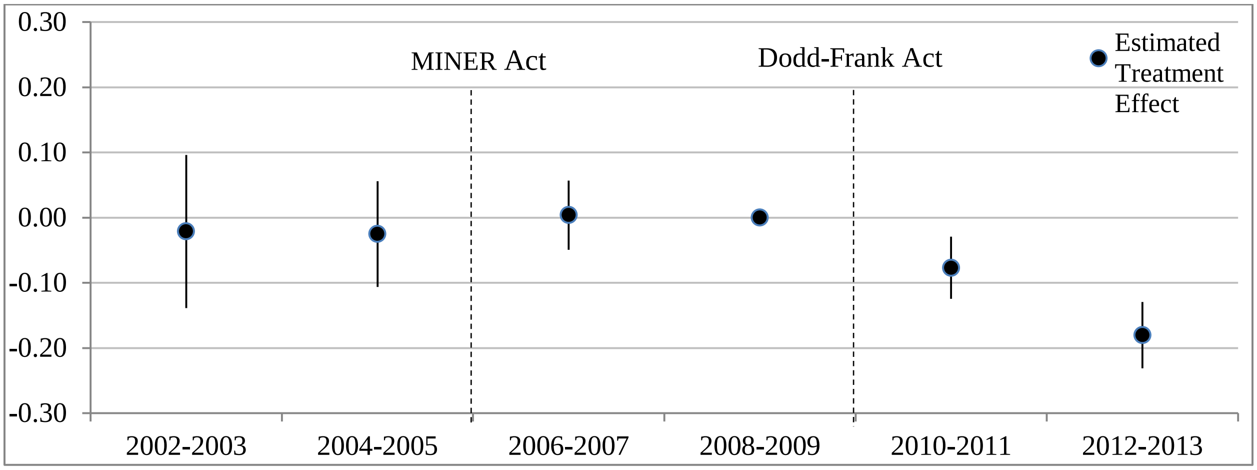
Panel B: Labor Productivity

Dependent Variable: Log(Tons of Coal Produced Per Mine-Worker Hour)	*No CEM Weights*	*CEM Weights*
MSD	-0.081**	-0.061*
	(-0.032)	(-0.037)
Fixed Effects	Year & Mine	Year & Mine
R-squared	0.755	0.785
N (mine-periods)	6,192	6,192
Number of Unique Mines	1,499	1,499

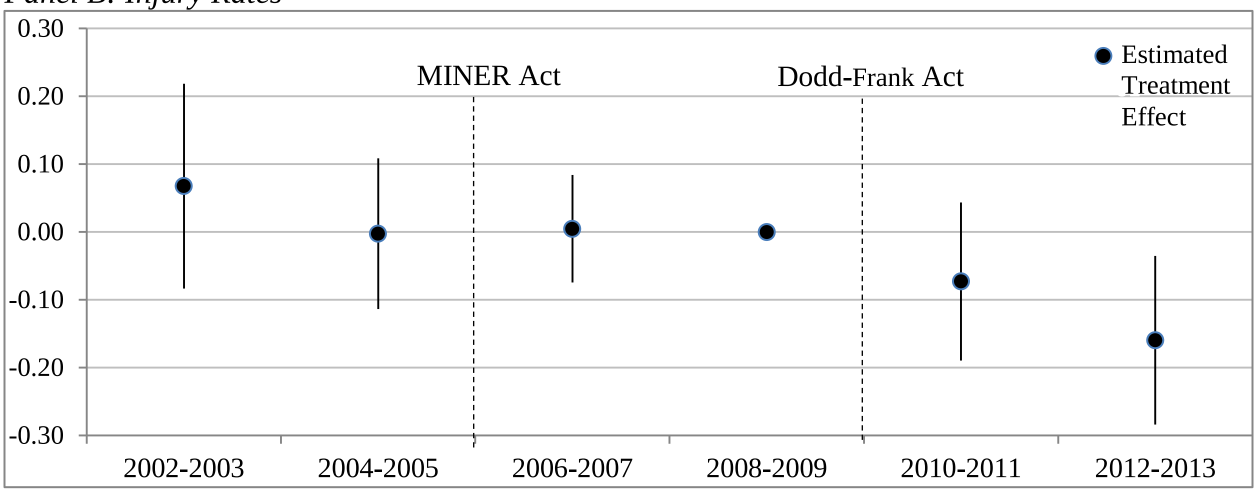
Notes: This table reports results from our analysis of the real effects of MSD before and after coarsened exact matching (CEM). The sample period is from 2002 to 2013. We estimate citation and injury rate effects, shown in Panel A, using Poisson regressions measured over two-year periods. We estimate labor productivity effects, shown in Panel B, using OLS regressions measured over one-year periods. We calculate the coefficients reported in the columns titled *CEM Weights* using CEM and the results reported in the columns titled *No CEM Weights* using the same common support sample as the *CEM Weights* columns, but without using the CEM weights. *MSD* is a binary indicator that takes on the value of one beginning in July 2010 following the passage of Dodd-Frank for mines owned by firms subject to the Act. We provide a detailed description of the variables in the notes to Table 2 and discuss our data collection procedures in Appendix B. All regressions include mine and year fixed effects. Standard errors, reported in parentheses, are clustered by mine. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Figure 1: Pattern of the Counter-Factual Treatment Effects

Panel A: Citation Rates



Panel B: Injury Rates



Panel C: Labor Productivity

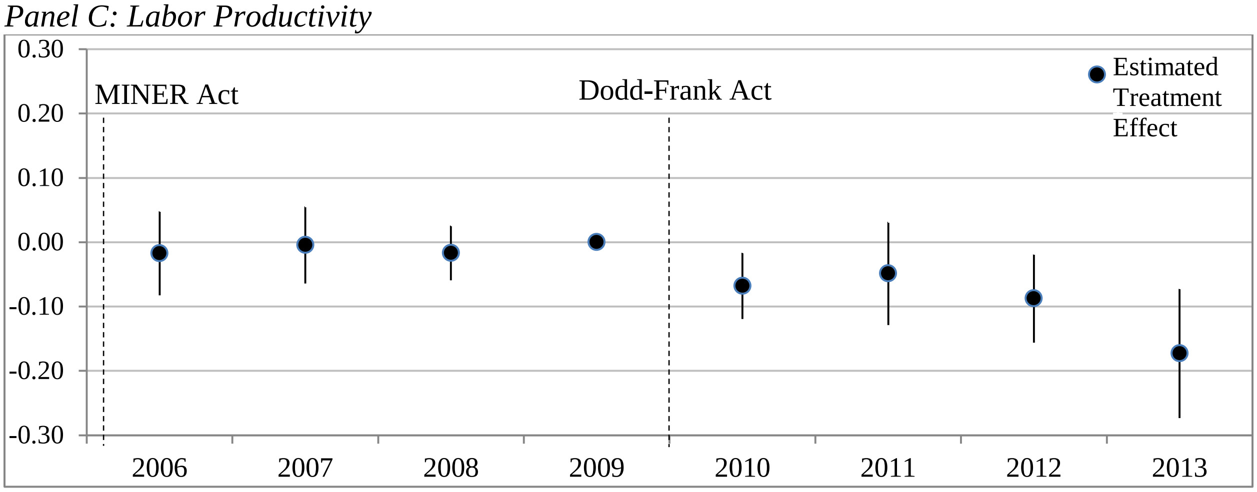
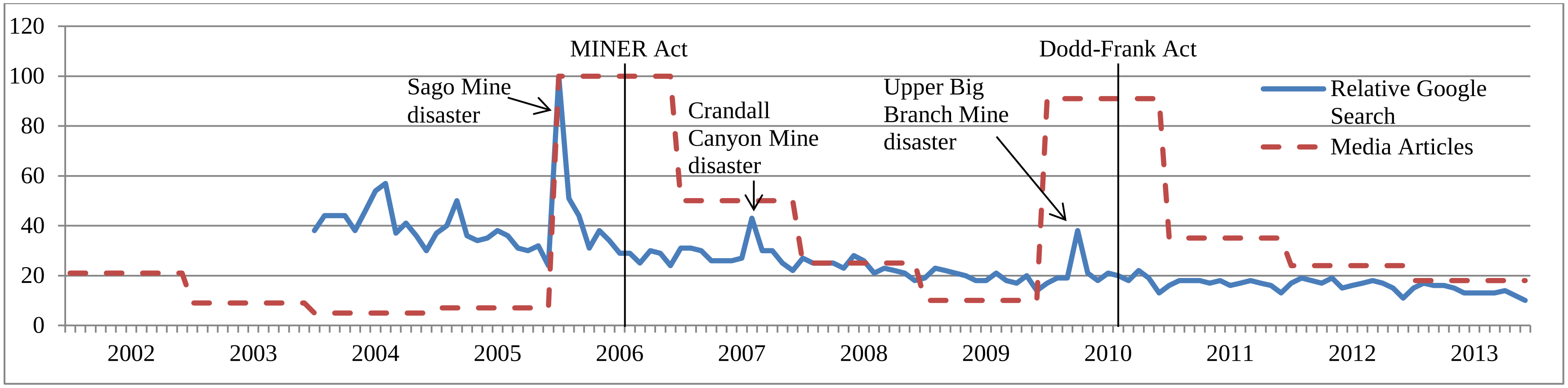


Figure 1 continued

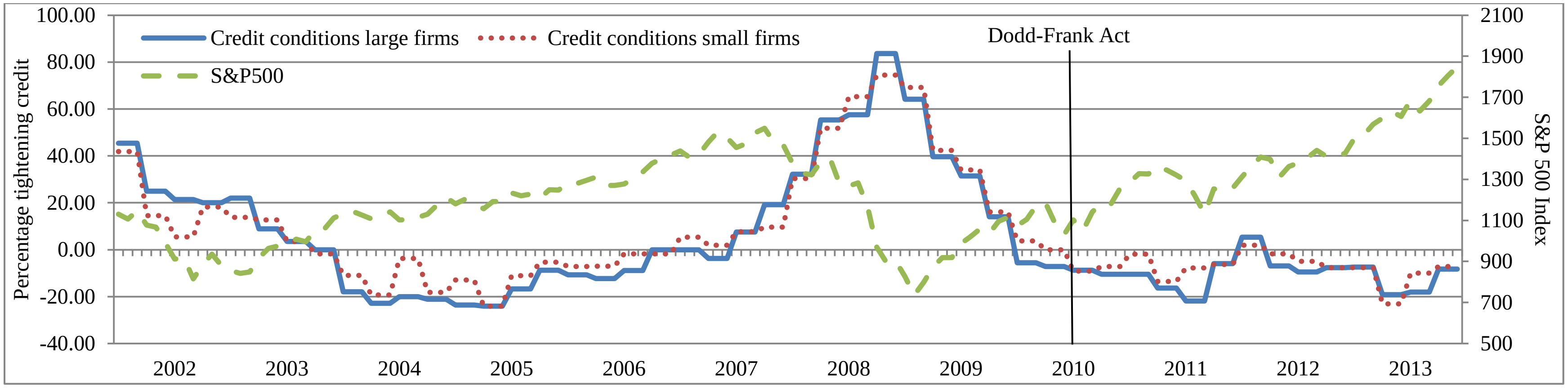
Notes: This figure displays Poisson (OLS) regression coefficient estimates and one-tailed 95% confidence intervals based on standard errors block-bootstrapped at the mine-owner level in Panels A and B (Panel C). We report results for citations (Panel A) and injury rates (Panel B) measured over two-year periods from 2002 to 2013 and for labor productivity (Panel C) measured annually from 2006 to 2013. To map out the pattern in the counter-factual treatment effects in Panels A and B (C), we include, in one regression, indicators for every two- (one-) year period in the sample except 2008-2009 (2009), which serves as the benchmark period (i.e., the coefficient is constrained to equal zero). In these specifications, we measure the pattern in the counter-factual treatment effects relative to the period immediately prior to the effective date of the Dodd-Frank Act. We provide a detailed description of the variables in the notes to Table 2 and discuss our data collection procedures in Appendix B.

Figure 2: Media Coverage of Mine Safety



Notes: This figure presents media articles from 2002 to 2013 and Google search activity related to mine safety from 2004 to 2013. *Relative Google Search* is an index that captures the frequency of Google searches that include the term "mine safety" measured relative to all other Google searches over the same period. *Media Articles* is an index for the annual number of newspaper articles that include the terms "mine safety" and/or "mine disaster." We plot both indices relative to a value of 100 set in the benchmark year of 2006. We obtain data on Google searches from Google Trends and data on newspaper articles from FACTIVA.

Figure 3: Credit and Equity Market Conditions



Notes: This figure presents summary statistics for two time-series proxies for the condition of the U.S. credit and equity markets. We measure *Credit conditions* as the net percentage of respondents to the October 2015 Senior Loan Officer Opinion Survey on Bank Lending Practices published by the Federal Reserve Board (available at http://www.federalreserve.gov/econresdata/statisticsdata.htm) who indicate a tightening of credit standards for commercial and industrial loans. We report credit conditions separately for large and small borrowers. We measure equity market conditions using the S&P 500 Index.

Table 1: Descriptive Statistics for Issuers Subject to Section 1503 of the Dodd-Frank Act

Panel A: Descriptive Statistics

(N=151)	*Mean*	*Std. Dev.*	*Min.*	*Median*	*Max.*
Number of Mines	23.62	70.38	1.00	3.00	539.00
Number of 8K IDOs	1.36	4.14	0.00	0.00	35.00
Average Total Assets (2010-2013)	15,391	43,403	2.38	3,334	419,315

Panel B: Industry Distribution

	Number of Issuers	*Percentage of Issuers*
Mining	50	33%
Construction	5	3%
Manufacturing	42	27%
Transportation and Utilities	29	19%
Wholesale Trade	2	1%
Services	3	2%
Non-classifiable	20	15%
Total number of firms	*151*	*100%*

Notes: This table presents descriptive statistics for issuers subject to Section 1503 of the Dodd-Frank Act. Panel A provides descriptive statistics for the 151 issuers that disclose mine-safety records as mandated by the Act. We describe the data collection procedures for issuers, mines, and imminent danger orders (IDOs) in Appendix B. We obtain *Average Total Assets*, in millions of $USD, from *Compustat* and calculate the average over fiscal years from 2010-2013. Panel B provides the SIC industry sector distribution.

Table 2: Descriptive Statistics on Citation Rates, Injury Rates, and Labor Productivity

Panel A: Citation Rates

Variable	*N*	*Mean*	*Std. Dev.*	*Min.*	*Median*	*Max.*
Mines Owned by Firms Subject to Dodd-Frank (unique mines 2,726):						
Citations Rate	24,434	0.08	0.08	0.00	0.06	0.56
Severe Citation Rate (Disseminated)	24,434	0.02	0.03	0.00	0.00	0.50
Not-Severe Citation Rate (Not Disseminated)	24,434	0.06	0.06	0.00	0.05	0.52
Mines Owned by Firms Not Subject to Dodd-Frank (unique mines 23,533):						
Citations Rate	141,576	0.10	0.11	0.00	0.08	0.56
Severe Citation Rate	141,576	0.03	0.05	0.00	0.00	0.56
Not-Severe Citation Rate	141,576	0.08	0.09	0.00	0.06	0.56

Panel B: Injury Rates

Variable	*N*	*Mean*	*Std. Dev.*	*Min.*	*Median*	*Max.*
Mines Owned by Firms Subject to Dodd-Frank (unique mines 2,168):						
All Injuries	14,882	1.45	2.76	0.00	0.00	17.96
Mines Owned by Firms Not Subject to Dodd-Frank (unique mines 8,321):						
All Injuries	43,006	1.34	3.20	0.00	0.00	17.99

Table 2 continued

Panel C: Labor Productivity

Variable	*N*	*Mean*	*Std. Dev.*	*Min.*	*Median*	*Max.*
Mines Owned by Firms Subject to Dodd-Frank (unique mines 547):						
Labor Productivity	2,816	4.08	4.01	0.26	3.06	32.59
Mines Owned by Firms Not Subject to Dodd-Frank (unique mines 1,179):						
Labor Productivity	4,145	3.20	2.42	0.26	2.60	32.43

Notes: This table reports descriptive statistics for citation rates (Panel A), injury rates (Panel B), and labor productivity (Panel C) for mine-year observations included in the analyses in Tables 3-6. The sample period is from 2002 to 2013. We define the *Citation Rate* as the number of citations scaled by inspection hours and trim the top 1% of firm-year observations. We define *Severe Citations* as citations that must be included in financial reports for mines owned by firms subject to the Dodd-Frank Act. We define all other citations as *Not-Severe Citations*. We define the *Injury Rate* as the number of injuries scaled by mine worker hours multiplied by 200,000 and trim the top 1% of firm-year observations. We define *Labor Productivity* as tons of coal produced divided by mine-worker hours and trim the top 1% of firm-year observations. We discuss data collection procedures in Appendix B.

Table 3: Effect of MSD on Citation Rates

Dependent Variable: Citation Rates Measured over One- or Two-year Periods	*One-year Periods*		*Two-year Periods*	
	OLS	*Poisson*	*OLS*	*Poisson*
	(1)	*(2)*	*(3)*	*(4)*
MSD	-0.011***	-0.112***	-0.009***	-0.113***
	(0.002)	(0.033)	(0.002)	(0.032)
Fixed Effects	Year & Mine	Year & Mine	Year & Mine	Year & Mine
R-squared / Psuedo R-Squared	0.249	0.433	0.331	0.559
N (mine-periods)	166,010	166,010	95,383	95,383
Number of Unique Mines	26,259	26,259	26,203	26,203

Notes: This table reports results from our analysis of the effect of MSD on citation rates using both OLS and Poisson regressions. The sample period is from 2002 to 2013. *MSD* is a binary indicator that takes on the value of one beginning in July 2010 following the passage of Dodd-Frank for mines owned by firms subject to the Act. We provide a detailed description of the variables in the notes to Table 2 and discuss our data collection procedures in Appendix B. All regressions include mine and year fixed effects. Standard errors, reported in parentheses, are estimated by block-bootstrap at the mine-owner level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Table 4: Effect of MSD on Severe and Not-Severe Citation Rates

Dependent Variable: Citation Rates Measured over Two-year Periods	*Severe Citations* *(1)*	*Not-Severe Citations* *(2)*
MSD	-0.232***	-0.063***
	(0.061)	(0.026)
Fixed Effects	Year & Mine	Year & Mine
R-squared / Psuedo R-Squared	0.552	0.538
N (mine-two-year-periods)	79,366	88,188
Number of Unique Mines	17,333	19,873

Notes: This table reports results from our analysis of the effect of MSD on *Severe* and *Not-Severe* citation rates using Poisson regressions. The sample period is from 2002 to 2013. *MSD* is a binary indicator that takes on the value of one beginning in July 2010 following the passage of Dodd-Frank for mines owned by firms subject to the Act. We provide a detailed description of the variables in the notes to Table 2 and discuss our data collection procedures in Appendix B. All regressions include mine and year fixed effects. Standard errors, reported in parentheses, are estimated by block-bootstrap at the mine-owner level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Table 5: Effect of MSD on Injury Rates

Dependent Variable: Injury Rates Measured over One- or Two-year Periods	*One-year Periods*		*Two-year Periods*	
	OLS	*Poisson*	*OLS*	*Poisson*
	(1)	*(2)*	*(3)*	*(4)*
MSD	-0.196**	-0.130**	-0.231***	-0.130**
	(0.080)	(0.055)	(0.080)	(0.057)
Fixed Effects	Year & Mine	Year & Mine	Year & Mine	Year & Mine
R-squared / Pseudo R-Squared	0.191	0.488	0.257	0.598
N (mine-periods)	57,888	57,888	35,798	35,798
Number of Unique Mines	10,489	10,489	10,459	10,459

Notes: This table reports results from our analysis of the effect of MSD on injury rates using both OLS and Poisson regressions. The sample period is from 2002 to 2013. *MSD* is a binary indicator that takes on the value of one beginning in July 2010 following the passage of Dodd-Frank for mines owned by firms subject to the Act. We provide a detailed description of the variables in the notes to Table 2 and discuss our data collection procedures in Appendix B. All regressions include mine and year fixed effects. Standard errors, reported in parentheses, are estimated by block-bootstrap at the mine-owner level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Table 6: Effect of MSD on Labor Productivity

Dependent Variable: Log(Tons of Coal Produced Per Mine Worker Hour)	*One-year Periods*
MSD	-0.074***
	(0.030)
Fixed Effects	Year & Mine
R-squared	0.778
N (mine-years)	6,961
Number of Unique Mines	1,726

Notes: This table reports results from our analysis of the effect of MSD on labor productivity using an OLS regression. The sample includes annual coal mine observations over the period from 2006 to 2013. *MSD* is a binary indicator that takes on the value of one beginning in July 2010 following the passage of Dodd-Frank for mines owned by firms subject to the Act. We provide a detailed description of the variables in the notes to Table 2 and discuss our data collection procedures in Appendix B. The regression includes mine and year fixed effects. Standard errors, reported in parentheses, are estimated by block-bootstrap at the mine-owner level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Table 7: Impact of Mining-Related 8K Filings on Firm Value

Panel A: Market Reactions for the Full Sample

	Mean	*Median*
	(1)	*(2)*
CAR (0, 1)	-0.41%*	-0.20%*
	(-1.736)	(-1.781)
N (8K Filings)	187	187

Panel B: Market Reactions for Coal and Non-coal Mines

	Mean		*Median*	
	Coal	*Non-Coal*	*Coal*	*Non-Coal*
	(1)	*(2)*	*(3)*	*(4)*
CAR (0, 1)	-0.77%**	-0.14%	-0.70%***	-0.13%
	(-2.463)	(-0.368)	(-2.888)	(-0.103)
Test of difference (p-value)	0.230		0.063	
N (8K Filings)	119	60	119	60

Notes: This table reports average (median) cumulative abnormal returns (CARs) for the sample of mining-related 8K filings. We discuss data collection procedures in Appendix B. We compute CARs using the CRSP equal-weighted return index as a benchmark over an estimation window of [t, t+1], where t denotes the 8K filing date and we count time in trading days. Panel A reports CARs for the full sample. Panel B separately reports CARs for coal and non-coal mines. We report t-statistics (z-statistics) in parentheses for means (medians). In Panel B, we also report the p-values of a two-sided t-test on the difference in coefficients for coal and non-coal mines. ***, **, * denote significance at the 1%, 5% and 10% level, respectively.

Table 8: Impact of Mine-Safety Citations on Firm Value Conditional on Disclosure Timing and 8K Dissemination

Panel A: Market Reactions to the First and Subsequent 8Ks for Coal Mines

	Mean		*Median*	
	First 8K	*Subsequent 8Ks*	*First 8K*	*Subsequent 8Ks*
	(1)	*(2)*	*(3)*	*(4)*
CAR (0, 1)	-2.02%***	-0.55%	-1.80%**	-0.54%**
	(-2.826)	(-1.598)	(-2.199)	(-2.095)
Test of difference (p-value)	0.091		0.091	
N (8K Filings)	18	101	18	101

Panel B: Market Reactions following MSHA Website Disclosure Pre- and Post-Dodd-Frank

	Pre-Dodd-Frank		*Post-Dodd-Frank*		*Post minus Pre*	
	Mean	*Median*	*Mean*	*Median*	*Mean*	*Median*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
CAR (0, 1, 2, 3, 4)	0.13%	0.34%	-0.70%*	-0.81%**	-0.83%*	-1.15%**
	(0.548)	(1.031)	(-1.857)	(-2.230)	(-1.721)	(-2.370)
N (8K Filings)	551	551	171	171	722	722

Notes: This table reports average (median) cumulative abnormal returns (CARs) around the release of imminent danger orders (IDOs) through 8K filings and MSHA website postings. We discuss data collection procedures in Appendix B. CARs are computed using the CRSP equal-weighted return index as a benchmark over an estimation window of [t, t+1] in Panel A and [t, t+4] in Panel B, where t denotes the 8K filing date in Panel A and the MSHA website disclosure date in Panel B and time is counted in trading days. In Panel A, we limit the sample to coal mines and separately report CARs for the first MSD-8K filed by a mine owner (*First 8K*) and all subsequent MSD-8Ks (*Subsequent 8K*). Panel B separately reports CARs following the MSHA website disclosure before (*Pre-Dodd-Frank*) and after (*Post-Dodd-Frank*) the Dodd-Frank effective date. We report t-statistics (z-statistics) in parentheses for means (medians). In Panel A, we also report p-values of a t-test of coefficient differences between the *First 8K* and *Subsequent 8Ks*. ***, **, * denote significance at the 1%, 5% and 10% level, respectively.

Table 9: Mutual Fund Ownership Sensitivity to 8K Imminent Danger Orders

Dependent Variable: % Change in Holdings	
Mutual Fund Sensitivity to IDOs Pre- and Post-MSD:	
IDO	-0.007***
	(0.003)
MSD×IDO	-0.009*
	(0.005)
Incremental SRI-Fund Sensitivity to IDOs Pre- and Post-MSD:	
SRI×IDO	-0.045
	(0.051)
MSD×SRI×IDO	-0.112
	(0.097)
Incremental SRI Sensitivity Post-MSD:	
SRI×IDO + MSD×SRI×IDO (p-value)	0.057
Fixed Effects	Fund, Year-Qtr, Year-Qtr×SRI
Observations (Fund-Firm, Year-Qtr)	1,495,967
R-squared	0.050

Notes: This table presents the percentage change in ownership in quarters with mining-related-8K-IDO filings for SRI and non-SRI mutual funds. The sample period is from 2002-2013. IDO is a binary indicator variable that takes the value of one if a firm receives an imminent danger order (IDO) in a given quarter. MSD is a binary indicator that takes the value of one if the IDO is disclosed on the MSHA website and disseminated through an 8K filing (i.e., after the Dodd-Frank Act). SRI is a binary indicator that takes the value of one if a mutual fund identifies as socially responsible. We discuss data collection procedures for 8K filings in Appendix B. The mutual fund data are from *Thomson Reuters' Mutual Funds* database. SRI mutual fund data is from *The Forum for Sustainable and Responsible Investment* (USSIF) (we accessed this dataset in August 2015). The regression includes mutual fund, year-quarter, and year-quarter×SRI fixed effects. Standard errors, reported in parentheses, are clustered at the mutual fund level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels (two-tailed), respectively.