Real Effects of Information Frictions Within Regulators: Evidence from Workplace Safety Violations

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Abstract

The Occupational Safety and Health Administration (OSHA) is decentralized, where individual state-level field offices are responsible for undertaking inspections and sharing case information with other offices. Interviews with compliance officers suggest that this information structure leads to within-regulator information frictions. We study whether such frictions affect how overseen firms comply with workplace safety laws. We find evidence of geographic substitution, i.e., firms caught violating in one state subsequently violate less in that state, instead shifting violations elsewhere. Two key channels drive geographic substitution: inspections and punishment. Violations in one state do not trigger proactive OSHA inspections in other states. Moreover, firms face lower monetary penalties when shifting violations across state lines, consistent with greater frictions in the sharing of documentation required to assess severe penalties. Finally, more profitable firms shift violations less and firms with worse governance or culture shift violations more. While prior work highlights how internal information within firms affects corporate misconduct, our findings suggest that internal information within regulators impacts the likelihood and location of corporate misconduct as well.

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1. Introduction

How information flows within an organization is key to how that organization operates. Recent work studies the role of internal information in both facilitating and preventing corporate misconduct (e.g., Ege 2015; Heese and Pérez-Cavazos 2020). However, this work focuses on internal information within firms, implicitly assuming that regulators are constrained only by available resources. In practice, regulators also have bureaucratic structures that impact internal information flows, potentially altering the effectiveness of these regulatory bodies in detecting misconduct. Our paper explores the role of internal information in a prominent US regulatory body that oversees workplace safety, the Occupational Safety and Health Administration (OSHA). Specifically, we study whether information frictions within OSHA are associated with patterns in workplace safety violations by overseen firms.

OSHA delegates significant authority to state-level field offices, which are responsible for ensuring that firms in their state comply with federal workplace safety laws. Such delegation empowers those with localized expertise (Jensen and Meckling 1995; Christie, Joye, and Watts 2003), leading to efficient outcomes when centralization is costly (Melumad and Reichelstein 1987; Dessein 2002). However, delegation may be less effective vis-à-vis greater centralization if information sharing and processing across an organization is important (Bolton and Dewatripont 1994; Garicano 2000). The latter concern is particularly relevant to OSHA because field offices are only responsible for monitoring compliance with safety standards in their own state, meaning that they do not follow firms across state lines. Efficient information sharing between field offices is therefore important to OSHA's mission of ensuring firm-wide compliance with workplace safety standards and, in turn, preventing harm to American workers (Glaeser and Guay 2017).

OSHA compliance plausibly matters to firms. Prior work shows that firms' financial incentives reduce compliance with workplace safety standards (Cohn and Wardlaw 2016; Caskey

and Ozel 2017) while better enforcement improves compliance (Johnson, Levine, and Toffel 2020). Beyond direct monetary fines,[1] violations also result in time-consuming and costly remediation actions, heightened penalties for further noncompliance, and increased litigation risk. Violations, especially serious offences, also lead to local reputational damage, harming a firm's ability to do business locally (Johnson 2020). Our setting thus provides an opportunity to assess whether firms exploit internal, between-state information frictions within OSHA by shifting workplace safety violations across states over time.

To motivate our empirical predictions, we develop a two-period model in which a firm can reduce workplace safety to cut production costs in either of two states in which it operates. The firm's conduct is monitored by separate branches of OSHA in each state. The two OSHA branches may share findings from their respective inspections with each other but can only do so imperfectly, leading to information asymmetry between the two branches. The model shows that aggregate firm-wide misconduct decreases after an investigation by either branch. However, imperfect information sharing within OSHA means that relative costs of misconduct are not equal for the firm. As a result, after being investigated in one state, the firm is less likely to commit violations in the same state but substitutes violating behavior to the other state and, if information frictions are high enough, may actually increase violating behavior in the other state. We term this shift in behavior across states *geographic substitution*.

Because analytical models are necessarily limited to isolating specific economic forces, we also conducted interviews with several OSHA compliance officers in charge of workplace safety inspections. In these interviews, we learned that checking OSHA's internal information system, the OSHA Information System (OIS), is an important first step in preparing to inspect a

[1] In 2019 alone, OSHA conducted thousands of inspections, resulting in over $335 million in fines.

workplace. OSHA compliance officers record firm citations in this system but excluded from the OIS record are qualitative inspection details, case documents related to violations, or personal notes of the OSHA compliance officer in charge of assessing citations. Our interviewees argued that incomplete information sharing within OSHA makes tracking a firm's misconduct across states difficult, limiting the ability of OSHA inspectors to obtain broader firm-level supporting documentation necessary to effectively inspect businesses and cite violations.

We empirically test the predictions generated by our analytical model and our interviews using a large-sample, firm-state-year panel. Our design relies on a rich set of firm-by-state and year fixed effects. This design ensures that our results are not driven by broader firm, state, or firm-state level cross-sectional characteristics (such as the states in which a firm's headquarters or main manufacturing facilities are located) or time-varying market conditions.

We find that a firm's overall likelihood (i.e., collectively across all states) of violating OSHA standards is lower if the firm had a violation in the previous year. However, after a firm is caught committing a violation in one state, it is less likely to commit a violation in the same state but more likely to commit a violation in a different state. The latter result is unlikely to be driven by within-firm information frictions, given our fixed effects structure, because within-firm information frictions would inhibit the firm's ability to coordinate its actions in different states.[2] The reduction in future same-state violations may reflect learning by the firm about safety practices. However, our cross-state substitution results suggest that any attempt by firms to apply this learning to their operations in other states is dominated by economic incentives for

[2] Geographic substitution requires explicit or implicit coordination between establishments, which can occur directly via multitasking (Holmström and Milgrom 1991; Brüggen and Moers 2007), or indirectly via participative budgeting (Kanodia 1993), incentive schemes (Bernardo, Cai, and Luo 2004), or transfer pricing (Göx and Schiller 2006). Moreover, OSHA investigators typically correspond directly with workplace safety managers at firm headquarters when finding a violation, meaning that headquarters is aware of violations and, hence, able to coordinate a response even if those violations occur elsewhere.

geographic substitution. Even if our results reflect internal reallocation of workplace safety resources, this would still be consistent with the presence of within-OSHA information frictions. In the absence of within-OSHA information frictions, the penalty for a subsequent violation should be equally severe across locations, reducing the rational incentive to reallocate resources.[3]

We next explore the two key channels driving geographic violation substitution by studying inspections and the severity of punishment, related to the detection and deterrence of violations, respectively. To identify the detection channel, we distinguish between three types of inspections: reactive inspections (inspections made in response to a trigger event such as an injury or whistleblower referral), centrally planned inspections (those that OSHA headquarters requires field offices to carry out, but that are not in response to any trigger event), and discretionary inspections (inspections proactively initiated by individual state-level OSHA field offices). We find that a firm's likelihood of facing a reactive OSHA inspection increases subsequent to prior out-of-state violations. However, we find no change in how either OSHA headquarters or individual OSHA field offices select target firms for planned or discretionary inspections in response to out-of-state violations. These results suggest that information frictions within OSHA limit the effectiveness of OSHA's violation-detection efforts and are consistent with our interviewees' assertion that OSHA offices lack the necessary internal information about overseen firms' broader firm-wide activity to effectively choose inspection targets.

We next investigate the deterrence channel, i.e., whether information frictions may limit OSHA's ability to properly assess appropriate fines that deter future misconduct. By law, fines for workplace safety violations increase tenfold if the violation is deemed *Repeat* (the employer was cited for the violation before and violated again) or *Willful* (acted with disregard for worker

[3] Any differences across states are accounted for by the firm-by-state fixed effects in our empirical design.

safety). Our interviews and the OSHA Field Operations Manual indicate that (i) these violations require significant documentation of firms' past interactions with OSHA, and (ii) it is more difficult to obtain documentation from out-of-state offices than from same-state offices. We find that while violations in one state increase following a violation in another state, the penalties for these violations do not follow the firm and ratchet upward accordingly. Specifically, violations designated Repeat or Willful are more likely to occur following a violation within the same state but are no more likely following a violation in another state. Our results are consistent with OSHA state offices being less able, due to internal information frictions, to assess severe penalties to violating firms if those firms have shifted cutting corners across state lines. With less of a deterrence mechanism available to OSHA, there is a clear financial benefit to firms in shifting cost cutting related to workplace safety across state lines to avoid severe penalties.

As an additional test, we exploit the partially devolved nature of OSHA. The OSH Act permitted states to substitute their own state-level agencies, called "state plans", for federally-run OSHA offices. State plan offices must follow federal standards and use OIS but are partially state funded and are given more discretion in selecting inspection targets. However, this discretion may come at a cost. Our interviews with OSHA compliance officers suggested that fewer informal relationships exist with compliance officers in state plan states which, given OIS limitations, may further inhibit state plan states' abilities to respond to prior violations in other states. As a result, within-OSHA information frictions are likely to be higher between two states when one of those two states operates a state plan. Consistent with this argument, we find that geographic substitution in violations is stronger into state plan states. This finding corroborates our argument that our geographic substitution results reflect within-OSHA rather than within-firm information frictions, because within-firm frictions are unlikely to systematically vary across firm operations in two states based on whether one of those states has an OSHA state plan.

Our final set of tests explores firm-level financial motives, opportunities, and culture as drivers of geographic substitution, based on the fraud triangle (Wilks and Zimbelman 2004). With respect to financial motives, we find that firms engage in more geographic substitution following Repeat or Willful violations in other states. We also find that firms engage in more (less) geographic substitution when they just meet or beat analyst earnings benchmarks (have stronger financial performance), indicating greater (lesser) incentive for cost cutting. With respect to firm-level opportunities, we find that geographic substitution is stronger in firms with higher internal information quality, suggesting that internal information quality helps firms engage in regulatory arbitrage (Gallemore and Labro 2015). We also find that firms with more dispersed operations are more likely to engage in geographic substitution, suggesting that dispersed operations provide firms with more options for where to shift violations. Conversely, firms with higher board independence, reflecting better governance and monitoring of management, are less likely to engage in geographic substitution. Finally, firms with greater ability to rationalize poor behavior – as evidenced by weaker compliance cultures – are more likely to engage in geographic substitution, indicating that attitudes toward best practices play a role in substitution behavior.

Our study makes three main contributions. First, a wide body of work highlights the importance of information sharing and delegation to an organization's effectiveness (Abernethy, Bouwens, and van Lent 2004; Li and Sandino 2018, 2021). We contribute to this literature by providing evidence on the real effects of information sharing systems within OSHA. Our findings suggest that the structure of OSHA, including bureaucratic constraints, may present information frictions that underlie a distinct cost of delegation. In this regard, our study suggests a need to better understand the effects of informational constraints within other federal regulators where multiple branches are involved in the enforcement process (e.g., Stice-Lawrence 2020).

Second, we provide insight into how a regulator's information environment affects overseen firms' practices. We contribute to a nascent literature on how a regulator's "blind spots" may encourage firms to engage in regulatory arbitrage (Aobdia 2018; Beuselinck et al. 2019). Because we focus on how both the frequency and geography of corporate misconduct is affected by internal information asymmetry within a regulator, we also contribute to the literature on the costs and benefits of federalism, especially in the context of workplace safety (e.g., Morantz 2009).

Third, a growing literature in accounting studies the antecedents and consequences of regulatory investigations (e.g., Blackburne, Kepler, Quinn, and Taylor 2020; Call, Martin, Sharp, and Wilde 2018; Solomon and Soltes 2020). Consistent with studies on SEC investigations, our findings suggest that a lack of investigations incentivizes firms to engage in misconduct more often. We add to this literature by distinguishing proactive from reactive enforcement practices and highlighting how inefficiencies in a regulator's internal information environment can hamper its ability to proactively undertake investigations. In doing so, our study bridges prior empirical work that focuses on either proactive enforcement, through mechanisms such as inspection target selection (e.g., Bonsall, Holzman, and Miller 2020) or reactive enforcement, through mechanisms such as whistleblowing (e.g., Bowen, Call, and Rajgopal 2011; Heese and Pérez-Cavazos 2021).

2. Related Literature and Background

2.1 Related literature

2.1.1 Workplace safety

Our work is related to recent studies on the financial determinants of workplace safety. Cohn and Wardlaw (2016) find that firms respond to unexpected financial constraints by cutting safety-related expenses which, in turn, leads to a higher injury rate in constrained firms. Caskey and Ozel (2017) show that short-term capital market pressures – in the form of meeting or beating

analyst forecasts – may induce actions that lead to more frequent workplace illnesses and injuries. Similarly, Bernstein and Sheen (2016) and Cohn, Nestoriak, and Wardlaw (2021) find that private equity buyouts, which suddenly shift a firm's investor base, lead to decreases in subsequent workplace safety incidents. We differ from these studies in two ways. First, we address workplace safety from the regulator's rather than the firm's perspective, building on work on policies enacted to deter workplace safety-related misconduct (Johnson 2020). We show that information frictions likely reduce the positive externalities of increased enforcement across jurisdictions. Second, we use data on actual violations of workplace safety laws rather than injury rates. While the two constructs are related, studying violations and inspections treats OSHA as an active participant in, rather than a passive observer of, workplace safety (Glaeser and Guay 2017).

We also build on prior work on the efficiency of OSHA's deterrence efforts. For example, Johnson (2020) finds that OSHA's policy of "regulation by shaming"—publishing press releases for violations incurring fines above a threshold—leads to a reduction in violations at other nearby facilities. Johnson, Levine, and Toffel (2017) study local spillover effects of randomized OSHA inspections, finding that facilities close to inspected establishments experience declines in subsequent workplace injury rates. The authors attribute this to local information transmission across firms. Our study differs from these in its focus on interstate information transmission within the regulator and its effects on firm behavior. In addition, while these two studies focus on federally-run OSHA plans, we also consider state plans to better understand the role that information plays in workplace safety outcomes. In doing so, we draw on and contribute to literature on the benefits and costs of federalism in workplace safety regulation.[4]

[4] Bradbury (2006) documents a negative association between state plan presence and workplace fatalities. In contrast, Morantz (2009) finds that state plans are associated with a higher rate of non-fatal injuries and

2.1.2 The geography of misconduct

Geographic factors can affect firms' misconduct decisions. For example, Dyreng, Hanlon, and Maydew (2012) find that multinational firms operating in weak rule-of-law countries engage in more earnings management while Beuselinck et al. (2019) find that multinational firms strategically manage earnings at the subsidiary level based on opportunities available in those subsidiaries' locations. Misconduct is also affected by the interaction between a firm's and a regulator's locations. For example, a firm's financial reporting quality is lower when its local SEC office's case backlog is higher (Bonsall, Holzman, and Miller 2020), while a shorter distance from a firm's headquarters to its nearest SEC office is associated with better financial reporting quality (Kedia and Rajgopal 2011) and more conservative usage of going-concern opinions (DeFond, Francis, and Hallman 2018). Similarly, Choi, Kim, Qiu, and Zang (2012) find that audit quality is higher when audit offices are closer to the client's headquarters. Within-auditor distance also affects financial reporting practices, as Beck, Gunn, and Hallman (2019) find that greater distance between audit offices reduces positive audit quality spillovers. Recent evidence suggests geography also impacts monitoring frictions. Stice-Lawrence (2020) shows that after a firm has a negative financial reporting event, its peer firms subsequently face heightened SEC monitoring of that firm's peers (i.e., attention spillovers). However, this effect attenuates when peers are covered by different SEC regional offices, suggesting information frictions within the SEC.

Because financial reporting is a firm-level construct, the studies noted above cannot speak to how regulatory frictions may affect the geography of misconduct *within* firms. We build on this literature by showing how geography affects within-firm decisions to engage in misconduct. While we are not aware of prior research on geographic misconduct shifting by firms, prior

lower fines collected for similar violations. Finally, Jung and Makowsky (2014) argue that state plan enforcement practices are more responsive to local economics than federal plans.

research on misconduct shifting by individuals suggests that this is plausible. For example, firearms flow from jurisdictions with weak gun-control laws to jurisdictions with strict laws (Knight 2013), resulting in higher rates of violent crime and criminal firearm possession in strict-law areas bordering weak-law areas (Dube, Dube, and Garcia-Ponce 2013). Misconduct may also shift across state lines in response to dynamic enforcement practices. For example, Iyengar (2008) shows that the California Three Strikes law (where a third qualifying felony conviction results in an escalated sentence) led criminals with second and third-strike eligibility to migrate to neighboring states (where the consequences would be lower) to commit crimes.

2.1.3 Internal information environments

Prior work highlights both the costs and benefits of decentralization within organizations. Decentralization empowers frontline employees who better understand localized needs (Baiman, Larcker, and Rajan 1995), but at the cost of potentially less effective communication across the organization (Melumad, Mookherjee, and Reichelstein 1992; Alonso, Dessein, and Matouschek 2008). Delegation is also more effective when doing so increases alignment with the local business environment (Robinson and Stocken 2013). However, while more delegation occurs under better external information environments (Sani 2021), it may come at the cost of firms making less use of decision-relevant data collection and dissemination (Labro, Lang, and Omartian 2019). We add to this literature by showing how the information environment and decentralized nature of a regulator can impact investigations and penalties, which in turn impacts firm behavior. Moreover, our findings on firm incentives and opportunities for geographic substitution suggest that there is significant interaction between firm-level and regulator-level frictions.

Specific to our setting, limited empirical work exists on the role of internal information in either facilitating or preventing workplace misconduct. The two most relevant studies in this

regard are Hope, Wang, Yue, and Zhao (2021), who show that higher firm-level information quality is associated with lower work-related injury rates, and Heese and Pérez-Cavazos (2020), who find that the introduction of direct airline routes between a firm's headquarters and facility cities reduces misconduct in those facilities. Our study builds on these prior papers by studying the role of internal information in the regulator rather than in overseen firms.

2.2 Background

2.2.1 OSHA enforcement

Under the Occupational Safety and Health (OSH) Act of 1970, OSHA is responsible for inspecting and examining workplaces to ensure compliance with workplace safety regulations.[5] OSHA is decentralized: inspections and enforcement are federally overseen but administered by state-level offices.[6] Federal law requires inspections to be conducted without advance notice so that firms cannot pre-emptively cover up issues.[7] During an inspection, an OSHA inspector engages in a walkaround at the place of business, recording any safety-related issues they observe. The inspector then determines whether there was a violation and documents their findings. Violations occur if four conditions are met: (i) a workplace hazard is present; (ii) that hazard violates a relevant OSHA standard; (iii) the employer had knowledge of the standard; and (iv) there was employee exposure to the hazard. Finally, the inspector alerts the company, which includes engaging directly with company safety officers (including firm-level management). The inspector then offers a plan for remediating the violation and assesses an appropriate penalty.

[5] See https://www.osha.gov/laws-regs/oshact/completeoshact.
[6] Firms only face OSHA inspections at the state level, which differs from the financial sector where banks may face supervision by both federal and state regulators (Agarwal, Lucca, Seru, and Trebbi 2014).
[7] See the OSHA Field Operations Manual. Exceptions relate to cases in which there is imminent danger, or when notice is necessary to aid in the inspection. Under the latter, advance notice "shall not be given more than 24 hours before the inspection is scheduled to be conducted" (29 CF 1903.6(b)).

Penalties come in two forms. The first is a smaller penalty assessed to a single workplace violation, such as the lack of proper guards on a metal-stamping machine or failing to provide proper signage regarding hazardous chemicals. The current penalty for this common violation is $13,494.[8] A heightened penalty of $134,937 results for violations deemed to be *Repeat* or *Willful*. Repeat violations are assessed if the employer has been previously cited for a similar violation, whereas Willful violations are defined as those in which the employer knowingly failed to comply or acted with indifference to employee safety. Beyond direct fines, violations also result in time-consuming and costly ex-post remediation actions. Firm officers and safety supervisors must meet with OSHA compliance officers and invest time addressing safety issues to these officers' satisfaction. Corporate counsel is typically involved in any negotiation with OSHA. Failure to meet officers' requests results in further, heightened penalties and actions taken by OSHA and can expose the firm to legal issues (Li and Raghunandan 2021). Violations may also lead to reputational damage, harming a firm's ability to do business in an area in which it commits a violation as well as its ability to secure government contracts (Johnson 2020). While we cannot directly measure each of these costs, the fact that all of these costs follow from OSHA enforcement actions underscores the relevance of understanding this process for firms.

2.2.2 Information frictions within OSHA

Inspection details, including violations, are recorded in a centralized electronic database maintained by OSHA headquarters, the OSHA Information System (OIS). OIS contains hard information, including citations for violations, assessed penalties, and the OSHA compliance manager involved in the case and their associated field office. From interviews with OSHA compliance officers, we learned that checking OIS is an important first step in preparing to inspect

[8] See Federal Register Vol. 85, No. 10 (https://www.govinfo.gov/app/details/FR-2020-01-15).

a workplace. The information recorded in OIS includes how a firm has been cited previously, what the citations were for, and the location and relevant dates of the violation(s).

However, inspection details, case documents related to violations or remediation actions, and personal notes of the OSHA compliance officer in charge of assessing any citations are not available on OIS and must be obtained, either electronically or in paper form, directly from the relevant OSHA field office and its staff. Obtaining case documents from a past inspection requires formal requests that can only be completed by directly involving supervisors overseeing field office operations. In our interviews, OSHA compliance managers noted the emergence of an informal information sharing practice across OSHA state offices for obtaining inspection details due to the lack of complete information available via OIS. This informal system relies on supervisors from different states having a good working relationship. Otherwise, these types of requests can take months to get a response, if they are addressed at all.

Our interviewees made it clear that the above organizational friction has a meaningful impact on how they conduct investigations, particularly for geographically dispersed employers. Notably, OSHA compliance officers in charge of an employer inspection may decide to forgo obtaining past case documents for a firm if it involves requesting documentation from a field office in a different state. One interviewee argued that the frictions described above are especially meaningful in determining whether to classify violations as Repeat or Willful. As discussed in Section 2.2.1, for Repeat or Willful violations, the OSHA compliance officer must show that a firm had knowledge of the prior violation and either continued to violate or actively ignored its employees' health and safety. Such a violation can only be assessed if a paper trail exists tying a manager or corporate officer to each violation. The documentation necessary for creating this paper trail does not exist on the federal centralized information system OIS. A compliance officer must therefore rely on informal communication with officers involved in prior investigations to

obtain relevant documents. Our interviewees indicated that obtaining documentation required to substantiate classifying a violation as Repeat or Willful was much easier to obtain if past violations were assessed by compliance officers in the same state, rather than in another state.

2.2.3 State plans

Twenty-one states, listed in Appendix A, have state plans to supplement the resources and standards set by federal OSHA in inspecting, monitoring, and assessing violations for private sector employers. State plans are OSHA-approved and are required by OSHA to be at least as effective as federal OSHA at protecting workers. Each year, OSHA conducts Federal Annual Monitoring Evaluations of state plans.[9] Each state plan adopts its own additional safety and health standards and regulations. State Plan state jurisdictions have significantly more discretion in undertaking inspections, but their assessment of violations and relevant penalties must follow the OSHA Field Operations Manual as for federal OSHA state jurisdictions.[10]

State plan state jurisdictions were adopted early enough before our sample period to be considered exogenous to the outcomes we study (see Appendix A for adoption dates). Due to state plan idiosyncrasies, there may be greater information frictions between state plan states and non-state plan states. Our interviews with OSHA compliance officers suggest that this may reflect required reciprocity in gathering relevant documents across jurisdictions. Because state plan state jurisdictions have their own set of policies, communication may be impeded.[11]

[9] See https://www.osha.gov/stateplans.
[10] For further details, see the State Plan Policy and Procedures Manual (https://www.osha.gov/sites/default/files/enforcement/directives/CSP_01-00-005.pdf).
[11] This is consistent with the argument that when specialization is high and communication is costly, it is inefficient for agents within an organization to collaborate (Bolton and Dewatripont 1994).

3. Model

There is limited work studying how within-regulator information flows affect firms' misconduct decisions. To make our investigation more concrete and to motivate our empirical predictions, we therefore present a simple stylized model adapted from Schantl and Wagenhofer (2020). Because we wish to understand how information frictions within OSHA may lead geographic substitution to arise within a firm, our model consists of a single firm operating in two locations, with a separate OSHA office in each location. Our empirical hypotheses follow directly from the model's main proposition. We include a more technical discussion of the model in Appendix B. A reader focused primarily on our empirics may wish to proceed directly to Section 4.

A single firm operates plants in two different states $j \in \{1, 2\}$. For simplicity we assume both plants are capacity-constrained such that the firm always produces up to its full capability in each location. We do not explicitly model the demand for the firm's output nor the firm's production function. The firm also incurs production costs $\tilde{c}$ in each location, where production costs can be high ($\tilde{c} = c_H$) with some probability or are otherwise low ($\tilde{c} = c_L$). Low production costs, before considering the effects of enforcement, provide the firm with additional profits that are normalized to 1 ($c_H - c_L = 1$) in each location, without loss of generality.

We assume that if the firm observes low costs, it takes no illegal or manipulative actions with respect to workplace safety.[12] If the firm's production costs are high, however, it can illegally cut corners in each market to lower its production costs for that market. The firm chooses a probability m_j that illegal cost-cutting succeeds for each location j. Cost-cutting success in one location results in a benefit normalized to 1. However, the firm incurs a fine F if it is caught in successful cost-cutting. We let $\widehat{b_j}$ be the firm's belief about the probability that OSHA detects the

[12] In practice, a firm may always have some desire to engage in cost-cutting. Our insights are valid as long as this desire is convex—that is, the firm's benefit from cutting costs is higher when its costs are higher.

firm's illegal actions in market *j*. The firm also incurs disutility from manipulative effort in each region, scaled to m_1 and m_2, regardless of whether its manipulation succeeds. In summary, we let the firm's net utility from manipulation be given by

$$U(m_1, m_2|c = c_H) = m_1\left(1 - \widehat{b_1} \cdot F\right) + m_2\left(1 - \widehat{b_2} \cdot F\right) - \left[\frac{1-\theta}{2}m_1^2 + \frac{1-\theta}{2}m_2^2 + \frac{\theta}{2}(m_1 + m_2)^2\right] \quad (1)$$

The structure of Equation (1) follows that in Schantl and Wagenhofer (2020). The constants $\frac{1-\theta}{2}$ and $\frac{\theta}{2}$ for $\theta \in (0,1)$ reflect a normalization for the sake of parsimony. The disutility of manipulation reflects both market-level costs ($\frac{1-\theta}{2}m_1^2$ and $\frac{1-\theta}{2}m_2^2$) of manipulation in those markets and also firm-level costs $\frac{\theta}{2}(m_1 + m_2)^2$ of the total manipulation by the firm. Market-specific costs include managerial career concerns or low morale of employees working at an unsafe facility. Firm-level concerns include litigation risk or reputational damage that may arise due to systematically poor employee treatment. Li and Raghunandan (2021) document that firms engaging in higher levels of labor-related misconduct are more likely to subsequently settle employee class-action lawsuits, with costs upwards of $10 million per settlement, suggesting that the marginal cost of manipulation is increasing across markets. Finally, firm-level costs may exist if firm culture of workplace safety is important for operational efficiency and profitability.[13] As shown in Appendix B, manipulation in each region is decreasing in the probability of inspection in that region but increasing in the probability of inspection in the other region.

Two OSHA branches ("OSHA1" and "OSHA2") seek to detect misconduct when it occurs, but detecting misconduct is costly. Achieving success with probability b requires that an OSHA office expend effort $\frac{kb^2}{2}$, where k is a constant. Both OSHA branches can infer whether a plant had low or high production costs based on its output. An OSHA branch will therefore only

[13] For a real world example, see the success of Paul O'Neill's implementation of strict workplace safety standards at Alcoa (Harvard case: https://www.hbs.edu/faculty/Pages/item.aspx?num=26838).

(potentially) investigate when it observes low costs for the firm, because the firm has no incentive to increase its costs. Each OSHA branch can see reported costs for its location, but not the other.[14]

Along with the observable signal of costs, OSHA in each region observes a noisy signal $\tilde{y}_j$ of the true costs (i.e., the costs before the firm engages in any cost-cutting efforts), following Schantl and Wagenhofer (2020). This signal is given by

$$\tilde{y}_j = \tilde{c} + \tilde{I}_j \tag{2}$$

where $\tilde{I}_1$ and $\tilde{I}_2$ are independent noise terms. Without loss of generality, we assume that in the previous year the firm had a chance to manipulate in only region 1. If the firm did not manipulate, or if the firm did manipulate and was not caught by OSHA1, then neither OSHA1 nor OSHA2 learns any information and the variances of $\tilde{I}_1$ and $\tilde{I}_2$ are given by $u^2 + \alpha^2$ for non-zero u and α.

If OSHA1 detects a violation, it gains knowledge of the firm's operational processes through its inspections and remediation efforts with the firm, reducing uncertainty in the signal $\tilde{y}_j$, which is modelled as a reduction in the variance of $\tilde{I}_1$ to u^2 (from $u^2 + \alpha^2$). OSHA1 then imperfectly conveys information to OSHA2 due to information frictions in sharing information beyond OIS (OSHA Information System). This information reduces the variance of $\tilde{I}_2$ to $u^2 + \delta^2$ (from $u^2 + \alpha^2$), where $\delta^2 < \alpha^2$. That is, OSHA2's signal is more precise than before, but is still noisier than OSHA1's signal. The term δ^2 reflects the level of information frictions present.[15] A higher δ^2 means OSHA2 learns less from OSHA1. We do not outline the model equilibrium here. The model's main results (proved in Appendix B) are contained in the following proposition:

[14] While this assumption is useful for tractability of the model, it does not alter our main conclusions. Moreover, in interviews with OSHA inspectors, our reasoning is in keeping with the functional oversight OSHA offices have over firms in and out of the state.

[15] We do not endogenize δ^2. In practice, OSHA1 might choose δ^2 based on information-sharing costs or investigative resources available. Moreover, as individual OSHA offices spend more effort on sharing information with other offices, they will have fewer resources available for conducting their own investigations. In our interviews with OSHA compliance officers, we identified a microfoundation for the existence of non-trivial informational frictions between OSHA offices, which we discuss in Section 2.

Proposition 1. *If OSHA1 has observed a violation in the previous year:*

(i) *Overall manipulation is lower than in the case where OSHA1 did not observe a violation in the previous year*

(ii) *Manipulation in market 1 is lower when OSHA1 has observed a prior-year violation compared to when OSHA1 has not observed a prior-year violation. However, manipulation in market 2 when OSHA1 has observed a prior-year violation may be either higher or lower compared to when OSHA1 did not observe a prior-year violation. Specifically, there is some threshold value for which manipulation in market 2 when OSHA1 has observed a prior-year violation is higher than the no-prior-year-violation case if and only if frictions are above the threshold.*

(iii) *Manipulation in market 1 decreases when the level of information frictions increase while manipulation in market 2 increases as a function of information frictions.*

Condition (i) of Proposition 1 states that when OSHA becomes more informed following the detection of a violation, the sum of the firm's manipulation across markets decreases. This is consistent with the prior literature, both empirical (e.g., Macher, Mayo, and Nickerson 2011) and theoretical (e.g., Laffont and Tirole 1986), which suggests that regulators can deter manipulation by being better informed. Part (i) of Proposition 1 implies our first empirical hypothesis:

Hypothesis 1. *Firms that are sanctioned by OSHA for workplace safety violations are less likely to commit workplace safety violations in the following year.*

Part (ii) of Proposition 1 explores the tension resulting from asymmetric information between OSHA1 and OSHA2. On one hand, OSHA2 is more informed after OSHA1 observes a violation, increasing the likelihood OSHA2 will investigate the firm. On the other hand, the fact that OSHA1 is relatively more informed encourages the firm to substitute manipulation in market 1 to market 2. In Condition (ii), we learn that which of these two forces dominate depends on whether the level of information frictions exceeds a threshold. Whether this is the case is an empirical question. Based on our interviews we expect that, empirically, information frictions often do exceed this theoretical threshold. We thus have a second empirical hypothesis:

Hypothesis 2. *Information frictions within OSHA lead to firms engaging in geographic misconduct substitution. That is, a firm that commits a violation in one location is less likely to commit a violation in the same location next year but more likely to commit a violation in a different location next year.*

Part (iii) of Proposition 1 extends condition (ii) by establishing that the level of information frictions matters. Greater information frictions lead the firm to substitute away from manipulation in market 1 toward manipulation in market 2. When information frictions are more severe, OSHA2's signal is noisier relative to OSHA1's. Hence, OSHA2 is less likely than OSHA1 to investigate even when it sees a high signal. This generates our third empirical hypothesis:

Hypothesis 3. *The level of geographic misconduct substitution by the firm is positively associated with the level of information frictions within OSHA.*

4. Empirical strategy

4.1 OSHA Data

We obtain OSHA inspection and violation data from the US Department of Labor's Enforcement Data webpage.[16] The data contain the name and address of the firm being inspected, the inspection date, inspection type, whether violations occurred, and, if violations occurred, further information about those violations. OSHA's classification of inspection types is detailed enough that we are able to distinguish between inspections that are discretionary on the part of regional OSHA offices (i.e., initiated without either a directive from federal OSHA headquarters or in response to a trigger event), inspections that are centrally planned by OSHA headquarters, and inspections that are reactive (in response to a trigger event such as a workplace injury or a whistleblower complaint). We provide further details on OSHA inspection types in Appendix C. With respect to violations, we observe for each violation the penalty amount assessed by OSHA as well as whether the violation is classified as Repeat or Willful. We collapse violation and inspection data to the firm-state-year level. Since OSHA's unit of organization is the state level, we view this as the most natural level at which to conduct our analyses.

[16] https://enforcedata.dol.gov/views/data_summary.php

4.2 Baseline econometric specification

Our base specification tests whether committing an OSHA violation in year t affects the likelihood that a firm commits an OSHA violation in year t+1. Our unit of analysis is the firm-state-year level. We omit firm-state-years for which we do not observe at least one establishment. Our sample selection process is outlined in Table 1.

Our research design relies on firm-by-state fixed effects, which eliminate time-invariant firm, state, and joint firm-state factors as drivers of our findings. For example, although there may be cross-sectional variation across locations in both enforcement practices (Bonsall, Holzman, and Miller 2020) and the proclivity for engaging in misconduct (Parsons, Sulaeman, and Titman 2018) our results cannot be explained by the enforcement rate for a particular state's OSHA office or the nature of a firm's operations in a specific state. Importantly, this fixed effects structure also controls for firms' overall level of activity within each state.[17] We also include year fixed effects to account for macroeconomic factors, whether economy-wide or concentrated within specific industries, that may drive the underlying decision to commit a violation. Because a nonlinear binary choice model (e.g., logit or probit) cannot accommodate our fixed effects structure due to the incidental parameters problem (Chamberlain 1984), we estimate a linear probability model:

$$ViolAny_{i,j,t+1} = \beta_0 + \beta_1 ViolInState_{ijt} + \beta_2 ViolOutState_{ijt} + \alpha Controls_{ijt} + \theta_{ij} + \gamma_t + \varepsilon_{ijt} \quad (3)$$

In Equation (3) above, i indexes firm, j indexes state, and t indexes time. The quantities θ_{ij} and γ_t denote firm-by-state and year fixed effects, respectively, while ε_{ijt} is an error term. $Controls_{ijt}$ includes the number of establishments that firm i has in state j in year t and financial measures found by prior literature to affect workplace safety (Cohn and Wardlaw 2016; Caskey and Ozel

[17] Without firm-by-state fixed effects, we may observe a spurious positive correlation between year-t violations and year-t+1 violations, because a firm with a larger economic presence in a state will mechanically have more violations in both years than a firm with a smaller presence in the state.

2017). These financial measures include firm assets, return on assets, leverage, and market-to-book ratio. Controlling for the number of establishments that each firm has in each state in each year addresses alternative explanations related to firm-state level changes in economic activity over time, which are not fully captured by firm-by-state fixed effects.[18] The primary dependent variable that we consider, $AnyViol_{it+1}$, is an indicator that equals 1 if the firm committed at least one OSHA violation in any state in year *t+1*. The key independent variables in Equation (3) are $ViolInState_{ijt}$, an indicator that equals 1 if the firm committed at least one violation in state *j* in year *t* and $ViolOutOfState_{ijt}$, an indicator that equals 1 if the firm committed at least one violation in any other state in year *t*. Robust standard errors are clustered by firm. This specification provides insight into the *overall* likelihood that a firm engages in repeated workplace safety violations. Hypothesis 1 predicts negative values of both β_1 and β_2.

4.3 Geographic substitution in workplace misconduct

We next augment Equation (3) to test whether firms engage in geographic substitution related to misconduct, i.e., whether after committing a violation in some state *A* in year *t* they are (i) less likely to commit a violation in state *A* in year *t*+1 but (ii) more likely to commit a violation in some other state *B* in year *t*+1. To do so, we estimate the following specification:

$$ViolInState_{i,j,t+1} = \beta_0 + \beta_1 ViolInState_{ijt} + \beta_2 ViolOutOfState_{ijt} + \alpha Controls_{ijt} + \theta_{ij} + \gamma_t + \varepsilon_{ijt} \quad (4)$$

In Equation (4), $ViolInState_{ijt}$ and $ViolOutOfState_{ijt}$ are defined as before. Negative values of both β_1 and β_2 would imply that geographic substitution is dominated by the deterrence effect of heightened OSHA scrutiny. Conversely, a positive β_2 but negative β_1 implies that geographic

[18] While we cannot observe firm-state level employee counts in our data, this is a valid measure as long as a firm's economic activity in a given state is related to the number of establishments the firm has in that state. ReferenceUSA, where we obtain establishment data from, does contain some information on employment but this information is known to be highly unreliable (see, e.g., Makridis and Ohlrogge 2017).

substitution dominates these potential mitigating factors. We acknowledge that a positive β_2 in Equation (4) is not sufficient on a standalone basis to conclude that within-OSHA information frictions affect firm behavior. However, we emphasize that a positive coefficient on β_2 is not consistent with information frictions *within the firm*. Within-firm information frictions (e.g., if a firm learns "best practices" in its locations in State *B* but does not transmit information about these best practices to its locations in state *A*) imply greater statistical independence in the firm's operations in the two states, leading to an insignificant coefficient on β_2. This, in turn, biases against us finding results consistent with geographic substitution information frictions within OSHA.

5. Results

5.1 Descriptive statistics

Panels A and B of Table 2 provide descriptive information about OSHA violations and inspections by year and 2-digit NAICS industry. For a full list of variable definitions, we refer the reader to Appendix D. Panel A indicates that OSHA violation and inspection rates are generally stable over time. The percentage of firm-state-years with at least one violation ranges between 3.2% and 4.7% over our sample period with an overall sample mean of 4.1%, while the percentage of firm-state-years with at least one inspection ranges between 5.5% and 7.2% with an overall sample mean of 6.5%. These results are consistent with our finding in the underlying inspection-level data (untabulated) that more than 60% of inspections result in at least one violation. The relatively high "hit rate" may reflect the fact that most inspections are reactive, i.e., in response to a tip or trigger event (such as an injury). In further support of this is our inspection-level finding (see Appendix C) that state office-driven discretionary inspections comprise less than 8% of total inspections that OSHA undertook during our sample period.

Turning to Panel B, we see that firms in the retail trade, manufacturing, transportation, and hospitality industries appear to most frequently commit OSHA violations and are inspected the most frequently by OSHA. These industries are all labor-intensive and rely on low-wage workers who may be less aware of their rights in the workplace. The relative proportion of discretionary inspections comprises a larger share of total inspections in the construction industry than in others. Surprisingly, we see similar ratios of discretionary inspections to total inspections in both high-violation industries (e.g., retail trade) and low-violation industries (e.g., healthcare).

In Panel C we provide descriptive statistics for our regression sample used in Tables 3 - 8. The average firm-state-year commits a violation approximately 4.1% of the time. Nearly half (48%) of firm-state-years represent firms that committed a violation in at least one state in that year (i.e., $AnyViol_{it} = 1$). This is unsurprising, given that a single violation in a single state will set $AnyViol_{it}$ to 1 for all firm-states in which that firm operates. Sample firms have a median of four establishments in the states in which they operate. Sample firms are also generally large and relatively profitable, as evidenced by even the 10th percentile of ROA being positive.

5.2 Baseline model

We begin by implementing Equation (3) using a firm-state-year panel. We present results from this specification in Table 3. The dependent variable in both cases is $ViolAny_{it+1}$, an indicator that equals 1 if firm *i* commits an OSHA rule violation in any state in year *t*+1. In Column (1) we include only the independent variables of interest, $ViolInState_{ijt}$ and $ViolOutOfState_{ijt}$, while in Column (2) we also include firm-level control variables. We find that committing an OSHA violation in any location in one year is negatively associated with committing an OSHA violation in any location in the next year. A lower firm-wide violation rate in the year following a detected violation is consistent with the prediction in our model and in Hypothesis 1, that OSHA sanctions

serve to deter firms from committing future OSHA violations. This result is also consistent with prior work on the deterrence effect, which shows that the OSHA enforcement process reduces future violations by the same firm (e.g., Weil 1996; Levine, Toffel, and Johnson 2012).

5.3 Geographic substitution

While we observe a decrease in the firm-wide violation rate after a prior-year violation, this decrease need not be uniform across states in which the firm operates. There are economic reasons to expect a non-uniform effect across states because of OSHA's structure. OSHA's decentralized structure leads to information frictions across state lines (as shown by our model and corroborated by our interviewees) and, hence, imperfect sharing of case-related information across states. Firms thus have incentives to substitute opportunistic behavior across states because the expected cost of shifting violation locations is lower than the expected cost of continuing to commit violations in the same state over time. Hence, while a firm's likelihood of committing a future violation in the same state following a current-year violation will decrease, it may not reduce its future violation likelihood to the same extent (if at all) in other states.

We explicitly test for such heterogeneity by estimating Equation (4) in Table 4. Column (1) includes our full set of fixed effects but no control variables, while Column (2) introduces control variables. We find that violations in a given state are associated with fewer violations in the same state in the next year. However, violations in out-of-state facilities are associated with more in-state violations the next year. The latter result is consistent with geographic substitution and indicates that within-OSHA information frictions dominate any potential learning effect.[19] The findings in Column (2) imply that if the results are driven by something other than

[19] See Hypothesis 2 and the accompanying Condition (ii) of Proposition 1 for more details.

substitution, it must be related to worker safety outcomes but unrelated to firm performance, capital structure, or valuation. Moreover, if firms shift violations across establishments, rather than across states, this should lead to substitution within states, biasing against our findings.

To allow for a more quantitative interpretation of our findings, in Columns (3) and (4), we consider penalty severity rather than incidence. We replace $ViolInState_{ijt}$ and $ViolOutOfState_{ijt}$ with $\ln Penalty\$InState_{ijt}$ and $\ln Penalty\$OutOfState_{ijt}$, the natural logarithms of one plus the dollar values of penalties assessed for in-state and out-of-state violations, respectively. Using dollar penalties allows us to do a back-of-the-envelope calculation to determine the elasticity of substitution in penalty dollars across state lines. Because the average observation in our data is of a firm with operations in 30 other states, we multiply that by the coefficient on $\ln Penalty\$OutOfState_{ijt}$ to find that every $1000 in penalties in one state results in the firm substituting behavior in a way that leads to an increase of $111 in penalties in other states. In other words, there is an 11.1% elasticity of substitution (0.37% × 30 states). This result is in keeping with the existence of exploitable information frictions within OSHA that the firm can take advantage of. To better understand the interactions between firm and OSHA behavior, we focus the remainder of our analysis on the incidence of violations rather than penalty dollars. Finally, in untabulated analyses, we also find that our results are robust to the inclusion of firm by year fixed effects, indicating that our findings are unlikely to be explained by learning or firm-specific shocks to operational efficiency.

6. How do within-OSHA information frictions affect violation behavior?

Information frictions within OSHA may inhibit inspectors' ability to assess fines through one of two channels: (i) less efficient selection of target firms to inspect, and (ii) an inability to hold firms accountable for habitual violations by assessing appropriate penalties. In this section, we investigate these two channels. Because a violation requires a preceding inspection and because

deterrence should be tightly related to the punishments that can be assessed, these are likely the first order mechanisms behind geographic substitution.

6.1 Inspections

If information frictions affect local OSHA inspectors' abilities to respond to violations outside their jurisdiction, then we should see patterns arise on the extensive margin of inspector behavior: inspections. To assess this possibility, we model the degree to which inspections in a state follow from prior violations inside and outside of that state. We alter equation (4) by replacing the dependent variable with $AnyInspectionInState_{ijt+1}$, a dummy variable that equals one if there is an inspection conducted of firm *i* in state *j* in year *t*+1, and then including dummy variables for whether or not there was a violation in the state or in another state. We also control for prior-year "clean" inspections, i.e., indicators $CleanInspInState_t$ and $CleanInspOutOfState_t$, that equal one if a firm faced year-*t* inspections but no violations in-state and out-of-state, respectively.

Most inspections are not undertaken at the discretion of state-level OSHA offices. Instead, they are more often taken in direct response to triggering events (e.g., confidential tips or workplace injuries) or are determined by a formula set at the federal level.[20] Individual OSHA offices have little say in whether to conduct these inspections with the reactive inspections occurring only after something has gone wrong. To understand how information frictions affect inspection behavior, it is therefore important to understand patterns in more discretionary, proactive inspections. Discretionary inspections rely on ad hoc decisions made at the state OSHA level and, according to our interviews, depend on available resources, availability of supporting

[20] OSHA highlights a list of industries to focus on each year, and the source documents underlying these lists suggest that prior-year violations likely play a role in determining this set of industries, but beyond this we are not able to fully reverse-engineer the determinants of OSHA inspections.

case information, and information gathering that is independent of obligatory inspection triggers such as confidential tips and workplace injuries.

Our results in Table 5 underscore the importance of separately identifying and studying discretionary inspections. In columns (1) and (2), we consider all inspections and find that inspections are indeed higher in year t+1 in response to violations in all jurisdictions in year t. Unsurprisingly, we also find a negative and significant relation between clean inspections in one year and the likelihood of inspection in the next. Given OSHA's limited resources, we would expect a firm that has been inspected and found to be compliant with workplace safety laws to be less likely to immediately face re-investigation. In columns (3) – (8), we replace the dependent variable with indicator variables based on the presence of three types of inspections. These indicator variables are $ReactiveInState_{ijt+1}$, an indicator that equals 1 for firm-state-years that only face inspections that are reactive on OSHA's part, $PlannedInState_{ijt+}$, an indicator that equals 1 for firm-state-years with at least one inspection determined by OSHA headquarters but no inspections undertaken at the state office's discretion, and $DiscInState_{ijt+1}$, an indicator that equals 1 for firm-state-years with at least one discretionary inspection. Notably, reactive inspections are by construction only undertaken in response to whistleblower tips, accidents, or injuries. When separating inspections in this manner, we continue to find a relation between out-of-state violations in year t and reactive inspections in year t+1 in columns (3) and (4). However, we find no relation between out-of-state violations in year t and either planned or discretionary inspections in year t+1 in columns (5)-(8). The former result is consistent with a mechanical, reactive OSHA response to geographic substitution by firms. The latter is consistent with OSHA compliance officers facing informational hurdles in applying their knowledge of past violations when those past violations occur outside the state.

It is plausible that our results on inspections are driven by information spillovers across workers. While Johnson (2020) finds that media coverage of OSHA violations is primarily local, it could still be the case that a firm's employee in one state learns of a violation by the firm in another state, raising her awareness of related workplace safety issues in her own place of work. This, in turn, may increase the likelihood that the employee reports these issues to OSHA, triggering a whistleblower-induced inspection. Of course, a whistleblowing complaint may also arise because of actual operational changes that arise from geographic violation substitution. Nonetheless, to test the argument above, in untabulated analyses we separately investigate whistleblower-induced and accident or injury-driven inspections. Across both types of reactive inspections, we find similar results to those in Table 5 columns (3) and (4). As such, while we cannot rule out the possibility that employee learning induces some non-discretionary inspections, it does not appear to be the driver of our results on non-discretionary inspections.

6.2 Repeat and Willful violations

Typical penalties for OSHA violations are on the order of tens of thousands of dollars. While this is significant for smaller firms, such penalties would have less of an effect on the bottom line among the publicly traded firms we study. However, penalties associated with *Repeat* and *Willful* violations are tenfold in size, as mandated by federal statute.[21] These penalties are also publicized by OSHA via press releases, leading to additional reputation costs (Johnson 2020).

Internal information sharing plays an important role in OSHA's ability to detect and assess Repeat and Willful violations. Case notes and knowledge of past inspections at other plants are often necessary to substantiate the decision to label a violation as Repeat or Willful. If, as the

[21] See Code of Federal Regulations 29 CFR 1903.15(d)(1-2).

OSHA compliance officers we interviewed assert, information frictions lead to difficulties in obtaining said documentation, then one should expect that local OSHA inspectors have less supporting information to pursue severe penalties for Repeat and Willful violations. In turn, it may be cheaper in expectation for firms to engage in geographic substitution rather than consistently committing violations in the same state. This prediction represents a firm-level analogue of crime displacement and patterns in individuals' misconduct decisions (Iyengar 2008).

In columns (1)—(2) of Table 6, we investigate whether information frictions play a role in assessing these severe penalties. We estimate a modified version of equation (4) that replaces the dependent variable with $RWinState_{ijt}$, an indicator that equals one if there is a Repeat or Willful violation for firm i in state j in year t. We find that a violation in a given state leads to an increase in the likelihood that a Repeat or Willful (RW) violation is assessed in the same state the next year. This result is consistent with a lack of information frictions making it easier to assess severe fines, as OSHA compliance officers have unfettered access to case materials from their own files and from files of other officers in the same state. Given our findings in Table 4, our results also indicate an increase in the rate of RW violations specifically rather than violations more broadly.

In contrast to the result above, we do not find a link between year-t general violations and year-t+1 RW violations across state lines (where information frictions play a role). In conjunction with our geographic substitution results in Table 4, this result indicates that while the overall rate of violations increases following an out-of-state violation, the RW violation rate—conditional on a violation occurring—goes down. We interpret this finding as indicative that violations that should be flagged by OSHA branches in other states as Repeat or Willful are not being assessed as such, due to informational frictions. In sum, our findings in Tables 5 and 6 suggest that OSHA's internal information frictions reduce the efficacy of inspections and the assessing of penalties.

6.3 State Plans

OSHA offices in 21 states employ State Plans, which follow similar standards to federal OSHA offices but exert more discretion in certain areas. As we discuss in Section 2, this discretion leads to less information sharing between OSHA State Plans and other states. To further rule out within-firm frictions as a driver of our results, we explore substitution into State Plan vs. non-State Plan states. Ceteris paribus, there is no reason within-firm information frictions should vary according to whether a given state uses an OSHA state plan. In Table 7 we estimate an augmented version of equation (4) that incorporates interactions of both $ViolInState$ and $ViolOutState$ with $StatePlan$, an indicator that equals one for firm-states overseen by a State Plan (SP). We find stronger geographic substitution into SP states, consistent with greater information frictions.

To understand the mechanism underlying the results in Table 7, we examine differences in inspection patterns in state plan states. State Plan OSHA offices have greater discretion in their inspections and may use this discretion to make more efficient inspection decisions. To test this possibility, in Table 8 we introduce interaction terms between *StatePlan* and our violation and inspection variables. In columns (1)-(4), we find mixed evidence of differences between State Plan and non-State Plan states for inspections outside of state offices' discretion (Reactive and Planned). However, we find no evidence in columns (5) and (6) that State Plan states undertake more efficient discretionary inspection decisions, suggesting that the results in Table 7 are not driven by intentional differences in inspection patterns.

7. What drives firms to engage in geographic substitution?

Our final set of tests explores strategic factors that may influence how firms respond to information frictions within OSHA. We consider factors related to each of the three sides of the fraud triangle – firm-level pressures, opportunities, and rationalization (Wilks and Zimbelman

2004) – as drivers of geographic substitution. Specifically, we consider the roles of financial incentives, corporate governance and monitoring, and corporate culture.

7.1 Financial incentives

Poor labor practices can arise in response to financial pressures (Cohn and Wardlaw 2016; Raghunandan 2021). To assess the role of such pressures, we construct three measures of firms' financial incentives to engage in geographic violation substitution. In all cases, we construct variables to correspond to the timing of the dependent variable, i.e., t+1. The sample size varies across these three tests due to differences in data availability for the three measures we consider.

We first consider out-of-state Repeat or Willful violations. A firm receiving a Repeat or Willful violation may have stronger financial incentives to engage in geographic substitution because of the increased likelihood that further violations in the same state will also be classified as Repeat or Willful, whereas heightened penalties do not follow firms across states, as shown in Table 6. Consistent with this idea, when we include both $ViolOutOfState_{ijt}$ and $RWOutOfState_{ijt}$ in a modified version of Equation (4), we find a stronger substitution effect in column (1) of Table 9 Panel A when an out-of-state violation in year t is classified as Repeat or Willful.

We next consider overall financial performance. Financially stronger firms may both face less pressure to engage in geographic violation substitution for cost-cutting reasons and be more willing to increasing firm-wide compliance expenditures in response to a violation in a particular state. We find results consistent with this notion in column (2) of Table 9 Panel A, where we include an interaction term for top-performing firms, $TopDecileROA_{t+1}$ (measured as being in the top decile of the sample by ROA). The negative coefficient on the interaction term suggests that financially stronger firms shift violations across states less.

A clear and periodic incentive firms face is to meet short-term earnings benchmarks. Prior literature (Caskey and Ozel 2017; Raghunandan 2021) finds that firms facing meet-or-beat incentives are more likely to engage in labor practices harmful to employees. Building on this literature, we test whether firms that just meet or beat earnings expectations are more likely to engage in geographic substitution. To do so we construct an indicator, $MeetorBeat_{it}$, that equals one if firm *i* just meets or beats the analyst consensus ("street") earnings forecast. We then interact $MeetorBeat_{it}$ with $ViolOutOfState_{ijt}$. Our results in column (3) of Table 9 Panel A suggest that firms with meet-or-beat incentives are more likely to engage in geographic substitution.

7.2 Firm opportunities and culture

We next turn to firms' opportunities to engage in geographic substitution and the culture necessary to rationalize poor behavior. We contribute to prior literature (e.g., Beasley 1996; Kedia, Luo, and Rajgopal 2019; Hope et al., 2021) on the role opportunities and culture play in facilitating firms' decisions to engage in misconduct by focusing on decisions to engage in, and strategically shift, violations of workplace safety laws. We consider four distinct constructs that may affect the extent to which firms are willing or able to engage in geographic substitution. These constructs are (i) internal information quality, as a firm with poor internal information may not be able to exploit frictions within OSHA's information environment; (ii) corporate governance, as a better-governed firm may be unable to internally justify geographic substitution; (iii) geographic dispersion of firm operations, as more dispersed firms may have more options for how and where they engage in geographic substitution; and (iv) corporate compliance culture, as firms with greater willingness to break rules may be more willing to rationalize shifting misconduct rather than improving workplace safety across the organization. As with Panel A, sample sizes vary across the four columns of Table 9 Panel B due to differences in data availability.

To measure internal information quality, we follow Gallemore and Labro (2015) and Hope et al. (2021) by considering a firm to have high internal information quality if it does not disclose an internal control weakness (*NoICW*, an indicator that equals one for such firm-years and zero otherwise). The positive and significant coefficient on the interaction between *NoICW* and *ViolOutOfState* in column (1) of Table 9 Panel B suggests that geographic substitution arises more easily when firms have the internal information capability to exploit inefficiencies within OSHA.

We measure corporate governance using the percentage of independent directors on the firm's board, *BoardIndep*. Prior literature (e.g., Beasley 1996) identifies the role of an independent board in mitigating corporate misconduct. If workplace misconduct creates long-term harm to culture or operational efficiency, an independent board may curtail a manager's ability to engage in geographic substitution. The negative and significant coefficient on the interaction between *BoardIndep* and *ViolOutOfState* in column (2) of Table 9 Panel B suggests that geographic substitution is weaker for firms with more independent boards.

A firm's opportunities to engage in geographic substitution depend on how its operations are spread across states. To measure within-firm geographic dispersion, we follow Garcia and Norli (2012) and count the number of distinct states that a firm mentions in its annual 10-K filings, which we label *Dispersion*. Underlying this metric is the argument that a firm will only mention states in its 10-K that it deems material to its operations; a firm for which more states are material is more dispersed. Because dispersion is mechanically correlated with firm size and varies systematically by industry, we de-mean *Dispersion* with respect to size decile and two-digit NAICS industry. The positive and significant coefficient on the interaction between *Dispersion* and *ViolOutOfState* in column (3) of Table 9 Panel B suggests that firms with more options for engaging in geographic substitution do so more frequently.

Finally, we turn to compliance culture, as a firm's culture may drive its willingness to continue violating safety standards even after being made aware of prior violations. We follow Kedia, Luo, and Rajgopal (2019) to measure culture, creating an indicator $WeakCompliance$ that equals one if the firm faced federal penalties for *non*-OSHA violations in the prior three years. We obtain federal penalty data from Violation Tracker, a comprehensive dataset on corporate misconduct assessed by more than 50 federal agencies published by the non-profit entity Good Jobs First. The most common types of violations are environmental violations (assessed by the Environmental Protection Agency), wage-related violations (assessed by the Department of Labor's Wage and Hour Division), and antitrust and consumer protection violations (assessed by the Department of Justice). In column (4) of Table 9 Panel B we observe a positive and significant coefficient on the interaction between $WeakCompliance$ and $ViolOutOfState$, suggesting geographic substitution is indeed more prevalent in firms with a weaker compliance culture.

8. Conclusion

We study whether information frictions within the Occupational Safety and Health Administration (OSHA) affect firm violations of workplace safety laws. We find that firms caught violating in one state subsequently violate less in that state, instead shifting violations elsewhere. This geographic substitution cannot be explained by differential enforcement rates across states and is more pronounced in states with greater regulatory information frictions, indicating that geographic substitution is not driven by information frictions within firms. We also investigate how information frictions affect OSHA inspection behavior and the potential deterrence effects of severe penalties. We find that out-of-state violations impact reactive investigations (those based on whistleblowers or injuries), but not centrally-planned inspections or those taken at the discretion of local offices. Additionally, violations in one state lead to an increase in severe

(Repeat or Willful) penalties in the same state, but the severe penalty rate decreases for firms previously violating in a different state. This result is consistent with frictions limiting the sharing of documentation required by statute to assess these penalties.

Collectively, our findings show that information frictions within a decentralized regulator have a measurable impact on firm misconduct. These frictions likely reduce the positive externalities derived from increased enforcement actions in one jurisdiction. Our findings thus highlight a potential informational cost that decentralized organizations face. OSHA imposes a federal standard for workplace safety, but it delegates authority in implementing that standard to state offices. If OSHA were to address information frictions, it would likely need to better align objectives for individual OSHA offices with the entire organization (Nagar 2002), increasing the incentive to share information across states. Our results also suggest the need for decentralized organizations to invest in internal information systems, as the limitations of the internal OSHA Information System repeatedly arose in interviews with OSHA compliance officers. We caution that the costs of such an investment must be weighed. Prior research shows that better local disclosure improves enforcement efficiency (Johnson 2020). Given our findings on geographic substitution, there may also be a role for disclosure in annual reports as an additional deterrent (Christensen, Floyd, Liu, and Maffett 2017). Our study suggests a need for future research into other institutional factors to obtain a fuller picture of enforcement efficiency in federal regulators.

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APPENDIX A: State Plan Adoption Years

The table below presents a list of states in which workplace safety laws are enforced through state plans, as well as the years that these state plans went into effect. We obtain this information from OSHA's website directly (https://www.osha.gov/stateplans).

State	Year State Plan Adopted	State	Year State Plan Adopted
Alaska	1977	New Mexico	1984
Arizona	1981	North Carolina	1976
California	1977	Oregon	1982
Hawaii	1978	South Carolina	1976
Indiana	1981	Tennessee	1978
Iowa	1976	Utah	1976
Kentucky	1980	Vermont	1977
Maryland	1980	Virginia	1984
Michigan	1981	Washington	1982
Minnesota	1976	Wyoming	1980
Nevada	1981		

APPENDIX B: Model in Detail

B.1 Model setup

B.1.1 Firm's problem

A single representative firm operates plants in two different geographic locations $j \in \{1, 2\}$. For simplicity we assume that both locations are capacity-constrained such that the firm always produces up to its full capability in each location. That is, we do not explicitly model the demand for the firm's output nor the firm's choice of how much output to produce. The firm obtains revenue R_j in each location from its output. The firm also incurs production costs $\tilde{c}$ in each location. The production costs can be high ($\tilde{c} = c_H$) with probability p or low ($\tilde{c} = c_L$) with probability $1 - p$. Low production costs, before considering the effects of enforcement, provide the firm with additional profits that are normalized to 1 in each location. That is, without loss of generality we assume that $c_H - c_L = 1$. The firm's costs are the same in both locations, i.e., the realization of $\tilde{c}$ is common across the firm. "High" and "low" costs could reflect whether, for example, the firm's prior investments into improving efficiency or automation succeeded. In the absence of any manipulation, the firm's profits are therefore given by $\pi = R_1 + R_2 - 2\tilde{c}$.

We assume that if the firm observes low costs, it takes no illegal or manipulative actions with respect to workplace safety. If the firm's production costs are high, however, it can illegally cut corners in each market to lower its production costs *for that market*. We model the firm's attempts to lower its costs (when it observes high costs) as follows. The firm chooses a probability m_j for each location with which illegal cost-cutting succeeds. If cost-cutting succeeds in location *j* the firm obtains a benefit normalized to 1 in location *j*. However, when the firm engages in illegal cost-cutting, it will incur a fine *F* if it is caught. We let b_j be the probability that OSHA detects the firm's illegal actions in market *j*, and $\widehat{b_j}$ be the firm's conjecture of this probability. The firm also incurs disutility from manipulative effort, regardless of whether its manipulation succeeds. This disutility is a function of both m_1 and m_2. Specifically, we let the firm's net utility from manipulation be given by

$$U(m_1, m_2 | c = c_H) = m_1\left(1 - \widehat{b_1} \cdot F\right) + m_2\left(1 - \widehat{b_2} \cdot F\right) - \left[\frac{1-\theta}{2} m_1^2 + \frac{1-\theta}{2} m_2^2 + \frac{\theta}{2}(m_1 + m_2)^2\right] (1, repeated)$$

The structure of Equation (1) closely follows that in Schantl and Wagenhofer (2020).

When the firm sees $c = c_L$ it does not cut costs. If instead the firm sees $c = c_H$ it chooses probabilities with which cost-cutting occurs in each of the two markets. The first-order conditions for Equation (1) with respect to m_1, m_2 are

$$m_1 = (1 - b_1 \cdot F) - \theta m_2 \quad (B1)$$

$$m_2 = (1 - b_2 \cdot F) - \theta m_1 \quad (B2)$$

Rearranging yields the following optimal levels of manipulation:

$$m_1 = \frac{1}{1+\theta} - \frac{F \cdot \left(\widehat{b_1} - \theta \widehat{b_2}\right)}{1 - \theta^2} \quad (B3)$$

$$m_2 = \frac{1}{1+\theta} - \frac{F \cdot \left(\widehat{b_2} - \theta \widehat{b_1}\right)}{1 - \theta^2} \quad (B4)$$

From (4) and (5), we see that manipulation in each region is *decreasing* in the conjectured probability of inspection in that region but *increasing* in the conjectured probability of inspection in the other region.

B.1.2 OSHA

OSHA operates two separate branches in locations 1 and 2 (hereafter "OSHA1" and "OSHA2"). Both branches seek to detect misconduct when it occurs, but detection is costly. OSHA investigations are successful with probability b, expending effort $\frac{kb^2}{2}$, where k is a constant. Both OSHA branches can infer whether a plant had low or high production costs based on its output, so an OSHA branch only decides whether to investigate when it sees low costs r_L. OSHA branches are assumed to only observe reported costs for its location, e.g., OSHA1 does not see what the firm's reported costs are in location 2.[22] Let r_j denote the firm's observable signal of production costs in region j. If the firm does not cut corners and has high costs, then $r_j = r_H$. Conversely, if the firm either naturally has low costs or has high costs but cuts corners to reduce its costs, then $r_j = r_L$. Because the firm has no incentive to increase its costs, when $r_j = r_H$ OSHA in region j knows that the firm has not taken any illegal actions and thus does not investigate., An investigation only occurs when low costs are reported.

Following Schantl and Wagenhofer (2020), each region observes a noisy signal $\tilde{y}_j$ of the true costs before cost-cutting efforts. This signal is given by

$$\tilde{y}_j = \tilde{c} + \tilde{I}_j \qquad (2, repeated)$$

where $\tilde{I}_j$ is a random noise term normally distributed with mean 0. The variance of $\tilde{I}$ depends on previous-year outcomes. Specifically, and without loss of generality, we assume that in the previous year the firm had a chance to manipulate in region 1 (but not region 2). If the firm did not manipulate, or if the firm did manipulate and was not caught by OSHA1, then neither OSHA1 nor OSHA2 learns any further information. When this is the case, the variance of both $\tilde{I}_1$and $\tilde{I}_2$ is given by $u^2 + \alpha^2$.

If instead OSHA1 successfully detected a violation in the previous year, we assume that it was able to learn some information that reduces the variance of $\tilde{I}_1$ in the process. As a result, the variance of $\tilde{I}_1$ instead becomes u^2. However, OSHA1 cannot perfectly convey what it has learned to OSHA2 because of information frictions within OSHA. It can, however, enter information into OSHA's internal records which provides OSHA2 with additional information that improves the precision of $\tilde{I}_2$. We model this by assuming that when OSHA1 has detected a violation in the prior period, the variance of the firm-specific information $\tilde{I}_2$ becomes $u^2 + \delta^2$, where $\delta^2 < \alpha^2$. That is, the information $\tilde{I}_2$ becomes more precise but is still noisier than the information $\tilde{I}_1$ due to imperfect information sharing. The term δ^2 reflects the level of *information frictions* present. When δ^2 is higher, OSHA2 learns less from a successful investigation by OSHA1 in the previous year.

Upon receiving a signal, OSHA in region j must choose its investigative effort. Given its quadratic investigation costs, the level of investigation b maximizes

$$\max_{b_j} \mathbb{P}\left(\tilde{c} = c_H | r_j = c_L, y_j\right) \cdot b - \frac{kb^2}{2} \qquad (B5)$$

which yields $b = \frac{\mathbb{P}\left(\tilde{c}=c_H | r_j=c_L, y_j\right)}{k}$.

[22] While this assumption is useful for tractability of the model, it does not alter our main conclusions.

B.2 Equilibrium

Let σ_j^2 denote the variance of the signal y_j in period j, conditional on knowing the true cost c. If OSHA1 catches a violation in the previous year, then $\sigma_1^2 = u^2$ and $\sigma_2^2 = u^2 + \delta^2$. By contrast, if OSHA2 does not catch a violation in the previous year, then $\sigma_1^2 = \sigma_2^2 = u^2 + \alpha^2$. If OSHA in region j observes r_L and conjectures a manipulation level $\widehat{m}_j$, then for a given realization of the signal y_j the ex-post likelihood that the firm has engaged in illegal activities to cut its costs is given by

$$\mathbb{P}\left(c = c_H \middle| r_L, y_j\right) = \frac{p\widehat{m}_j \phi\left(y_j \middle| r_L, \sigma_j^2\right)}{p\widehat{m}_j \phi\left(y_j \middle| r_L, \sigma_j^2\right) + (1-p)\phi\left(y_j + 1 \middle| r_L, \sigma_j^2\right)} = \frac{1}{1 + \frac{1-p}{p\widehat{m}_j} \cdot \frac{\phi\left(y_j + 1 \middle| r_L, \sigma_j^2\right)}{\phi\left(y_j \middle| r_L, \sigma_j^2\right)}} \quad (B6)$$

where $\phi(\cdot)$ represents the normal distribution with mean zero.

To solve for the rational expectations equilibrium, we set the conjectured manipulation $\widehat{m}_j$ equal to the actual manipulation in region j. Since $b_j = \frac{1}{k}\mathbb{P}\left(c = c_H \middle| r_L, y_j\right)$, this implies

$$m_1 = \frac{1}{1+\theta} - \frac{F}{(1-\theta^2)k} \cdot \mathbb{E}_{y_1, y_2}\left(\frac{1}{1 + \frac{1-p}{pm_1} \cdot \frac{\phi\left(y_1 + 1 \middle| r_L, \sigma_1^2\right)}{\phi\left(y_1 \middle| r_L, \sigma_1^2\right)}} - \theta \frac{1}{1 + \frac{1-p}{pm_2} \cdot \frac{\phi\left(y_2 + 1 \middle| r_L, \sigma_2^2\right)}{\phi\left(y_2 \middle| r_L, \sigma_2^2\right)}} \right) (B7)$$

$$m_2 = \frac{1}{1+\theta} - \frac{F}{(1-\theta^2)k} \cdot \mathbb{E}_{y_1, y_2}\left(\frac{1}{1 + \frac{1-p}{pm_2} \cdot \frac{\phi\left(y_2 + 1 \middle| r_L, \sigma_2^2\right)}{\phi\left(y_2 \middle| r_L, \sigma_2^2\right)}} - \theta \frac{1}{1 + \frac{1-p}{pm_1} \cdot \frac{\phi\left(y_1 + 1 \middle| r_L, \sigma_1^2\right)}{\phi\left(y_1 \middle| r_L, \sigma_1^2\right)}} \right) (B8)$$

From (B7) and (B8) we can establish the model's main results and, hence, empirical predictions. We summarize these results in the following proposition:

Proposition 1. *If OSHA1 has observed a violation in the previous year:*

- *(i) Overall manipulation – i.e., $m_1 + m_2$ – is lower than in the case where OSHA1 did not observe a violation in the previous year*
- *(ii) Manipulation in market 1 is always lower when OSHA1 has observed a prior-year violation compared to when OSHA1 has not observed a prior-year violation. However, manipulation in market 2 when OSHA1 has observed a prior-year violation may be either higher or lower compared to when OSHA1 did not observe a prior-year violation. Specifically, there is some threshold value $\overline{\delta^2} \in [0, \alpha^2]$ for which manipulation in market 2 when OSHA1 has observed a prior-year violation is higher than the no-prior-year-violation case if and only if $\delta^2 > \overline{\delta^2}$.*
- *(iii) Manipulation in market 1 decreases when the level of information frictions δ^2 increase while manipulation in market 2 increases as a function of δ^2.*

Proof of Proposition 1

B.1 Condition (i)

To verify Condition (i), first note that we can add cross-terms and cancel $(1-\theta)$ in the denominator of the second term of the expressions for m_1, m_2 to rewrite overall manipulation $m_1 + m_2$ as

$$m_1 + m_2 = \frac{2}{1+\theta} - \frac{F}{(1+\theta)k}\mathbb{E}_{y_1, y_2}\left(\frac{1}{1 + \frac{1-p}{pm_1} \cdot \frac{\phi\left(y_1 + 1 \middle| r_L, \sigma_1^2\right)}{\phi\left(y_1 \middle| r_L, \sigma_1^2\right)}} + \frac{1}{1 + \frac{1-p}{pm_2} \cdot \frac{\phi\left(y_2 + 1 \middle| r_L, \sigma_2^2\right)}{\phi\left(y_2 \middle| r_L, \sigma_2^2\right)}} \right) (B9)$$

Recall that the variances of the signals received in both markets y_1, y_2 are lower when a violation has been previously observed in market 1 in period 1, relative to the case where no violation was observed. Verifying condition (i), then, is equivalent to verifying that the right-hand side of (A1) is increasing in σ_1^2 and σ_2^2. In turn, this is equivalent to verifying that

$$G \equiv \mathbb{E}_{y_1,y_2}\left(\frac{1}{1+\frac{1-p}{pm_1}\cdot\frac{\phi(y_1+1|r_L,\sigma_1^2)}{\phi(y_1|r_L,\sigma_1^2)}}+\frac{1}{1+\frac{1-p}{pm_2}\cdot\frac{\phi(y_2+1|r_L,\sigma_2^2)}{\phi(y_2|r_L,\sigma_2^2)}}\right) \quad (B10)$$

is decreasing in σ_1^2 and σ_2^2.

To verify that this is the case, we can rewrite the expression above using the integral equivalent:

$$G=\int_{\mathbb{R}}\frac{1}{1+\frac{1-p}{pm_1}\cdot\frac{\phi(y_1+1|r_L,\sigma_1^2)}{\phi(y_1|r_L,\sigma_1^2)}}\phi(y_1|r_L,\sigma_1^2)dy_1+\int_{\mathbb{R}}\frac{1}{1+\frac{1-p}{pm_2}\cdot\frac{\phi(y_2+1|r_L,\sigma_2^2)}{\phi(y_2|r_L,\sigma_2^2)}}\phi(y_2|r_L,\sigma_2^2)dy_2 \quad (B11)$$

Using the formula for a normal distribution, each term of the two terms in the expression above can be rewritten as

$$\frac{1}{\sqrt{2\pi\sigma_i^2}}\int_{\mathbb{R}}\frac{e^{-\frac{(2x+1)}{\sigma_i^2}}}{1+\frac{1-p}{pm_i}\cdot e^{-\frac{(2x+1)}{\sigma_i^2}}}e^{-x^2/2\sigma_i^2}dy_i \quad (B12)$$

By differentiating under the integral sign it is straightforward to verify that for any value of m_i, we have

$$\frac{\partial}{\partial\sigma_i^2}\int_{\mathbb{R}}\frac{1}{1+\frac{1-p}{pm_i}\cdot e^{-\frac{(2x+1)}{\sigma_i^2}}}e^{-\frac{x^2}{2\sigma_i^2}}dy_i=\int_{\mathbb{R}}\left[\frac{\partial}{\partial\sigma_i^2}\frac{e^{-\frac{x^2}{2\sigma_i^2}}}{1+\frac{1-p}{pm_i}\cdot e^{-\frac{(2x+1)}{\sigma_i^2}}}\right]dy_i<0 \quad (B13)$$

Applying the product rule implies that the overall expression given in (A4) is decreasing as well. As a result, when both σ_1^2 and σ_2^2 *decrease* as a result of OSHA1 successfully detecting a violation in period 1, total manipulation across the two markets decreases.

B.2 Conditions (ii) and (iii)

We next turn to market-by-market manipulation, as described in Conditions (ii) and (iii) of Proposition 1. To do so, we now rely on specific expressions for the variances σ_1^2, σ_2^2. We can subtract (B8) from (B7) to obtain

$$m_1-m_2=\frac{F}{(1-\theta)k}\cdot\mathbb{E}_{y_1,y_2}\left(\frac{1}{1+\frac{1-p}{pm_2}\cdot\frac{\phi(y_2+1|r_L,\sigma_2^2)}{\phi(y_2|r_L,\sigma_2^2)}}-\frac{1}{1+\frac{1-p}{pm_1}\cdot\frac{\phi(y_1+1|r_L,\sigma_1^2)}{\phi(y_1|r_L,\sigma_1^2)}}\right) \quad (B14)$$

Because the expression

$$\mathbb{E}_{y_1,y_2}\left[\frac{1}{1+\frac{1-p}{pm_i}\cdot\frac{\phi\left(y_i+1\middle|r_L,\sigma_i^2\right)}{\phi\left(y_i\middle|r_L,\sigma_i^2\right)}}\right]$$

is decreasing in σ_i^2, we know that for any $x>0$ and any $\delta^2>0$, we must have

$$\mathbb{E}_{y_1,y_2}\left[\frac{1}{1+\frac{1-p}{px}\cdot\frac{\phi(y_i+1|r_L,u^2)}{\phi(y_i|r_L,u^2)}}\right]>\mathbb{E}_{y_1,y_2}\left[\frac{1}{1+\frac{1-p}{px}\cdot\frac{\phi(y_i+1|r_L,u^2+\delta^2)}{\phi(y_i|r_L,u^2+\delta^2)}}\right] \qquad (B15)$$

Using (B14) and (B15), we can establish that $m_1<m_2$ when a prior-period violation has occurred. To see this, first note that when the variance of the signal in both periods is the same – that is, when $\sigma_1^2=\sigma_2^2$ – we will have a symmetric solution $m_1=m_2$, i.e., $m_1-m_2=0$. As a result, the right-hand side of Equation (B14) must also equal zero. This, in turn, implies that

$$\frac{1}{1+\frac{1-p}{pm_2}\cdot\frac{\phi(y_2+1|r_L,u^2+\delta^2)}{\phi(y_2|r_L,u^2+\delta^2)}}=\frac{1}{1+\frac{1-p}{pm_1}\cdot\frac{\phi(y_1+1|r_L,u^2+\delta^2)}{\phi(y_1|r_L,u^2+\delta^2)}} \qquad (B16)$$

Expression (B15) also implies that

$$\mathbb{E}_{y_1,y_2}\left(\frac{1}{1+\frac{1-p}{pm_1}\cdot\frac{\phi(y_1+1|r_L,u^2+\delta^2)}{\phi(y_1|r_L,u^2+\delta^2)}}\right)<\mathbb{E}_{y_1,y_2}\left(\frac{1}{1+\frac{1-p}{pm_1}\cdot\frac{\phi(y_1+1|r_L,u^2)}{\phi(y_1|r_L,u^2)}}\right) \qquad (B17)$$

For Equation (B14) to remain valid, it must therefore be the case that m_1 decreases or m_2 increases (or both) when $\sigma_1^2=u^2,\sigma_2^2=u^2+\delta^2$ (relative to the case $\sigma_1^2=\sigma_2^2=u^2+\delta^2$). Either case would imply that $m_1<m_2$ when a prior-period violation has occurred.

Finally, to establish that m_1 decreases after a violation relative to the no-prior-violation case, let the superscripts V and NV denote a violation and non-violation having occurred in the prior period, respectively. Condition (i) of Proposition 1 can be re-stated as

$$m_1^V+m_2^V<m_1^{NV}+m_2^{NV} \qquad (B18)$$

While, as described above, expressions (B16) and (B17) imply that

$$m_1^V<m_2^V \qquad (B19)$$

The combination of expressions (B18) and (B19), plus the fact that by symmetry we must have $m_1^{NV}=m_2^{NV}$, implies that

$$2m_1^V<m_1^V+m_2^V<m_1^{NV}+m_2^{NV}=2m_1^{NV} \qquad (B20)$$

The inequality chain (B20) implies that $m_1^V<m_1^{NV}$, i.e., that the likelihood of manipulation in market 1 is lower after a prior-period violation has been detected in market 1. This establishes the first part of Condition (ii).

To establish the second part of Condition (ii), i.e., to document the link between m_2^V and m_2^{NV}, we consider two extreme values for the level of information frictions present δ^2: (i) $\delta^2=0$ (i.e., perfect information transmission from OSHA1 to OSHA2), and (ii) $\delta^2=\alpha^2$ (i.e., no information transmission at all).

Consider first the case of perfect information transmission between OSHA1 and OSHA2, i.e., where $\delta^2 = 0$. In this case, $\sigma_1^2 = \sigma_2^2 = u^2$. When $\sigma_1^2 = \sigma_2^2$, the convexity of the penalty function implies a symmetric equilibrium (i.e., with equal manipulation in both markets). In conjunction with the inequality in (B18), it must therefore be the case that

$$m_2^V = m_1^V < m_1^{NV} = m_2^{NV}$$

and so manipulation in market 2 is lower after a violation in market 1 in the prior period.

Now consider the case where there is no information transmission from OSHA1 to OSHA2, i.e., where $\delta^2 = \alpha^2$. Manipulation in market 2 after a violation in market 1 is given by:

$$m_2^V = \frac{1}{1+\theta} - \frac{F}{(1-\theta^2)k} \cdot \mathbb{E}_{y_1,y_2}\left(\frac{1}{1+\frac{1-p}{pm_2^V} \cdot \frac{\phi(y_2+1|r_L, u^2+\alpha^2)}{\phi(y_2|r_L, u^2+\alpha^2)}} - \theta \frac{1}{1+\frac{1-p}{pm_1^V} \cdot \frac{\phi(y_1+1|r_L, u^2)}{\phi(y_1|r_L, u^2)}} \right) \quad (B21)$$

Define the quantities

$$X_1^V \equiv \mathbb{E}_{y_1,y_2}\left[\frac{1}{1+\frac{1-p}{pm_1^V} \cdot \frac{\phi(y_1+1|r_L, u^2)}{\phi(y_1|r_L, u^2)}} \right]$$

$$X_1^{NV} \equiv \mathbb{E}_{y_1,y_2}\left[\frac{1}{1+\frac{1-p}{pm_1^{NV}} \cdot \frac{\phi(y_1+1|r_L, u^2+\alpha^2)}{\phi(y_1|r_L, u^2+\alpha^2)}} \right]$$

It is straightforward to establish that $X_1^V > X_1^{NV}$ using the same approach as in the proof of Condition (i). When $\delta^2 = \alpha^2$ we know that m_2^V is the value of μ that solves the equation

$$\mu = \frac{1}{1+\theta} - \frac{F}{(1-\theta^2)k} \cdot \left(\mathbb{E}_{y_1,y_2}\left(\frac{1}{1+\frac{1-p}{p\mu} \cdot \frac{\phi(y_2+1|r_L, u^2+\alpha^2)}{\phi(y_2|r_L, u^2+\alpha^2)}} \right) - \theta X_1^V \right) \quad (B22)$$

while m_2^{NV} is the value of μ that solves the equation

$$\mu = \frac{1}{1+\theta} - \frac{F}{(1-\theta^2)k} \cdot \left(\mathbb{E}_{y_1,y_2}\left(\frac{1}{1+\frac{1-p}{p\mu} \cdot \frac{\phi(y_2+1|r_L, u^2+\alpha^2)}{\phi(y_2|r_L, u^2+\alpha^2)}} \right) - \theta X_1^{NV} \right) \quad (B23)$$

In Equations (B18) and (B19), the only term that is different is X_1^V in (B22) versus X_1^{NV} in (B23). Because $X_1^V > X_1^{NV}$, the value of μ that solves (B22) must be *greater* than the value of μ that solves (B23), i.e., when $\delta^2 = \alpha^2$ and no information is transmitted, we have $m_2^V > m_2^{NV}$.

We have thus established that when $\delta^2 = \alpha^2$, a previous-period violation in market 1 leads to *more* violation in market 2 (i.e., $m_2^{NV} < m_2^V$), while when $\delta^2 = 0$, a previous-period violation in market 1 leads to *less* violation in market 2 (i.e, $m_2^{NV} > m_2^V$). Because of continuity, if Condition (iii) of Proposition 1 holds – that is, if $\frac{\partial m_2^V}{\partial \delta^2} > 0$ and $\frac{\partial m_1^V}{\partial \delta^2} < 0$ – then there must be some threshold

$\overline{\delta^2}$ such that a previous-period violation in Market 1 leads to a higher likelihood of violations in Market 2 if and only if $\delta^2 > \overline{\delta^2}$.

To verify Condition (iii) of Proposition 1, we need to show that $\frac{\partial m_2^V}{\partial \delta^2} > 0$ and $\frac{\partial m_1^V}{\partial \delta^2} < 0$ in the system of equations (B7) and (B8). We have already proven that for $i \in \{1,2\}$,

$$\frac{\partial}{\partial \sigma_i^2}[m_1 + m_2] > 0 \qquad (B24)$$

Because of the chain rule, inequality (B24) implies that

$$\frac{\partial}{\partial \delta^2}[m_1 + m_2] > 0$$

i.e., that

$$\frac{\partial m_1}{\partial \delta^2} + \frac{\partial m_2}{\partial \delta^2} > 0 \qquad (B25)$$

Hence, in order to verify Condition (iii) of Proposition 1 – and to therefore establish the existence of the threshold value $\overline{\delta^2}$ – it suffices to show that $\frac{\partial m_1}{\partial \delta^2} < 0$. To do so, we consider the right-hand side of Equation (B7). Because the distribution of y_1 is invariant to δ^2, to show that $\frac{\partial m_1}{\partial \delta^2} < 0$ it suffices to show that

$$\frac{\partial}{\partial \delta^2}\mathbb{E}_{y_1,y_2}\left(\frac{1}{1 + \frac{1-p}{pm_2^V} \cdot \frac{\phi(y_2 + 1 | r_L, u^2 + \delta^2)}{\phi(y_2 | r_L, u^2 + \delta^2)}}\right) < 0 \qquad (B26)$$

Inequality (B26) can be verified by differentiating under the integral sign exactly as in the case of inequality (B13), confirming the proof of Condition (iii). □

End of proof

Condition (i) of Proposition 1 implies that when OSHA becomes more informed *in aggregate*, the firm's overall level of manipulation (i.e., the sum across all markets) decreases. This is consistent with prior literature, both empirical (e.g., Macher, Mayo, and Nickerson 2011) and theoretical (e.g., Laffont and Tirole 1986) which suggests that regulators can deter manipulation by being better informed. Condition (i) of Proposition 1 directly implies our first empirical hypothesis:

Hypothesis 1. *Firms that are sanctioned by OSHA for workplace safety violations are less likely to commit workplace safety violations in the following year.*

Condition (ii) of Proposition 1 implies the need for empirical tests because of two countervailing forces that occur as a result of OSHA1 being informed about $\tilde{I}$. On the one hand, OSHA2 is *more* informed when OSHA1 learns $\tilde{I}$ since $\delta^2 < \alpha^2$, meaning that ceteris paribus it is more likely to investigate for any given signal. On the other hand, the fact that OSHA1 is *better* informed than OSHA2 encourages the firm to substitute away from manipulating in market 1 to manipulating in market 2. In Condition (ii), we show that which of these two forces dominate depends on whether the level of information frictions exceeds a threshold $\overline{\delta^2}$. Whether this is the

case is an empirical question. Based on our interviews we expect that, empirically, $\delta^2 > \overline{\delta^2}$. This generates our second empirical hypothesis:

Hypothesis 2. *Information frictions within OSHA lead to geographic misconduct substitution on the part of overseen firms: a firm that commits a violation in one location is less likely to commit a violation in the same location next year but more likely to commit a violation in a different location next year.*

Condition (iii) of Proposition 1 extends condition (ii) by establishing that the *level* of information frictions matters: greater information frictions lead the firm to substitute away from manipulation in market 1 toward manipulation in market 2. This is intuitive: when information frictions are more severe, OSHA2's signal is noisier relative to OSHA1's. Hence, OSHA2 is less likely to investigate even when it sees a high signal. This generates our third empirical hypothesis:

Hypothesis 3. *The level of geographic misconduct substitution by the firm is positively associated with the level of information frictions within OSHA.*

APPENDIX C: OSHA inspection classification

OSHA classifies inspections into two types: programmed or unprogrammed. These two types of inspections are then further subdivided into thirteen categories, as we detail in Table C1. The goal of this section is to delineate between inspections that are reactive, those that are centrally planned by OSHA headquarters, and those that are undertaken at the discretion of individual state-level OSHA offices (i.e., proactive). We outline our categorization below. For more details on inspection types and methods, refer to the OSHA field operations manual (available at https://www.osha.gov/enforcement/directives/cpl-02-00-164).

C.1 Programmed Inspections

Programmed inspections are random, with target selection determined by a formula that is centrally determined by federal OSHA headquarters in Washington, D.C. While OSHA does not disclose its exact formula, the Field Operations Manual suggests that the formula is based on factors such as industry, establishment size, recency of past inspections, and history of workplace safety violations. While state plans ("SP states") may amend this formula (e.g., to place greater focus on specific industries), their amended formula must follow similar guidelines and be formally approved by federal OSHA headquarters. The approval process limits the discretion that state plans may take in determining targets of programmed inspections. The primary reason for these strictures is to ensure that firms cannot anticipate programmed inspections with any precision.

There are three types of programmed inspections: (i) *planned*, (ii) *programmed related*, and (iii) *programmed other*. Planned inspections are those that are conducted by a state office in response to a direct order from federal OSHA, rather than at the discretion of state-level offices, and so we classify these as centrally planned. However, in the course of preparing for and conducting a planned inspection, a state-level office may encounter issues that lead it to conduct additional, related inspections (falling under (ii) or (iii) above). These additional inspections are undertaken at the discretion of the state office, and so we classify them as discretionary.

C.2 Unprogrammed Inspections

Unprogrammed inspections reflect any OSHA inspection that is not programmed and encompass inspections undertaken for a wide range of reasons. The majority of unprogrammed inspections are those conducted in response to triggering events such as the reporting of a workplace accident or fatality/catastrophe, a complaint made by an employee, or a referral from someone knowledgeable of a workplace safety issue at a place of business (e.g., factory, warehouse, or retail location). The latter two cases (employee complaint or referral) comprise what is more commonly known as whistleblowing. Because these four types of inspections (accident, fatality/catastrophe, complaint, and referral) are in response to trigger events, rather than proactively undertaken on OSHA's part, we classify them as reactive.

Finally, other types of unprogrammed inspections include those taken at the explicit discretion of state-level OSHA offices. Most common among these are *monitoring* and *follow-up* inspections, which reflect a state-level office proactively checking in on a facility (often in response to a prior

safety issue in that workplace). On rare occasions, OSHA explicitly gives a firm an exemption from complying with a given standard (referred to as a *variance*—see https://www.osha.gov/variance-program for details on the variance program.). An inspection classified as *variance* reflects OSHA checking in on these exempt establishments to ensure that no other workplace safety procedures are ignored. Finally, as in the case of programmed inspections, when an OSHA state office conducts an unprogrammed inspection it may encounter issues that lead it to conduct additional, related inspections. These are classified as *unprogrammed related*, *unprogrammed other*, or *other*. All of these inspections reflect a proactive decision by a state-level OSHA office (rather than a directive from federal OSHA or a trigger event) to undertake an inspection, and so we classify these as discretionary inspections.

We summarize our approach in the table below. Our investigations sample includes 68,493 individual inspections of public company establishments (which we then aggregate to the firm-state-year level, as outlined in Section 4). We provide the distribution of these investigations by type below.

OSHA Inspection Types

Inspection Type	Category	Classification	Number of Investigations in Sample
Programmed	Planned	Centrally planned	22,721
Programmed	Programmed Related	Discretionary	650
Programmed	Programmed Other	Discretionary	358
Unprogrammed	Accident	Reactive	4,354
Unprogrammed	Fatality/Catastrophe	Reactive	535
Unprogrammed	Complaint	Reactive	27,736
Unprogrammed	Referral	Reactive	7,761
Unprogrammed	Monitoring	Discretionary	487
Unprogrammed	Variance	Discretionary	3
Unprogrammed	Follow-Up	Discretionary	1,592
Unprogrammed	Unprogrammed Related	Discretionary	1,996
Unprogrammed	Unprogrammed Other	Discretionary	67
Unprogrammed	Other	Discretionary	233
TOTAL			**68,493**

APPENDIX D: Empirical variable definitions

We define below each of the variables used in our regression specifications.

Variable	Unit of measurement	Definition
$ViolAny_{it}$	Firm-year	Indicator variable that equals 1 if firm *i* committed at least one OSHA violation in year *t*, in any state (e.g., this variable equals one for an observation corresponding to firm *i* in state *j* in year *t* even if the firm only committed a violation in some other state *k* in year *t*)
$ViolInState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* committed at least one OSHA violation in state *j* in year *t*
$ViolOutOfState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* committed at least one OSHA violation in any state other than *j* in year *t*
$\ln Penalty\$InState_{ijt}$	Firm-state-year	Natural logarithm of 1 plus the OSHA-assessed penalties firm *i* faces in a state *j* in year *t*
$\ln Penalty\$OutOfState_{ijt}$	Firm-state-year	Natural logarithm of 1 plus the OSHA-assessed penalties firm *i* faces in all states other than state *j* in year *t*
$RWInState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* committed at least one *Repeat* or *Willful* violation in state *j* in year *t*
$AnyInspectionInState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* faced at least one OSHA inspection (regardless of whether inspection was discretionary, reactive, or centrally planned, and regardless of whether a violation was found or not) in state *j* in year *t*
$ReactiveInState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* faced at least one reactive OSHA inspection but no centrally planned or discretionary inspections (regardless of whether a violation was found or not) in state *j* in year *t*
$PlannedInState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* faced at least one centrally-planned OSHA inspection but no discretionary inspections (regardless of whether a violation was found or not) in state *j* in year *t*
$DiscInState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* faced at least one discretionary OSHA inspection (regardless of whether a violation was found or not) in state *j* in year *t*
$CleanInspInState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* faced at least one OSHA inspection but did not commit any violations in state *j* in year *t*

$CleanInspOutOfState_{ijt}$	Firm-state-year	Indicator variable that equals 1 if firm *i* faced at least one OSHA inspection but did not commit any violations in any state other than *j* in year *t*
$StatePlan_{j}$	State	Indicator variable that equals 1 if state *j* operates an OSHA State Plan
$MeetOrBeat_{it}$	Firm-year	Indicator variable that equals one if firm *i* just meet or beat analyst consensus earnings per share by zero or one cents per share in year *t*
$NoICW_{it}$	Firm-year	Indicator variable that equals 1 if firm *i* did not have an internal control material weakness in year *t* (coded as missing for firm-years that did not need to disclose an internal control opinion)
$Dispersion_{it}$	Firm-year	Natural logarithm of number of states mentioned in firm *i*'s 10-K corresponding to year *t*, minus average value of this quantity within size decile and two-digit NAICS industry
$BoardIndep_{it}$	Firm-year	Percentage of independent directors on the firm's board of directors
$WeakCompliance_{it}$	Firm-year	Indicator variable that equals one if firm *i* received federal sanctions for non-OSHA violations in years *t*-2 through *t*. Non-OSHA violation data obtained from Good Jobs First's *Violation Tracker* database and reflects sanctions from over 50 federal agencies. Among the most commonly-occurring are fines assessed by Environmental Protection Agency, Wage & Hour Division, and Department of Justice
$LogEstabs_{ijt}$	Firm-state-year	Natural logarithm of the number of distinct establishments firm *i* operates in state *j* in year *t*
$LogAssets_{it}$	Firm-year	Natural logarithm of firm-year total assets
ROA_{it}	Firm-year	Return on assets, measured as ratio of net income to lagged assets
$Leverage_{it}$	Firm-year	Ratio of total short- and long-term debt to assets
$MarketToBook_{it}$	Firm-year	Market to book ratio

TABLES

Table 1: Sample construction

This table outlines our sample selection process.

	Firm-State-Years	
	Obs. Dropped	Obs. Remaining
Start: 24,358 firm-years corresponding to the 2,728 distinct Compustat firms with at least one OSHA inspection between 2002 and 2016, multiplied by 50 states where these firms could hypothetically have establishments		1,217,900
Less: Firm-state-years with zero establishments	(739,264)	478,636
Less: Firm-state-years with missing lead/lag data	(46,329)	**432,307**
Less: Firm-states with missing Compustat financial statement data	(39,932)	**392,375**

Table 2: Descriptive statistics

This table provides descriptive statistics for OSHA violations and for our regression sample. Panels A and B detail the proportion of firm-state-years with at least one OSHA violation, inspection, and discretionary inspection, respectively, broken down by year and by industry. Panel A provides descriptive statistics by year, while Panel B provides descriptive statistics by industry. Panel C provides descriptive statistics for control variables in our final regression sample.

Panel A: OSHA firm-state-year violation rates by year

Year	OSHA violations	OSHA inspections	Discretionary OSHA inspections
2002	0.041	0.065	0.007
2003	0.043	0.067	0.007
2004	0.043	0.068	0.007
2005	0.041	0.065	0.008
2006	0.042	0.066	0.006
2007	0.042	0.068	0.007
2008	0.043	0.068	0.007
2009	0.047	0.072	0.008
2010	0.046	0.069	0.006
2011	0.040	0.063	0.005
2012	0.039	0.066	0.006
2013	0.039	0.067	0.006
2014	0.036	0.062	0.007
2015	0.035	0.060	0.006
2016	0.032	0.055	0.005
Overall	**0.041**	**0.065**	**0.007**

Panel B: OSHA firm-state-year violation and inspection rates by industry

NAICS Industry	OSHA violations	OSHA inspections	Discretionary OSHA inspections
Admin/Support/Waste Management	0.032	0.059	0.011
Agriculture	0.038	0.067	0.008
Arts and Recreation	0.035	0.060	0.007
Construction	0.030	0.076	0.021
Education	0.006	0.015	0.000
Finance	0.011	0.022	0.002
Healthcare	0.027	0.049	0.003
Hospitality	0.041	0.062	0.006
Information	0.013	0.027	0.002
Manufacturing	0.052	0.082	0.007
Mining, Oil and Gas	0.027	0.052	0.009
Other	0.074	0.116	0.012
Professional Services	0.012	0.020	0.002
Real Estate	0.026	0.040	0.006
Retail Trade	0.052	0.078	0.008
Transportation	0.048	0.083	0.007
Utilities	0.034	0.066	0.012
Wholesale Trade	0.036	0.055	0.004
Overall	**0.041**	**0.065**	**0.007**

Panel C: Regression sample (n = 392,375)

This panel provides descriptive statistics for all variables used in the regressions in Tables 3 – 8.

Variable	Mean	Median	Std. Dev.	10th %ile	90th %ile
$ViolAny_t$	0.478	0.000	0.500	0.000	1.000
$ViolInState_t$	0.041	0.000	0.197	0.000	0.000
$ViolOutOfState_t$	0.467	0.000	0.499	0.000	1.000
$\ln Penalty\$InState_t$	0.260	0.000	1.433	0.000	0.000
$\ln Penalty\$OutOfState_t$	3.554	0.000	4.356	0.000	9.711
RWInState	0.002	0.000	0.044	0.000	0.000
AnyInspectionInState	0.065	0.000	0.247	0.000	0.000
ReactiveInState	0.034	0.000	0.181	0.000	0.000
PlannedInState	0.025	0.000	0.156	0.000	0.000
DiscInState	0.007	0.000	0.081	0.000	0.000
CleanInspInState	0.025	0.000	0.156	0.000	0.000
CleanInspOutOfState	0.123	0.000	0.329	0.000	1.000
State plan	0.412	0.000	0.492	0.000	1.000
Log establishments	1.668	1.386	1.463	0.000	3.761
Log assets	8.107	7.968	1.954	5.750	10.592
Return on assets (ROA)	0.053	0.052	0.080	0.022	0.141
Leverage	0.223	0.194	0.190	0.000	0.476
Market to book	2.898	2.201	4.216	0.853	5.812

Table 3. Response to past violations

This table provides OLS estimates of equation (3) using a firm-state-year panel from 2002-2016, where the dependent variable is *ViolAny*, an indicator for whether the firm violates an OSHA rule in any state in a given year. *ViolInState* is an indicator for whether the firm violates an OSHA rule in a given state in a given year. *ViolOutOfState* is an indicator for whether the firm violates an OSHA rule in any other state in a given year. Column (1) includes year fixed effects and firm by state fixed effects. Column (2) adds additional controls. Control variables include the natural log of the number of establishments the firm has in the state, the natural log of assets of the firm, return on assets, leverage, and market to book. Robust standard errors are clustered by firm and corresponding t-statistics are presented in brackets. The markings ***, **, and * denote results significant at the 1%, 5%, and 10% levels.

Dependent variable: $ViolAny_{t+1}$		
	(1)	(2)
$ViolInState_t$	-0.0085**	-0.0175***
	[-2.33]	[-4.86]
$ViolOutOfState_t$	-0.0665***	-0.0785***
	[-6.68]	[-7.51]
$\ln Estabs_t$		0.0307***
		[5.97]
$\ln Assets_t$		0.0837***
		[6.46]
ROA		0.0719
		[1.11]
Leverage		-0.0230
		[-0.47]
MB		-0.0010
		[-0.96]
Controls	NO	YES
Year FE	YES	YES
Firm by State FE	YES	YES
Adjusted R^2	0.4277	0.4322
Obs.	432,307	392,375

Table 4. Geographic substitution in violations

This table provides OLS estimates of equation (4) using a firm-state-year panel from 2002-2016. *ViolInState* is an indicator for whether the firm violates an OSHA rule in a given state in a given year. *ViolOutOfState* is an indicator for whether the firm violates an OSHA rule in any other state in a given year. ln*Penalty$InState* is the natural log of 1 plus the OSHA-assessed penalties a firm faces in a given state in a given year. ln*Penalty$OutOfState* is the natural log of 1 plus the OSHA-assessed penalties a firm faces in all other states in a given year. In Columns (1) and (2) we estimate equation (4) using violations and in Columns (3) and (4), we replace all violation variables with logs of their respective penalty amounts. Columns (1) and (3) include year fixed effects and firm by state fixed effects, while Columns (2) and (4) include additional controls. Coefficients are omitted for brevity, but control variables include the natural log of the number of establishments the firm has in the state, the natural log of assets of the firm, return on assets, leverage, and market to book. Robust standard errors are clustered by firm and corresponding t-statistics are presented in brackets. The markings ***, **, and * denote results significant at the 1%, 5%, and 10% levels.

Dependent variable:	$ViolInState_{t+1}$		$\ln Penalty\$InState_{t+1}$	
	(1)	(2)	(3)	(4)
$ViolInState_t$	-0.0536***	-0.0575***		
	[-12.00]	[-12.57]		
$ViolOutOfState_t$	0.0045***	0.0027***		
	[5.96]	[3.51]		
$\ln Penalty\$InState_t$			-0.0596***	-0.0615***
			[-13.22]	[-13.63]
$\ln Penalty\$OutOfState_t$			0.0053***	0.0037***
			[6.53]	[4.58]
Controls:				
Controls	NO	YES	NO	YES
Year FE	YES	YES	YES	YES
Firm by State FE	YES	YES	YES	YES
Adjusted R^2	0.1709	0.1743	0.1570	0.1592
Obs.	432,307	392,375	432,307	392,375

Table 5. OSHA inspections

This table provides OLS estimates of equation (4) but replacing the dependent variable to reflect inspections rather than violations, using a firm-state-year panel from 2002-2016. See Appendix C for the classification of discretionary and non-discretionary inspections. *ViolInState* is an indicator for whether the firm violates an OSHA rule in a given state in a given year. *ViolOutOfState* is an indicator for whether the firm violates an OSHA rule in any other state in a given year. *CleanInspInState* is an indicator variable for whether the firm was inspected and had no violation in a given state in a given year. *CleanInspOutOfState* is an indicator for whether the firm was inspected and had no violation in any other state in a given year. In columns (1) and (2) the dependent variable is *AnyInspectionInState*, an indicator for whether OSHA conducts an inspection of the firm in a given state in a given year. In columns (3) and (4), the dependent variable is *ReactiveInState*, an indicator for whether OSHA conducts a reactive inspection (i.e., in response to a trigger event) but no centrally planned or discretionary inspections of the firm in a given state in a given year. In columns (5) and (6), the dependent variable is *PlannedInState*, an indicator for whether there was at least one "planned" inspection (i.e., proactively requested by OSHA headquarters) of the firm in a given state in a given year but no inspections undertaken at the discretion of the state office. Finally, in columns (7) and (8), the dependent variable is *DiscInState*, an indicator for whether OSHA conducts a discretionary inspection of the firm (i.e., an inspection undertaken at the discretion of a state-level OSHA field office) in a given state and year. Columns (1), (3), (5), and (7) include year fixed effects and firm by state fixed effects, while columns (2), (4), (6), and (8) include additional controls. Coefficients are omitted for brevity, but control variables include the natural log of the number of establishments the firm has in the state, the natural log of assets of the firm, return on assets, leverage, and market to book. Robust standard errors are clustered by firm and corresponding t-statistics are presented in brackets. The markings ***, **, and * denote results significant at the 1%, 5%, and 10% levels.

	$AnyInspectionInState_{t+1}$		$ReactiveInState_{t+1}$		$PlannedInState_{t+1}$		$DiscInState_{t+1}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$ViolInState_t$	-0.0249***	-0.0294***	-0.0248***	-0.0278***	-0.0176***	-0.0182***	0.0175***	0.0166***
	[-5.19]	[-6.21]	[-7.39]	[-8.36]	[-5.02]	[-5.02]	[9.80]	[9.43]
$ViolOutOfState_t$	0.0072***	0.0039***	0.0048***	0.0034***	0.0021***	0.0008	0.0002	-0.0003
	[6.96]	[3.73]	[6.36]	[4.38]	[3.71]	[1.32]	[0.69]	[-0.86]
$CleanInspInState_t$	-0.0563***	-0.0591***	-0.0350***	-0.0352***	-0.0173***	-0.0195***	-0.0040**	-0.0044**
	[-12.30]	[-12.77]	[-10.07]	[-9.94]	[-6.05]	[-6.66]	[-2.14]	[-2.25]
$CleanInspOutOfState_t$	-0.0005	-0.0021*	0.0001	-0.0008	0.0003	-0.0002	-0.0008**	-0.0011**
	[-0.41]	[-1.86]	[0.07]	[-0.97]	[0.44]	[-0.26]	[-2.07]	[-2.54]
Controls:								
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm by State FE	YES	YES	YES	YES	YES	YES	YES	YES
Adjusted R^2	0.2281	0.2322	0.1369	0.1384	0.1317	0.1346	0.0459	0.0458
Obs.	432,307	392,375	432,307	392,375	432,307	392,375	432,307	392,375

Table 6. Repeat and willful violations

This table provides OLS estimates of equation (4) but replacing the dependent variable and adding additional interaction terms, using a firm-state-year panel from 2002-2016. The dependent variable, *RWInState*, is an indicator for whether OSHA assesses a Repeat or Willful violation for the firm in a given state in a given year. *ViolInState* is an indicator for whether the firm violates an OSHA rule in a given state in a given year. *ViolOutOfState* is an indicator for whether the firm violates an OSHA rule in any other state in a given year. *StatePlan* is an indicator for whether the state administers its own State Plan OSHA. Column (1) includes year fixed effects and firm by state fixed effects. Column (2) includes additional controls. Coefficients are omitted for brevity, but control variables include the natural log of the number of establishments the firm has in the state, the natural log of assets of the firm, return on assets, leverage, and market to book. Robust standard errors are clustered by firm and corresponding t-statistics are presented in brackets. The markings ***, **, and * denote results significant at the 1%, 5%, and 10% levels.

Dependent variable: $RWInState_{i,j,t+1}$		
	(1)	(2)
$ViolInState_t$	0.0035***	0.0037***
	[3.52]	[3.70]
$ViolOutOfState_t$	0.0002	0.0001
	[1.29]	[0.81]
Controls:		
Controls	NO	YES
Year FE	YES	YES
Firm by State FE	YES	YES
Adjusted R^2	0.0524	0.0443
Obs.	432,307	392,375

Table 7. Geographic substitution into State Plan states

This table provides OLS estimates of equation (4) adding in additional interaction terms and using a firm-state-year panel from 2002-2016. *ViolInState* is an indicator for whether the firm violates an OSHA rule in a given state in a given year. *ViolOutOfState* is an indicator for whether the firm violates an OSHA rule in any other state in a given year. *StatePlan* is an indicator for whether the state administers its own State Plan OSHA. Additional interactions are included between *StatePlan* and each of *ViolInState* and *ViolOutOfState*. Column (1) includes year fixed effects and firm by state fixed effects, while Column (2) includes additional controls. Coefficients are omitted for brevity, but control variables include the natural log of the number of establishments the firm has in the state, the natural log of assets of the firm, return on assets, leverage, and market to book. Robust standard errors are clustered by firm and corresponding t-statistics are presented in brackets. The markings ***, **, and * denote results significant at the 1%, 5%, and 10% levels.

Dependent variable: $ViolInState_{t+1}$		
	(1)	(2)
$ViolInState_t$	-0.0607***	-0.0638***
	[-10.86]	[-11.22]
$ViolOutOfState_t$	0.0028***	0.0011
	[3.43]	[1.29]
$ViolInState_t \times StatePlan$	0.0135**	0.0121*
	[2.06]	[1.78]
$ViolOutOfState_t \times StatePlan$	0.0040***	0.0039**
	[2.71]	[2.41]
Controls:		
Controls	NO	YES
Year FE	YES	YES
Firm by State FE	YES	YES
Adjusted R^2	0.1710	0.1743
Obs.	432,307	392,375

Table 8. State plan discretion in inspections

This table provides OLS estimates of equation (4) but replacing the dependent variable and adding additional interaction terms, using a firm-state-year panel from 2002-2016. *ViolInState* is an indicator for whether the firm violates an OSHA rule within a given state in a given year. *ViolOutOfState* is an indicator for whether the firm violates an OSHA rule in any other state in a given year. *StatePlan* is an indicator for whether the state administers its own State Plan OSHA. *CleanInspInState* is an indicator variable for whether the firm was inspected and had no violation in a given state in a given year. *CleanInspOutOfState* is an indicator for whether the firm was inspected and had no violation in any other state in a given year. In columns (1) and (2), the dependent variable is *ReactiveInState*, an indicator for whether OSHA conducts a reactive inspection but no centrally planned or discretionary inspections of the firm in a given state in a given year. In columns (3) and (4) the dependent variable is *PlannedInState*, an indicator for whether there was at least one "planned" inspection of the firm in a given state in a given year but no inspections undertaken at the discretion of the state office. In columns (5) and (6), the dependent variable is *DiscInState*, an indicator for whether OSHA conducts a discretionary inspection of the firm in a given state in a given year.Additional interactions are included between *StatePlan* and each of *ViolInState*, *ViolOutOfState*, *CleanInState*, and *CleanOutOfState*. Columns (1), (3), and (5) include year fixed effects and firm by state fixed effects, while Columns (2), (4), and (6) include additional controls. Coefficients are omitted for brevity, but control variables include the natural log of the number of establishments the firm has in the state, the natural log of assets of the firm, return on assets, leverage, and market to book. Robust standard errors are clustered by firm and corresponding t-statistics are presented in brackets. The markings ***, **, and * denote results significant at the 1%, 5%, and 10% levels.

	ReactiveInState$_{t+1}$		*PlannedInState*$_{t+1}$		*DiscInState*$_{t+1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
ViolInState$_t$	-0.0266***	-0.0298***	-0.0218***	-0.0227***	0.0173***	0.0162***
	[-5.69]	[-6.36]	[-4.64]	[-4.69]	[6.04]	[5.77]
ViolOutOfState$_t$	0.0045***	0.0033***	0.0013**	-0.0002	-0.0002	-0.0007*
	[5.23]	[3.69]	[2.03]	[-0.28]	[-0.46]	[-1.92]
CleanInspInState$_t$	-0.0400***	-0.0402***	-0.0231***	-0.0244***	-0.0032	-0.0038
	[-8.17]	[-8.03]	[-5.80]	[-5.98]	[-1.19]	[-1.40]
CleanInspOutOfState$_t$	0.0004	-0.0003	0.0002	-0.0004	-0.0008**	-0.0012***
	[0.45]	[-0.28]	[0.32]	[-0.52]	[-1.96]	[-2.61]
ViolInState$_t$ × *StatePlan*	0.0034	0.0039	0.0083	0.0089	0.0004	0.0007
	[0.61]	[0.67]	[1.47]	[1.54]	[0.10]	[0.18]
ViolOutOfState$_t$ × *StatePlan*	0.0008	0.0003	0.0021*	0.0025*	0.0009	0.0010
	[0.56]	[0.21]	[1.74]	[1.88]	[1.41]	[1.35]
CleanInspInState$_t$ × *StatePlan*	0.0096	0.0098	0.0112**	0.0096*	-0.0017	-0.0012
	[1.46]	[1.46]	[2.01]	[1.66]	[-0.45]	[-0.31]
CleanInspOutOfState$_t$ × *StatePlan*	-0.0009	-0.0014	0.0002	0.0005	0.0000	0.0002
	[-0.55]	[-0.77]	[0.14]	[0.36]	[0.05]	[0.22]
Controls:						
Controls	NO	YES	NO	YES	NO	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm by State FE	YES	YES	YES	YES	YES	YES
Adjusted R^2	0.1369	0.1385	0.1318	0.1346	0.0459	0.0458
Obs.	432,307	392,375	432,307	392,375	432,307	392,375

Table 9. When is substitution stronger?

This table provides OLS estimates of equation (4) with additional interaction terms, using a firm-state-year panel from 2002-2016. All specifications tabulated reflect extensions of column (2) of Table 4. In Panel A, we consider the role of firms' financial incentives in facilitating geographic substitution, whereas in Panel B we consider the role of opportunities and culture. In both panels, *ViolInState* is an indicator for whether the firm violates an OSHA rule in a given state in a given year. *ViolOutOfState* is an indicator for whether the firm violates an OSHA rule in any other state in a given year. In all columns in both panels, we interact various proxies for financial incentives or opportunities with *ViolOutOfState*. All columns of both panels include year fixed effects, firm by state fixed effects, and additional controls. Coefficients are omitted for brevity, but control variables include the natural log of the number of establishments the firm has in the state, the natural log of assets of the firm, return on assets, leverage, and market to book. Robust standard errors are clustered by firm and corresponding t-statistics are presented in brackets. The markings ***, **, and * denote results significant at the 1%, 5%, and 10% levels.

Panel A: Financial incentives for geographic substitution

In this panel we consider the role of financial incentives in firms' decisions to engage in geographic substitution, using three measures. The first, *RWOutOfState*, is an indicator for whether OSHA assesses a Repeat or Willful violation for the firm in any other state in a given year. The second, *TopDecileROA* is an indicator for whether the firm is in the top decile of the sample based on return on assets. The third, *MeetOrBeat* is an indicator for whether the firm just meet or beat analyst consensus earnings per share by zero or one cents per share.

Dependent variable: $ViolInState_{t+1}$			
	(1)	(2)	(3)
$ViolInState_t$	-0.0576***	-0.0575***	-0.0543***
	[-12.62]	[-12.61]	[-11.32]
$ViolOutOfState_t$	0.0025***	0.0034***	0.0026***
	[3.15]	[4.16]	[3.03]
$RWOutOfState_t$	0.0064**		
	[2.11]		
$ViolOutOfState_t \times TopDecileROA_{t+1}$		-0.0074**	
		[-1.97]	
$TopDecileROA_{t+1}$		0.0008	
		[0.52]	
$ViolOutOfState_t \times MeetOrBeat_{t+1}$			0.0045**
			[2.04]
$MeetOrBeat_{t+1}$			-0.0017
			[-1.53]
Controls:			
Controls	YES	YES	YES
Year FE	YES	YES	YES
Firm by State FE	YES	YES	YES
Adjusted R^2	0.1743	0.1744	0.1726
Obs.	392,375	392,207	355,671

Panel B: Opportunities to engage in geographic substitution

In this panel we consider the role of opportunities in firms' decisions to engage in geographic substitution, using four measures. The first, *NoICW*, is an indicator variable that equals one for firms that do not disclose any material internal control weaknesses. The second, *BoardIndep*, is the percentage of independent directors on the board of directors. The third, $Dispersion_{t+1}$, is the number of states mentioned in the firm's 10-K in year t+1, following Garcia and Norli (2012), but adjusted for industry and size decile. The fourth, *WeakCompliance*, is an indicator for whether the firm has had non-OSHA related fines in the past three years.

Dependent variable: $ViolInState_{t+1}$				
	(1)	(2)	(3)	(4)
$ViolInState_t$	-0.0603***	-0.0569***	-0.0538***	-0.0486***
	[-11.95]	[-11.94]	[-11.22]	[-10.37]
$ViolOutOfState_t$	-0.0032	0.0121***	0.0027***	0.0014
	[-0.86]	[2.58]	[3.32]	[1.35]
$ViolOutOfState_t \times NoICW_{t+1}$	0.0062*			
	[1.65]			
$NoICW_{t+1}$	-0.0021			
	[-1.02]			
$ViolOutOfState_t \times BoardIndep_{t+1}$		-0.0133**		
		[-2.08]		
$BoardIndep_{t+1}$		0.0130*		
		[1.92]		
$ViolOutOfState_t \times Dispersion_{t+1}$			0.0026*	
			[1.65]	
$Dispersion_{t+1}$			-0.0006	
			[-0.38]	
$ViolOutOfState_t \times WeakCompliance_{t+1}$				0.0035**
				[2.09]
$WeakCompliance_{t+1}$				0.0000
				[0.03]
Controls:				
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Firm by State FE	YES	YES	YES	YES
Adjusted R^2	0.1713	0.1718	0.1725	0.1762
Obs.	339,670	366,038	352,904	327,807