COVER LETTER—APPLICATION TO NBER PHD STUDENT WORKSHOP ON CLIMATE FINANCE

Applicant name:	Ali Ahmadi
Contact:	Schulich School of Business York University, Canada aliahmdi@yorku.ca https://sites.google.com/view/aahmadi/
Committee chair:	Ambrus Kecskés (Please see other reference on my attached CV)
Research interests:	Corporate finance, Corporate governance, Labor finance, Sustainable finance, Artificial intelligence, Investments
Expected graduation date:	Summer 2026

Dear Members of the Selection Committee,

I am writing to express my strong interest in participating in the NBER PhD Student Workshop on Climate Finance. My doctoral research investigates critical but underexplored drivers of firm value, with a focus on empirical corporate finance. I work across areas spanning corporate governance, sustainability and climate finance, innovation and technology, labor finance, and investments.

My research portfolio consists of projects at various stages of development in the pipeline. In my Job Market Paper, I causally demonstrate that strengthening executives' personal liability for corporate pollution destroys shareholder value through increasing compliance costs, despite the apparent social merits. In a second, co-authored work (with Ambrus Kecskés, Roni Michaely, and Phuong-Anh Nguyen), we provide causal evidence that corporate production of AI innovation, rather than mere AI adoption, enhances value by permanently decreasing both the systematic and idiosyncratic risk of the producer firm. In a third joint work in progress (with Ambrus Kecskés and Phuong-Anh Nguyen), we identify the exogenous inflow of foreign-born labor as a significant source of value creation in mergers and acquisitions, realized through strengthening of the acquirer firm's culture.

In addition to these core projects, I am also working with my co-authors Ambrus Kecskés and Phuong-Anh Nguyen in developing the conceptual framework of other high-impact studies. These include (1) examining the impact of international trade competition on corporate pollution, (2) studying the corporate governance implications of corporate AI production with a focus on managerial incentives and compensation contracts, and (3) examining the effect of local air pollution on migration patterns and labor shortage, and the implications for corporate innovation.

I have enclosed my CV and job market paper for your consideration. Thank you for your time and attention to my application.

Sincerely,
Ali Ahmadi

ALI AHMADI

SCHULICH SCHOOL OF BUSINESS, YORK UNIVERSITY, CANADA
aliahmdi@yorku.ca ■ https://sites.google.com/view/aahmadi/ ■ +1-647-467-9067

EDUCATION

Ph.D. in Finance, Schulich School of Business, York University, 2020–2026 (expected)

M.Sc. in Business Administration, Finance Major, Sharif University of Technology, 2016–2019

B.Sc. in Electrical Engineering, Sharif University of Technology, 2012–2016

RESEARCH INTERESTS

Corporate finance, Corporate governance, Labor finance, Sustainable finance, Artificial intelligence, Investments

WORKING PAPERS

The Double-Edged Sword of Executive Personal Liability: Firm Value vs. Social Responsibility (Job Market Paper)

Best Paper Award, Canadian Sustainable Finance Network Conference, 2025

Selected Conferences (including scheduled): European Finance Association (EFA) Doctoral Tutorial 2025, Northern Finance Association (NFA) PhD Poster Session 2025, Financial Management Association (FMA) Annual Meeting 2025, Canadian Sustainable Finance Network (CSFN) 2025

Producing AI Innovation and Its Value Implications (with Ambrus Kecskés, Roni Michaely, and Phuong-Anh Nguyen)

Best Paper Award, Academy of Finance Conference, 2025
Best Paper Award, Eurasia Business and Economics Society Conference, 2025
Best Paper Award, Vietnam International Conference in Finance, 2025
Best Paper Award, Finance Symposium, 2024

Selected conferences: European Finance Association (EFA) 2024, CREDIT International Conference (GRETA) 2024, CCA-ESCP Workshop on Financial Institutions and Corporate Finance 2025, FMA Consortium on Asset Management 2025, Research in Behavioral Finance Conference (RBFC) 2024

HONORS, AWARDS, AND SCHOLARSHIPS

Best Paper, Canadian Sustainable Finance Network Conference (2025) – CAD 1,000
EFA Doctoral Tutorial Travel Stipend (2025) – EUR 1,000
University of Hong Kong Governance and Sustainability PhD Workshop Travel Stipend (2025) – HKD 5,000
NFA Travel Stipend (2025) – CAD 500
Canadian Securities Institute Research Foundation PhD Scholarship (2023-2025)

PhD fellowship, Schulich School of Business, York University (2020-2025)
Top Performance in National University Entrance Examination, Iran
Ranked 11, MBA Program (35,000+ participants, 2016)
Ranked 22, Bachelor Program (260,000+ participants, 2012)
Ranked 8, Foreign Language Studies (110,000+ participants, 2012)

TEACHING AND RESEARCH EXPERIENCE

Co-Instructor, Corporate Finance (Undergraduate), School of Administrative Studies, York University, Winter 2025, Evaluation: 4.7/5

Research Assistant, Supervised by Ambrus Kecskés and Phuong-Anh Nguyen, Schulich School of Business, York University, Fall 2020–Present

Teaching Assistant, Corporate Finance (MBA) and Strategic Planning (MBA), Sharif University of Technology, Fall 2017

SKILLS AND LANGUAGES

Software: Proficient in *Stata* and *R*
Languages: English (fluent), Persian (native)

REFERENCES

Ambrus Kecskés
Professor of Finance
Schulich School of Business
York University, Canada
akecskes@schulich.yorku.ca

Roni Michaely
Professor of Finance
Zhang Yonghong Endowed Chair
University of Hong Kong Business School
ronim@hku.hk

Kee-Hong Bae
Professor of Finance
Bob Finlayson Endowed Chair
Schulich School of Business
York University, Canada
kbae@schulich.yorku.ca

Phuong-Anh Nguyen
Assistant Professor of Finance
School of Administrative Studies
York University, Canada
anhvn@yorku.ca

The Double-Edged Sword of Executive Personal Liability: Firm Value vs. Social Responsibility

ALI AHMADI*

Abstract

Stronger personal liability for executives destroys shareholder value. I demonstrate this with environmental liabilities. Guided by predictions of a stylized model, I exploit detailed data on US publicly traded firms and the heterogeneity of their toxic emissions across pollutive subsidiaries nationwide. After a 1998 legal shock that strengthened executives' pollution liability in some US regions, firms with high exposure to the shock through their affected subsidiaries experienced an immediate and persisting 2.3% drop in equity value, supported by downward adjustment of analyst earnings forecasts. Realized cash flows also dropped, driven by an increase in compliance costs and a reduction in pollution-inducing sales. Further, exposed firms experienced an increase in cash flow volatility and CEO compensation. Affected subsidiaries lowered toxic emissions into water and air (targeted by the shock) by 8%, while reassuringly leaving ground emissions (unaffected by the shock) unchanged. This is achieved through reducing pollutive production, increasing pollution abatement, and strategic reallocation of pollution to unaffected subsidiaries within the firm. Aggregate pollution also decreased in exposed firms. At the macro level, pollutive industries with large operations in the affected regions experienced lower output, profits, pollution, and business creation. The value effect extends beyond the environmental domain, as confirmed using a 2022 Delaware state law amendment expanding executive liability protections.

July 27, 2025

JEL Classification: K22, G34, G38, Q58
Keywords: Corporate Governance, Sustainability, Executive Personal Liability, Corporate Pollution, Shareholder Value, Agency Problem, Investments

* Schulich School of Business, York University. Email: aliahmdi@yorku.ca. I greatly appreciate helpful comments of Sean Geobey, Jarrad Harford, Ambrus Kecskés, Phuong-Anh Nguyen, Zacharias Sautner, and Noah Stoffman, and seminar participants at the 2025 Canadian Sustainable Finance Network Conference. This paper received the Best Paper Award at the 2025 Canadian Sustainable Finance Network Conference and was financially supported by the Canadian Securities Institute Research Foundation.

1. Introduction

> *"Rather than assure that the laws were being obeyed by their subordinates, ... executives take great pains to make certain that they have no knowledge of any illegal activities."*
>
> Senator Estes Kefauver, 1961.[1]

Personal liability is a pivotal, yet underexplored facet of corporate governance. Executives in the US are not typically held personally liable for corporate law breaches unless they engage in the misconduct. Nevertheless, their authority often enables them to prevent misconduct, even without oversight duties, raising debates about the optimal scope of liability.[2] Rarely disputed, stronger personal liability for executives can improve corporate legal compliance and benefit social stakeholders. However, it can also increase compliance costs and deter value enhancing risk-taking, thereby harming firm performance and shareholder value. This paper provides the first large scale causal evidence on the negative impact on shareholder value of holding executives personally liable for corporate misconduct.

Prior evidence on the value effect of personal liability is inconclusive. Some studies find that stronger personal liability enhances shareholder value (Chalmers, Dann, and Harford, 2002; Donelson and Yust, 2014; Lin, et.al., 2019; Aguir and Aguir, 2020), while others report a detrimental or neutral effect (Brook and Rao, 1994; Hwang and Kim, 2018; Naaraayanan and Nielsen, 2021). Resolving these conflicting findings requires addressing the empirical challenges inherent in a causal analysis of executive personal liability. Most notably, clean identification requires an exogenous shock *only* to the personal liability of executives. Critically to the analysis of shareholder value, the shock must not alter shareholder rights vis-à-vis executives, as such changes would confound the observed effect of personal liability with shifts in shareholder

[1] See Laufer (1999).
[2] See for example, "The Yates Memo: Individual Accountability for Corporate Wrongdoing", U.S. Department of Justice (2015).

protection. Other limitations include attenuation of treatment through liability avoidance, lack of external validity due to small or non-representative samples, and homogenous treatments. These limitations constrain the applicability of the shocks to executive liability used in the prior studies.

My empirical design overcomes these challenges by leveraging the 1998 *United States v. Iverson* (henceforth *Iverson*) legal ruling that significantly expanded executives' personal liability for corporate pollution in specific U.S. regions. Crucially, executives' environmental liabilities affect shareholders only through the impact on executives, enabling a clean analysis of the value implications of personal liability.[3]

The main empirical findings reveal that stronger personal environmental liability for executives destroys shareholder value. This value destruction arises as executives' increased compliance efforts reduce and destabilize cash flows. Sales diminish as firms reduce pollutive production, while investment in pollution abatement increases costs. Additionally, the increased liability risk leads to higher executive compensation to offset their risk exposure.

These empirical findings are guided by and support the predictions of a stylized model of executive behavior under personal environmental liability. In the model, a utility maximizing executive chooses his compliance effort as a function of the personal environmental liability regime and the stochastic probability of regulatory inspection. More stringent personal liability risk induces higher effort. For the profit-maximizing firm, the model predicts lower output, cash flow levels, and pollution in stronger personal liability regimes. The stochastic probability of regulatory inspection introduces volatility into cash flows which is predicted by the model to be

[3] In addition, environmental liabilities are typically excluded from standard D&O insurance policies (Abraham, 1988; Siegelman, 2003) restricting executives' ability to avoid out-of-pocket penalties. Such liabilities are also tied to the location of pollution, further limiting executives' ability to shield themselves through jurisdictional choices.

increasing in the strength of personal liability. The lowered cash flow levels and the increased volatility (discount factor) ultimately decrease firm value.

As a foundation for empirically testing the model's predictions, I begin with a detailed exposition of the 1998 *Iverson* decision by the Ninth Circuit Court of Appeals.[4] The ruling strengthened executives' personal pollution liability by holding that mere knowledge of an environmental violation and the authority to prevent it was sufficient for liability under the Clean Water Act, thus eliminating the need to prove direct involvement. This decision was grounded in the mention of "any responsible corporate officer" in describing individuals who could be held personally liable for corporate environmental breaches, shared by both the Clean Water Act and Clean Air Act. Therefore, *Iverson* marked a pivotal legal precedent by applying the Responsible Corporate Officer Doctrine in an environmental case, which was historically avoided by courts due to ambiguous language of the legislation. Binding lower courts only in the Ninth Circuit, *Iverson* therefore created a legal disparity across U.S. regions which I exploit in a difference-in-difference research design.[5] The sample period spans from 1994 through 2003, capturing a decade around the ruling.

In my empirical design, a plant is considered as treated by *Iverson* if it is located in the Ninth Circuit, where prosecution for environmental violations is most likely. Similarly, a firm's exposure to *Iverson* is quantified by the proportion of its polluting operations located in the Ninth Circuit. To illustrate, executives face greater increases in personal liability post-*Iverson* when a larger share of the firm's activities fall under the Ninth Circuit's jurisdiction. I operationalize this

[4] In the US, circuit courts are intermediate-level courts. Each circuit court covers a geographic area containing multiple states. The United States Court of Appeals for the Ninth Circuit has jurisdiction over the states of Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, and Washington.

[5] Following the vertical precedent doctrine (a.k.a., hierarchical precedent doctrine), where the legislation's lack of clarity permits federal judges to have different interpretations of a statute, lower courts are bound by the precedent decisions of the upper courts which have a revisory role upon them.

exposure as either the share of subsidiaries or the proportion of on-site air and water emissions located in the Ninth Circuit. Both continuous, time-varying ratios are employed in subsequent analyses, as there is no theoretical basis to favor one measure over the other.[6]

Preceding my main analysis, I examine the macro effect of *Iverson* as a salient shock to the risk of managing pollutive businesses in the Ninth Circuit. While this analysis is independently notable, it suggestively validates *Iverson* as a salient shock to pollutive businesses in the Ninth Circuit. I find that the media extensively warned executives about the heightened liability risks.[7] Pollutive industries with large operations in the Ninth Circuit experienced significantly lower pollution, output, and profits after the shock. The reduction in output is consistent with cutting production to manage pollution. Furthermore, I find that post-shock net business creation declined in pollutive industries within the Ninth Circuit. This decline aligns with increased risk perceptions.

Next, I turn to my main analysis with the central question to the financial economist: What are the value implications of strengthening executive personal liability? I explore this question using forward-looking stock prices as the best available proxy for discounted future cash flows and shareholder value. As executives respond to increased liability by reallocating resources to pollution control, the increased compliance costs are borne out by shareholders. If the market incorporates this value-relevant information efficiently, the value of exposed firms should drop immediately around the *Iverson* decision.

This is indeed what I find: Firms whose pollutive subsidiaries are entirely located in the Ninth Circuit experience a 2.3% drop in their equity market value during the [-1,+1] daily window

[6] To address concerns about the endogeneity of firms actively managing their exposure to the shock after *Iverson*, I repeat my analysis using constant 1998 exposures and confirm that my inferences remain unchanged.

[7] Shortly after the Ninth Circuit decision, Los Angeles Times wrote: "Company executives beware. If your company violates federal water pollution laws, you can pay heavy fines or serve prison time, according to a recent ruling by the U.S. 9th Circuit Court of Appeal. … Ask Thomas E. Iverson Sr., who is serving a one-year sentence at a federal prison in Texas". Other sources covering the news include the EPA's official website, Associated Press Newswires, Chemical Week Associates, and Kitsap Sun.

around *Iverson*, relative to unexposed peers.[8] Interpreted alternatively, a one standard deviation increase in the exposure to *Iverson* (roughly 30 percentage points) reduces abnormal returns by roughly 14% of its standard deviation. The value decline begins shortly before the decision date and is not transient, persisting for at least 90 days after the shock.

The immediate drop in firm value in exposed parents reflects revised market expectations about future cash flows, risk, or both. To the best of my knowledge, there are no widely accepted measures of market *expectations* on risk, particularly one that can be studied in a short daily window around the shock. Instead, I focus on changes in expectations of cash flow levels, using analysts' earnings forecasts as a proxy. Around the *Iverson* decision, analysts downgrade forecasts for more exposed parents, with a one standard deviation increase in exposure leading to a 5% standard deviation drop in forecast revisions. This indicates that the observed value loss is partly attributable to anticipated declines in future cash flows following the executive liability shock.

Next, I turn to realized cash flows in years following *Iverson* to assess whether the market's anticipation of reduced cash flows is accurate. Theoretically, deterioration of cash flows in exposed firms is consistent with more aggressive pollution control. Supportively, I find that a one standard deviation increase in exposure to *Iverson* decreases return on assets and profit margins by 0.4 to 1 percentage point more after the shock, representing 4%-8% of the standard deviation of these outcomes. This cash flows decline is driven by both reduced sales and increased costs.

Consistent with the predictions of the stylized model, and to the extent that environmental liabilities of executives impose unanticipated legal and compliance costs on the firm and disrupt operations, *Iverson* is also expected to make cash flows less stable. I test this hypothesis using volatility of cash flows and find an economically sizeable and statistically significant increase in

[8] In the baseline analysis, cumulative abnormal returns are calculated by first adjusting raw daily returns for risk using Fama-French (2015) factor model and then cumulating starting from one day before the shock event.

the volatility of cash flows in exposed firms post shock. Finally, to shed further light on the impact on costs, I also study executive and director compensation. Consistent with the higher liability risk burden, exposed CEOs experienced higher compensations post shock. In contrast, directors, who are more distanced from daily operations, saw no significant compensation changes.

The remainder of my analysis explores the mechanisms behind value destruction in exposed firms. I hypothesize that the increased personal liability risk for executives causes more aggressive pollution control, increasing costs to shareholders. Hence, in what follows, I delve deeper into the impact on toxic emissions and pollution control mechanisms.

As a first step, I analyze plant-chemical-year data to assess *Iverson*'s impact on toxic emissions. Since *Iverson* specifically targets water and air pollution, my primary outcome is the emissions released on-site to these media. I find that affected plants reduce water and air emissions by about 8% following the shock, equivalent to roughly 2% of emissions' standard deviation, with no change in ground emissions. At the parent firm level, a one standard deviation increase in exposure to *Iverson* lowers toxic emissions by 4%, or 1% of emissions' standard deviation. These results are robust to scaling emissions by total assets, sales, or number of pollutive subsidiaries.

I then explore the four potential channels enabling the pollution control: Reducing production, investing in abatement technologies, strategic transfer of pollution across plants within the parent firm, and shifting pollution off-site or to alternative pollution media. My subsequent analysis presented below support all channels except the latter.

First, I find that affected plants reduce water- and air-polluting production by 3 percentage points post-shock, about 5% of the standard deviation. This likely lowers overall output or shifts production to less pollutive but costlier alternatives, thereby reducing cash flows.

Next, focusing on chemicals that are primarily released into water and air, I find that treated plants are 0.7 percentage points more likely to invest in process abatements after *Iverson*, corresponding to about 4% of the standard deviation of the outcome variable.[9] Process abatements address pollution at its source by modifying production processes, preventing the creation of pollution rather than simply managing it after the fact, and are therefore favored by EPA (Akey and Appel (2021) and Bellon (2023)). While environmentally beneficial, these investments increase operational costs for affected firms and their shareholders.

Third, I find evidence that parent firms strategically reallocate pollution to plants in states bordering the Ninth Circuit to avoid strengthened liability while preserving their supply chain network. Specifically, I find that a one standard deviation increase in a parent firm's exposure to *Iverson* amplifies the post-shock pollution of its plants in adjacent states by 6%. No similar effect is observed for unaffected plants outside the bordering states. However, this transfer does not fully offset reduced emissions at affected plants, so overall parent emissions still decline.

Finally, I find no evidence that plants shift pollution to ground outlets or increase off-site transfers for recycling or disposal. If anything, off-site transfers at affected plants decrease post-shock, mirroring the reduction in on-site emissions.

The main finding of this paper thus far highlights the value destroying effect of executive personal *environmental* liabilities. In a key robustness test, I assess the validity of this key finding beyond environmental liabilities. For nearly forty years, Delaware law has allowed firms to exempt

[9] Unlike for emissions where the data tells us whether the toxins have been released into water, air, or ground, the pollution prevention (P2) data is not broken down by the targeted medium. Hence, in my baseline analyses of production volume and abatement activities, for each facility-year, I restrict to chemicals that were primarily released into water and air in prior years by looking at each facility's emissions in the past three years. This is critical because chemicals that are released into ground are irrelevant to my current analysis and may bias my results (this may be true if, for instance, affected facilities compensate their abatement investments for water/air specific chemicals by decreasing abatements in ground specific chemicals).

directors from personal liability for fiduciary duty breaches[10]. A 2022 amendment to the Delaware General Corporation Law (DGCL) extended this protection to executives. Following this change, Delaware firms saw an immediate rise in equity value relative to other firms, suggesting that the impact of executive personal liability extends beyond environmental liabilities.

This paper primarily contributes to the literature on the value implications of executive and director personal liability. Several studies in this literature find that stronger personal liability is associated with *higher* firm value: Chalmers, Dann, and Harford (2002) study a sample of 72 IPOs during 1992 to 1996 and find that higher D&O liability insurance coverage predicts lower post-IPO stock performance. Donelson and Yust (2014) study a shock to Nevada corporate law that limited personal liability of directors and officers, and document decreased firm value for a small sample of Nevada-incorporated firms. Lin, et.al. (2019) study a German law reform that strengthened D&O liability and find increased firm value. Aguir and Aguir (2020) find that firms with greater director liability protection have lower firm value. Another strand of this literature associates stronger personal liability with *lower* firm value: Hwang and Kim (2018) document higher firm value as a result of stronger D&O insurance coverage in Korea. Naaraayanan and Nielsen (2021) find a decrease in firm value after introduction of personal liability in India.

Several empirical limitations lead to these contradictory findings. Critically, among others, the shocks to personal liability used in prior studies are often confounded with shifts in shareholder protection and fiduciary rights. This study overcomes these empirical challenges by exploiting a novel shock to executives' environmental liabilities, presenting the first large scale and causal evidence on value effect of executive personal liability for a large sample of U.S. public firms.

[10] Section 102(b)(7) of Delaware General Corporation Law.

Progressing from value implications, prior studies on personal liability document diminished supply and quality of directors following shocks to personal liability (Masulis et.al., 2020; Naaraayanan and Nielsen, 2021). Another thread explores the legal liabilities of executives following the enactment of the Sarbanes-Oxley Act (SOX). For example, Kang et al. (2010) and Linck et al. (2008) document a decline in investment activities and an increase in director costs, respectively, in the aftermath of SOX.[11] A related, yet distinct, branch of the literature examines executives' personal liabilities outside the legal realm, such as personal debt obligations, revealing that executives with greater personal liabilities tend to mitigate firm risk-taking (Wei and Yermack, 2011; Van Bekkum, 2016, Schoenherr, 2017, and Koudijs et.al., 2021). My findings complement this literature by providing causal evidence on the real and financial effects of personal liability.

I also contribute to the literature on the merits and harms of personal liability. While some argue corporate liability cannot replace individual accountability (e.g., Arlen, 1994; Polinsky and Shavell, 1993), others believe strict liability for executives is unjust (e.g., Greenberg and Brotman, 2014). My findings highlight that while holding executives personally accountable improves corporate legal compliance, it has negative economic consequences harming shareholders.

Furthermore, this paper augments the literature studying the principal-agent conflicts of interest. Foundational theoretical work in this field includes Holmstrom (1979), Mirrlees (1976), and Holmstrom and Milgrom (1987). More recent studies attribute the agency conflicts to various corporate outcomes such as low leverage (Morellec, 2004), opportunistic investments and executive compensation (Kempf et.al., 2016), and increased corporate philanthropy (Masulis and

[11] SOX presents inherent limitations for causal analysis of executive liability. First, SOX consisted of a complex sequence of intertwined regulations, making it challenging to isolate the exclusive impact of enhanced executive liability. Second, SOX was primarily designed to protect shareholder rights, complicating efforts to disentangle the benefits from the costs imposed on shareholders by the regulatory changes. Third, as a one-size-fits-all regulatory framework, SOX targeted all publicly traded firms uniformly, with any differential treatments being temporary at best, rendering causal comparisons among public firms infeasible.

Reza, 2014), among others. I examine personal liability as a source of agency costs, demonstrating that executives act against shareholders' interests to avoid personal liability risk.

Secondarily, this paper augments a recent strand of empirical work on the economics of limited environmental liability. Akey and Appel (2021) find that less strict parent liability standards for subsidiaries' cleanup costs results in increased toxic emissions and shareholder value. Bellon (2023) similarly documents deteriorated environmental performance as lenders face reduced exposure to the cleanup costs of their debtor's collaterals. Ohlrogge (2023) finds that a stronger liability against cleanup costs in the state of bankruptcy reduces toxic emissions. This paper addresses an overlooked but economically consequential aspect of environmental liabilities, namely executives' personal liability for corporate pollution.

Finally, this paper contributes to the literature on the determinants of corporate pollutive behavior (e.g., financial constraints (Kim and Xu, 2018), ownership structure (Shive and Forster, 2020), and political connections (Heitz et.al., 2021 and Xiao and Shen, 2022)). My findings enrich this literature by identifying executives' personal liability limits as a critical determinant of industrial pollution.

The remainder of this paper is as follows. Section 2 provides the institutional background for the legal events used in this study. Section 3 describes the identification strategy and data sources. Section 4 examines the macroeconomic consequences of *Iverson*. Section 5 outlines the methodology used in this study. Section 6 explores the value implications of strengthened executive personal liability. Section 7 examines the effect on toxic emissions and the mechanisms driving the value effect. Section 8 examines value implications of executive liability in a non-environmental context. Section 9 describes robustness tests. Section 10 concludes.

2. Institutional Background

2.1. United States v. Iverson

In September 1997, Thomas E. Iverson Sr., the founder of CH20 company, was indicted by the federal District Court of Washington for several counts of violations of the Clean Water Act (CWA) during 1992-1995. Remarkably, at the time of indictment, Iverson was considered the *former* president and chairman of the board, having retired from his official roles.

Iverson's company manufactured products including acid cleaners and alkaline compounds and shipped its blended chemicals to its customers in drums. The drums were returned after use and were cleaned and reused. This cleaning process generated a wastewater regulated by the CWA. During 1992 through 1995, the company failed to obtain a wastewater discharge permit and employed various illegal disposal methods. While Iverson was not directly involved in the company's illegal discharges during this time, evidence showed that he was informed and supportive of the improper disposal methods.

Subsequent to his initial indictment in September 1997, Iverson was convicted in U.S. District Court for the Western District of Washington in Seattle on five counts of violating the CWA on November 5, 1997. The trial court instructed the jury that the defendant could be found liable as a responsible corporate officer if: (1) He knew about the violating discharges, (2) had the authority to prevent it, and (3) failed to act. Iverson appealed, and the Ninth Circuit Court of Appeals upheld the District Court's decision on December 11, 1998.

The *United States v. Iverson (1998)* was a landmark case in which the Ninth Circuit applied the Responsible Corporate Officer Doctrine (RCOD) in an environmental case.[12] In defining the individuals who can be held liable for violations, the CWA defines the term "person" to include

[12] Appendix A presents the legal details of the RCOD and its application to the environmental law.

"any responsible corporate officer" but does not clearly define the term. Hence, the Ninth Circuit in *Iverson* concluded: "we generally interpret that term by employing the ordinary, contemporary, and common meaning of the words that Congress used." The court reasoned that under such a meaning, any corporate officer who is "answerable" or "accountable" for the unlawful discharge is liable under the CWA.

However, the court noted that this modified application of RCOD "relieve[s] the government only of having to prove that defendant personally discharged or caused the discharge of a pollutant. The government still had to prove that the discharges violated the law and that defendant knew that the discharges were pollutants."

2.2. Legal Implications of Iverson

The customized application of the RCOD in *Iverson* significantly increased the likelihood of convicting corporate officers in cases where prosecutors presented circumstantial evidence of the defendant's awareness of environmental violations, even without direct proof that the officer authorized the unlawful activity. The ruling allowed for the imputation of subordinates' illegal actions to a responsible officer, eliminating the need to demonstrate that the defendant had an explicit corporate duty to oversee or actively control the misconduct.

Critically to my analysis, the *Iverson* ruling is particularly relevant for establishments operating in the Ninth circuit for the following reasons:

First, following the vertical precedent doctrine (a.k.a., hierarchical precedent doctrine), where the legislation's lack of clarity permits federal judges to have different interpretations of a statute, lower courts are bound by the precedent decisions of the upper courts which have a revisory role upon them. As stated in Moore's Federal Practice (2nd edition, 1993): "As applied in a hierarchical system of courts, the duty of a subordinate court to follow the laws as announced by

superior courts is theoretically absolute". In the United State's legal system, circuit courts are considered superior to the district courts within the circuit and have a revisory role upon them. Therefore, district courts located in the Ninth Circuit should follow the Ninth Circuit court's *Iverson* decision in similar environmental cases. However, no such duty exists for other circuit courts or district courts located in other circuits. Indeed, a circuit court of appeals is not bound by decisions of coordinate circuit courts of appeals, and a district court judge may ignore the decisions of "foreign" courts of appeals.

Second, in environmental violation cases, the relevant jurisdiction for the government to initiate the legal action against the defendant is the location where the violation has taken place. Hence, in case of environmental violations, establishments located in the Ninth Circuit and the corresponding responsible officers will be litigated in the Ninth Circuit.

Taken together, subsequent to *Iverson*, corporate officers of firms operating in the Ninth Circuit faced a significantly higher chance of being convicted for corporate environmental violations compared to other circuits. I exploit this differential treatment as the basis of the identification in this paper.

3. Identification Strategy and Data Sources

3.1. Identification Strategy

In my empirical design, I exploit the decision made by the Ninth Circuit Court of Appeals in *United states v. Iverson* as an exogenous shock to the personal environmental liability of executives. Figure 1 presents the states affected by the ruling. In a difference-in-difference (DID) design, I use plants located in the affected regions (i.e., within Ninth Circuit) as the treated group and the plants located in the remaining regions (i.e., outside the Ninth Circuit) as control. Considering that the case was decided in December of 1998, I study a ten-year window

surrounding the event, with the pre-shock period ranging from 1994 to 1998 and the post-shock period ranging from 1999 to 2003 (inclusive). As such, the period between the initial District Court decision in November 1997 and the Ninth Circuit's ruling in December 1998 is included in the pre-treatment period. This is a conservative choice and, if anything, should attenuate my results if there is any anticipation effect prior to the event date in December of 1998.

[Insert Figure 1 about here]

3.2. Datasets and Key Variable Definitions

The main dataset employed in this paper is the Toxic Release Inventory (TRI) provided by EPA[13]. TRI reports emission statistics at the plant-chemical-year level for nearly 39,000 distinct plants and 600 toxic chemicals during the sample period used in this paper, 1994 through 2003.

For each plant, TRI lists a variety of identifiers including its industry, location, and parent name. In the TRI Basic Data File provided by EPA and used by most prior studies, the reported parent identifiers are header, i.e., corresponding to the last owner of the plant as of the date of TRI's latest update. Thereby, plant ownership is seemingly constant, whereas in reality, ownership change is quite frequent at the plant level. Indeed, as I confirm using TRI Basic Plus Data File, since the inception of TRI in 1987 through 2022, the average TRI plant has at least one ownership change and plants can have as many as nine distinct owners in their lifetime. Hence, I am careful to retrieve the historical parent names for each facility from the TRI Basic Plus Data File to account for ownership changes over the past two decades.

Since the key focus of my study is on the tradeoffs of higher executive liability for shareholders of publicly traded firms, I manually match the historical parent names to publicly traded firms using historical names retrieved from CRSP. Restricting TRI data to plants owned by

[13] For a detailed description of the TRI dataset and its reporting requirements, see Appel and Akey (2021).

publicly traded parents, my sample includes emission data on roughly 12,000 plants owned by 1600 parents and producing emissions in 574 toxic chemicals. Figure 2 presents the distribution of these plants across US states. The public status of parent firms also allows me to focus on plants with larger scales of production and higher emissions, hence lower probability of misreporting (Brehm and Hamilton, 1996). Appendix Table 2 presents the industry composition of TRI plants examined in this paper, with nearly 97% of plants classified in the manufacturing sector.

[Insert Figure 2 about here]

The TRI data is highly unbalanced in nature. Whereas plants are obligated to report chemical-years with positive emissions, there are no requirements governing reporting in chemical-years with zero emissions. Hence, plants can choose to report or not report the latter group of observations. This feature of the data can result in biased estimates to the extent that the data is mechanically censored at zero. Therefore, I partly restore the balancedness of the data by filling in the "relevant" but censored observations. Specifically, I identify a specific chemical as relevant to a specific plant if it is ever listed in its TRI reports. Next, I create a balanced panel at the plant-chemical-year level, subsequently restricting for each plant to its relevant chemicals and the years in which the plant appears in TRI data.[14] I impute missing emission values with zero.

The primary emission variables are constructed as the log of one plus the on-site emissions released into various pollution media, with emissions measured in pounds. I measure emissions broken down by each individual pollution medium (air, water, and ground) as well as aggregated across pollution media (e.g., water and air). My choice of studying on-site emissions, as opposed

[14] In addition, since TRI changes the composition of its listed chemicals over time and therefore not all chemicals appear in the data in all years, I only keep the plant-chemical-year observations for which the chemical-year pair has at least one non-missing observation.

to other forms of pollution such as off-site transfers, is motivated by the higher probability of environmental contamination caused by such emissions (Appel and Akey, 2021, and Bellon, 2023).

Turning to the characteristics of chemicals, it is noteworthy that all chemicals included in the TRI data are hazardous, but with varying levels of toxicity. Therefore, I further use the Integrated Risk Information System (IRIS) and match it with TRI using chemical identifiers to classify chemicals in my sample into those harmful for human health (238 chemicals) and non-classified chemicals (336 chemicals). I repeat my baseline emission regressions for each group of chemicals separately.

I utilize EPA's Pollution Prevention (P2) dataset to quantify two key methods plants adopt to moderate their pollution. First, plants can reduce their outcomes (e.g., products produced) or activities (e.g., heating by burning fuels) that involve emission of toxic chemicals. This is reported in P2 datasets as "production ratio" at the plant-chemical-year level, measuring the quantity of the outcome or activity that cause the emission of that specific chemical in the current year relative to the prior year.

Second, plants can invest in "abatement" technologies that reduce the toxic emissions even without reducing production. The abatement data, also available at the plant-chemical-year level, reports a dummy indicating whether the focal plant has invested in any abatement technologies to reduce the emissions in each specific toxin. Following Appel and Akey (2021) and Bellon (2023) I focus on process-related abatements. This preferred category of abatements manages to cut emission at the source by modifying production processes, e.g., replacing an old and pollutive production line. Other abatement methods include, for instance, modifying "operating" practices such as improved recordkeeping and managing the "leakage" of produced toxins, among others. I use the P2 data as is and do not make any attempts to make it balanced as I do for the TRI emission

data. This is because contrary to emissions, I cannot impute a reasonable value for production ratio or process-related abatements when missing.

Turning to the analysis at the parent firm level: Data on stock return comes from CRSP. Daily returns are adjusted for risk using Fama-French five-factor model. As such, the abnormal returns are risk neutral with respect to parent firm's size, B/M ratio, profitability, and investment. Analysts' annual EPS forecasts are retrieved from unadjusted I/B/E/S files. To make forecast values comparable across firms, I scale EPS forecasts by stock price, thereby converting analysts' EPS forecasts into forecasts of earning yields. Accounting data are from Compustat. Among the available candidate data sources for executive compensation, Execucomp provides the most comprehensive coverage during my sample period which is why I use it in this study.[15]

Finally, data on establishment count at the state-industry-year level is from the County Business Patters (CBP). I use employment weighted crosswalks between NAICS and SICs to convert post-1997 NAICS industries to SIC industry classification. I define net business creation as the change in the count of establishments in each industry-state-year relative to the prior year. Detailed data on manufacturing industries, their shipment value, value added, and total hours worked are from Becker, Gray, and Marvakov (2021).

3.3. Summary Statistics

Panel A of Table 1 reports the summary statistics on the key variables used in this paper. Variables definitions are reported in Appendix Table 1. Variables are winsorized at 1% and 99% thresholds where appropriate. According to Panel A, total on-site emissions for the average plant-chemical is roughly 8,000 pounds. The average production ratio is 1.07 meaning that plants on average increased their reported pollutive operations by 7% during my sample period. The 0.03

[15] One of the main alternatives, Capital IQ People Intelligence, only starts to become reasonably populated around 1997, albeit still with a fraction of its coverage in subsequent years.

average for process-related abatements shows my sample plants invested in abatement technologies in 3% of the plant-chemical-year observations.

An important group of variables in this paper is parent firms' exposure to Iverson, measured as parent firms' share of either on-site emissions or count of plants located in the Ninth Circuit. Depending on the specifications, the average exposure to Iverson ranges from roughly 8% to 14%. Standard deviations of the exposure variable ranges from roughly 20% for the plant-chemical-year level data to roughly 30% for the parent firm-year level data, which I use, respectively, when interpreting the corresponding tests.

[Insert Table 1 about here]

In Panel B of Table 1, I compare the treated and control group of plants across the key plant-level variables used in this study, in 1997, i.e., one year before the shock. Ideally, the difference between the two groups should be statistically zero. In my sample, however, the treated plants seem to be "unconditionally" cleaner prior to the shock with significantly lower emissions and higher abatements compared to the control plants. Nevertheless, conditional on the covariates used in the baseline regressions, the difference between the two groups is entirely wiped out. These covariates include fixed effects for plants, chemical-year pairs, SIC2 industry-year pairs, and parent firm's headquarters circuit-year pairs, as well as controls for the lag of the variable of interest. Further details about these covariates are specified in Section 5.4. Hence, conditional on the covariates, the treated and control group of plants can be considered comparable before *Iverson*.

4. Macroeconomic Effect of *Iverson* and the Impact on Business Risk

Before employing *Iverson* as a shock to executive environmental liability in my analysis of shareholder value, I examine its impact in the aggregate level, testing several hypotheses which

I present in turn below. While this analysis is notable in its own right, it also suggestively validates *Iverson* as a salient shock to the business environment, supporting its application in subsequent firm-level analyses.

Primarily, an increase in executives' environmental liabilities should decrease toxic emissions in affected businesses. Therefore, pollutive industries located in the Ninth Circuit are expected to experience a decrease in their pollution subsequent to *Iverson*. Second, to the extent that businesses reduce their production to manage pollution, *Iverson* should decrease aggregate output. Hence, pollutive industries with high exposure to the shock (through businesses located in the Ninth Circuit) should lower their production post shock. Finally, as *Iverson* increases the risk of being in charge of pollutive businesses in the Ninth Circuit, the shock is expected to diminish net business creation in pollutive businesses in the affected regions. This is because former business owners are more likely to shut down or relocate their operations to minimize their personal environmental liability risk. Similarly, prospective entrepreneurs in pollutive sectors are less likely to locate their business in areas with high personal environmental liability risks.

My findings provide support for all these predictions. Results are reported in Table 2. I start with aggregate outputs at the industry-year level in Panel A. I find that for an industry with an average exposure to the Ninth Circuit, a one standard deviation increase in pollutiveness lowers shipment value by roughly 3% more after *Iverson*, or nearly 2% of the standard deviation of the outcome variable (Column 1). Industry exposure to Ninth Circuit is measured using the share of 1992 emissions released in the Ninth circuit. Industry pollutiveness is also measured using 1992 emissions to ensure exogeneity, and described in Appendix Table 1. I find a similar effect and economic magnitude if I instead study total value added or total hours worked (Column 2 and Column 3), or if I scale output by industry employment in 1992 (Columns 4 through Column 6).

My analysis at this level is restricted to manufacturing industries for which highly granular production data is available. It is also reasonable choice considering that roughly 96% of pollutive plants in the TRI data for the period of my study are from the manufacturing sector.

Turning to the impact on aggregate pollution, in Panel B I find that pollutive industries with high exposure to the Ninth Circuit decrease their aggregate pollution significantly after the shock. I focus on on-site emissions into water and air as ground emissions were unaffected by *Iverson,* although my findings are robust if I instead examine total on-site emissions (not tabulated). As reported in Column 1, for an industry with average exposure to the Ninth Circuit, a one standard deviation increase in pollutiveness reduces emissions by 9% more after the shock. The inferences are robust if I study log of emissions (Column 1), or emissions scaled by industry level 1992 employment, current employment, total hours worked, or shipment value (Column 2 through Column 5). Reassuringly, no decrease is found in the ground emission which is unaffected by *Iverson* (not tabulated). Finally, as reported in Panel C, the decreasing effect on aggregate pollution is further confirmed using more granular data on emissions at industry-state-chemical-year level.

Finally, in Panel D, I study the impact on net business creation using data at industry-state-year level. After *Iverson*, a one standard deviation increase in an industry's pollutiveness lowers net business creation by roughly 1.5 units or 4% of its standard deviation more in industry-state-years located in the Ninth Circuit (Column 1). Importantly, this differential effect is interpreted in comparison to both pollutive industries in other circuits, as well as non-pollutive industries in the Ninth Circuit. I find a similar effect if I scale the outcome by employment in 1992 (Column 2) or if I instead study the change in employment (not tabulated).

These findings underscore the significance of *Iverson* for pollutive businesses at the macro level. In next steps, I delve into the microeconomic effect of the shock, using detailed data on publicly traded firms and their pollutive subsidiaries.

5. Model Specification

The analysis of economic and environmental outcomes is conducted at various levels in this paper. In this section, I describe the empirical design at each level in turn.

5.1. Analysis of Cumulative Abnormal Returns and Earning Forecast Revisions

In my analysis of the market response to Iverson, the outcomes of interest are either the cumulative abnormal returns (at parent firm level) or earnings forecast revisions (at parent firm or parent firm-analyst level), as defined in Appendix Table 1. These outcomes are regressed on the parents' exposure to Iverson as follows:

$$Outcome_f \text{ or } Outcome_{f,analyst} = \alpha . Exposure\ to\ Iverson_f + Constant \quad (1)$$

$Exposure\ to\ Iverson_f$ is measured in the year in which the event of interest takes place, i.e., 1997 for the initial District Court ruling on November 5th, 1997, and 1998 for the decision made by the Ninth Circuit on December 11th, 1998. Robust standard errors are used for statistical inference following Appel and Akey (2021). My statistical inferences are the same if I instead cluster standard errors by SIC2 industry or parent firm's headquarter circuit. Due to the low number of observations at this level (one observation per parent firm), adding the demanding time varying fixed effects as elsewhere in the paper is not feasible. Nevertheless, in robustness tests, I include fixed effects for SIC2 industries or parent headquarters circuit and confirm my inferences remain unchanged. The inferences are also unchanged if we include controls for the parent firm's total assets, age, and total count of plants.

5.2. Analysis of Cash Flows

I study the impact of strengthened executive liability on parent firms' cash flow and its core constituents using data at parent firm-year level. Specifically, I regress measures of profitability, sales, and costs on an interaction treatment and controls as follows:

$$Outcome_{f,t} = \alpha.Exposure\ to\ Iverson_{f,t-1} \times Post_t + \beta_1.Exposure\ to\ Iverson_{f,t-1} + \beta_2.X_{f,t-1} + \delta_f + \delta_{j,t} + \delta_{parent\ circuit,t} \quad (2)$$

In the equation above, *f*, *t*, and *j* indicate parent firm, time, and parent firm's SIC2 industry, respectively. The control variables $X_{f,t-1}$ include the parent's total assets, age, and count of plants. I sweep out any time-invariant heterogeneities across firms using firm fixed effects, δ_f. To the extent that there is a systematic difference between outcomes across industries or locations at each point in time, I include fixed effects for industry-year, $\delta_{j,t}$, and parent firm's headquarter circuit-year, $\delta_{parent\ circuit,t}$. Standard errors at this level are clustered at industry-year level.

Complementing my analysis of cash flow levels, I also study the evolution of cash flow volatility after *Iverson*. Unlike cash flow levels which are observed every year, volatility of cash flow is measured across multiple years. Hence, to accommodate this analysis, I modify Equation (2) in the spirit of Bernstein (2015) as follows, collapsing the firm-year sample to one observation per firm.

$$Outcome_{f,(1999-2003)} = \alpha.Exposure\ to\ Iverson_{1998} + \beta_1.Outcome_{f,(1994-1998)} + \beta_2.X_{f,1998} + \delta_j + \delta_{parent\ circuit} \quad (3)$$

In the above equation, *Outcome* is the volatility of annual cash flows measured for periods 1999 through 2003 (dependent variable) and 1994 through 1998 (control). The model includes all controls and fixed effect presented in Equation (2), except firm fixed effects.

5.3. Analysis of Executive Compensation

I exploit the granularity of the executive compensation data at the parent firm-executive-year level to examine the impact of *Iverson*. At this level, I examine whether executives at parents with high exposure to *Iverson* experience a differential level of compensation after the shock. My regressions for this analysis control for a demanding set of fixed effects and controls as follows:

$$Otcome_{f,e,t} = \alpha.Exposure\ to\ Iverson_{f,t-1} \times Post_t$$
$$+ \beta_1.Exposure\ to\ Iverson_{f,t-1} + \beta_2.X_{f,t-1}$$
$$+\delta_f + \delta_e + \delta_{j,t} + \delta_{parent\ circuit,t} + \delta_{age,t} + \delta_{size\ group,t} \quad (4)$$

In the equation above, *f*, *e*, *t*, and *j* indicate parent firm, individual, time, and parent firm's SIC2 industry, respectively. $Exposure\ to\ Iverson_{f,t-1}$, δ_f $\delta_{j,t}$, $\delta_{parent\ circuit,t}$, and $X_{f,t-1}$ are defined as in Equation (2). I sweep out any time-invariant heterogeneities across individuals using individual fixed effects, δ_e. Further, I use executive age as a proxy for skill and experience. Hence, I also include fixed effects for executive age-time pairs, $\delta_{age,t}$, and thereby look within executives with the same level of skill and experience at each point in time. Finally, I sort the observations into 20 equally sized groups based on the parent firm's size (i.e., total assets) and include fixed effect for each size group and time $\delta_{size\ group,t}$. Considering that firm size is a proxy for the rents and resources that can be appropriated by executives, this latter set of fixed effects allow me to compare executives in firms with similar size at each point in time. Standard errors at this level are clustered at industry-year level.

5.4. Analysis of Pollution

My analysis of pollution at the plant-chemical-year level comprises a core component of the examination of mechanisms. The specification used at this level, which is employed for studying toxic emissions, production ratio, and process-related abatements, is as follows:

$$Outcome_{p,c,t} = \alpha.Ninth\ Circuit_p \times Post_t$$

$$+\beta.X_{p,c,t-1} + \delta_p + \delta_{c,t} + \delta_{j,t} + \delta_{parent\ circuit,t} \quad (5)$$

In the above equation, p, c, t, and j indicate plant, chemical, time, and SIC2 industry, respectively. $Ninth\ Circuit_p$ and $Post_t$ are dummy indicators for being located in the Ninth Circuit and for post-1999 years (inclusive), respectively. δ_p, $\delta_{c,t}$, and $\delta_{j,t}$ are fixed effects for plant, chemical-year, and industry-years, therefore wiping out heterogeneities at the respective levels.

It is noteworthy that plants do not change location as per EPA's definition. Hence, the plant fixed effects subsume the time-invariant heterogeneities across plant locations. This is why the above equation excludes fixed effects for plant circuit. Ideally, one would like to sweep out time-varying heterogeneities across plant locations using plant circuit-year fixed effects. However, such fixed effects would be collinear with the main treatment and therefore infeasible. Instead, the best I can do is controlling for the same fixed effects but using the parent firm's headquarter circuit which I do using $\delta_{parent\ circuit,t}$.Therefore, I compare plants owned by parents that are located at the same geographic area at each point in time. These fixed effects are crucial if parent firms headquartered in different geographic regions tend to adopt systematically different environmental strategies for their subsidiaries.

Furthermore, in the baseline specification, I include the lag of the outcome variable as the control in $X_{p,c,t-1}$ for the following reason: Emissions at the plant-chemical-year level are a highly persistent series. Therefore, incorporating the lagged regressor as a control is imperative due to its high autocorrelation with current values. Excluding this lagged term would result in model misspecification, inducing dynamic panel bias and compromising the consistency of the estimates. While plant fixed effects control for time-invariant heterogeneity across plant-chemical pairs, they cannot capture the serial dependence intrinsic to the regressor, nor its intertemporal effect on

current outcomes. Thus, the inclusion of the lagged regressor is essential to disentangle temporal dependencies from contemporaneous effects, ensuring robust and consistent parameter estimates in a dynamic setting. Notably, however, my main inferences remain unchanged if I exclude this control. Equation (5) outlines the baseline specification used at this level of analysis. Standard errors at this level are clustered at the circuit level following Appel and Akey (2021) and Bellon (2023).

In my examination of pollution prevention activities, I also include a separate control for lagged on-site emissions into water and air in addition to the control for lag of the outcome variables. This is because a plant's past pollutiveness is a strong predictor of its observed attempts to manage its pollution. Specifically, higher past pollution levels increase current pollution prevention activities, which I confirm empirically. Therefore, my empirical design compares pollution prevention in plants with similar past pollutiveness.

Moving to the analysis of emissions at the parent firm-chemical-year level, I start from the data at the plant-chemical-year level and aggregate emissions across the subsidiaries of the same parent. The specification used at this level is identical to Equation (5) except for the following modification: Given that parents may own plants both inside and outside the Ninth Circuit, I replace the main treatment variable in Equation (5) with $Exposure\ to\ Iverson_{f,t-1} \times Post_t$ as defined in Equation (2) as well as in Appendix Table 1. Standard errors at this level are clustered at the parent firm's headquarter circuit level.

In robustness tests, I confirm that my findings are robust to clustering standard errors at the parent firm or chemical level, both for the analysis at plant-chemical-year and parent firm-chemical-year level. Notably, clustering by state is not justified for the empirical setup in this paper due to the following reason. The key assumption for clustering standard errors is that errors are

uncorrelated across clusters while they may or may not be correlated within clusters. The *Iverson* treatment, however, is by nature correlated across the states within a circuit, making state clustering unjustified.

Returning to a plant-chemical level sample, I also test hypotheses about the possibility of a strategic pollution reallocation within parent firms exposed to *Iverson*, from the Ninth Circuit to its bordering states. The model I estimate for these tests is as follows:

$$Outcome_{p,c,t} = \alpha_1 . Ninth\ Circuit_p \times Exposure\ to\ Iverson_{f,t-1} \times Post_t$$
$$+ \alpha_2 . Adjacent\ States_p \times Exposure\ to\ Iverson_{f,t-1} \times Post_t$$
$$+ \alpha_3 . Other\ States_p \times Exposure\ to\ Iverson_{f,t-1} \times Post_t$$
$$+ \beta_1 . Ninth\ Circuit_p \times Exposure\ to\ Iverson_{f,t-1}$$
$$+ \beta_2 . Adjacent\ States_p \times Exposure\ to\ Iverson_{f,t-1}$$
$$+ \beta_3 . Adjacent\ States_p \times Exposure\ to\ Iverson_{f,t-1}$$
$$+ \beta_4 . Ninth\ Circuit_p \times Post_t + \beta_5 . Adjacent\ States_p \times Post_t$$
$$+ \beta_6 . X_{p,c,t-1} + \delta_p + \delta_{c,t} + \delta_{j,t} + \delta_{parent\ circuit,t} \quad (6)$$

In the above equation, $Ninth\ Circuit_p$ is a dummy indicating if a plant is located in the Ninth Circuit. $Adjacent\ States_p$ and $Adjacent\ States_p$ are similarly dummies indicating if a plant is located in the Ninth Circuit's neighboring states and non-neighboring states, respectively, further specified in Section 7.2.3. Fixed effects and controls are defined similarly as in Equation (5). The coefficient of interest in this regression is α_2 which tracks the pollution of plants owned by highly exposed parents and located close to, but outside of, the Ninth Circuit.

6. Value Implications of Executive Personal Liability

I begin my main analysis with a key question to the owners of the firm, i.e., equity holders: How does increasing executives' personal accountability for corporate misconduct affect shareholder value?

Following *Iverson*, a shock that strengthens the environmental liability of corporate executives, firms are expected to become more legally compliant in the environmental domain. This higher legal compliance comes at a significant cost which, effectively, is paid by shareholders. Affected corporations need to adjust their operations to minimize the risk of environmental violations. This adjustment includes investing in abatement technologies which are known to be exorbitantly costly. Affected firms may also reduce their production levels to manage their pollution. These changes directly hurt the firm's sales and costs as the core components of cash flow. Furthermore, the supply of skilled executives will also shrink for firms with high exposure to executive liability, hence deteriorating corporate leadership. And those skilled executives who are willing to work for such firms will demand higher compensations in exchange for the liability risk burden. Taken together, I predict a significant reduction in shareholder value subsequent to a strengthening shock to executives' personal environmental liability, such as *Iverson*. These hypotheses are grounded in a stylized model of executive behavior under personal liability risk, presented in Appendix B.

In this section, I study the stock market's reaction to the Ninth Circuit decision in *Iverson*. I begin with an analysis of the abnormal stock returns around the decision date for firms highly exposed to the shock. I then move to studying how the market's expectations of the exposed firms' cash flows are revised around the shock.

6.1. Cumulative Abnormal Returns Around Iverson

I study stock prices as the best available measure of shareholder value and study its evolution around the *Iverson* decision date. Assuming market efficiency, any value relevant information, including the shock to the executive liability, must be impounded into prices within a short period of time after the news is public. I examine the cumulative abnormal returns (CAR) in various windows ranging from 1 day before December 11, 1998 (the date of the Ninth Circuit ruling) up to 10 days after the event. Daily stock returns are risk adjusted using the Fama and French (2015) five-factor model estimated using up to 100 trading days ending 10 days before the event.[16,17]

Panel A of Table 3 reports the result of estimating Equation (1) with CARs as dependent variables. I find an immediate and sizable drop in stock returns for parent firms exposed to *Iverson* as a result of the shock. A one standard deviation increase in parent firms' either measure of exposure to *Iverson* (roughly 30%) reduces CARs in a (-1,0) window by about 60 basis points. The drop in value persists such that parents with a one standard deviation higher exposure values lose about 2% of their equity market value in the (-1,+10) window. Interpreted alternatively, parent whose entire operations are located in the Ninth Circuit (exposure=1) lose roughly 2.3% of their equity market value within the [-1,+1] daily window after the shock, compared to parents with no exposure to *Iverson* (exposure=0). In Appendix Table 3, I confirm that the decline in market value

[16] In the analysis of stock returns, I exclude microcap stocks defined as those smaller than NYSE's 5th percentile size breakpoint. For reference, the breakpoint is $55.4M in December 1998 based on information available on Kenneth French's website. Collectively, these stocks comprise only 0.08% of the aggregate market capitalization in my sample. Removing them allows me to focus on the most economically significant firms and minimize the impact of the smallest and highly illiquid stocks. I also require a stock price above five dollars for a firm to be included in the regressions. Both filters are implemented using information available six days before the event. My findings do not critically depend on these filters and remain qualitatively similar if I do not impose them.

[17] My inferences remain unchanged if I instead risk-adjust using Fama and French (1993) three factor mode, Fama-French three factor model plus Carhart (1997) Momentum factor, or simply examine market-adjusted or raw returns.

of exposed firms persists at least until 90 days after the shock, in which point firms whose subsidiaries are all located in Ninth Circuit have lost nearly 17%-20% of their equity market value.

[Insert Table 3 about here]

I also estimate Equation (1) around the date of the initial District Court decision on November 5, 1997. I find a weakly negative but statistically insignificant market reaction. The results are reported in Panel B of Table 3.

Figure 3 presents the evolution of CARs for exposed parents in a [-5,+10] window around the shock. Importantly, there is no observable differential returns for the exposed parents in the early days of the window. Consistent with an anticipation effect, CARs start to decrease shortly before the decision date and continue to decrease, rather sharply, with no reversal.

[Insert Figure 3 about here]

To further support the long-term persistence of the value effect, I also examine the time-series returns of portfolios sorted on exposure to *Iverson* in the months following the decision. Specifically, I sort stocks into four groups based on their exposure to the shock in 1998 (zero, low, medium, and high) and study the cumulative monthly return to these portfolios during December 1998 (the month of *Iverson* decision) through March 1999. Separately for each of the four portfolios, I adjust portfolio returns for risk using Fama-French five-factor model with factor loadings estimated using 60 monthly returns during 1993 through 1997.

[Insert Figure 4 about here]

Figure 4 presents the cumulative abnormal returns to each portfolio. Regardless of how we measure the exposure to the shock and the weighting scheme, the high-exposure portfolio experiences an immediate drop in value relative to the zero-exposure portfolio, affirming the instantaneous value effect. Critically, the decline in relative risk-adjusted value of the high-

exposure portfolio persists in the following months, at least until the end of March 1999, i.e., roughly four months after the *Iverson* decision.

6.2. Analysts' Revision of Earnings Forecasts in Response to Iverson

The two core components affecting stock price are the market's *expectations* of future cash flows and risk. Once the expected value of each component changes, the market should adjust the price to reflect the updated expectations. After *Iverson*, expectations of both risk and cash flows are expected to change for the exposed parents as explained in the beginning of this section. Measuring expected risk is empirically challenging whereas I can reliably approximate the market's expectation of cash flows using analysts' earning forecasts. Therefore, in this subsection I examine analysts' EPS forecasts, focusing on how they revise their estimates for parents exposed to *Iverson* after the shock.

Specifically, for each parent firm-analyst pair, I measure earning forecast revision as the annual earnings forecast observed 1, 2, 3, or 4 periods after the *Iverson* decision date minus the forecast 1 period before the shock. Each period consists of 30 calendar days or one month, measured relative to December 11, 1998. In the same spirit as the analysis of CARs, I measure the pre-shock forecast one period before the decision date to account for potential anticipation effects. For each parent firm, I study the forecasts corresponding to the first fiscal yearend date that is on or after December 1999, i.e., a minimum of 12 months after the event date. This decision is made to allow for sufficient time for *Iverson* to impact the exposed parent firms' real performance. Nevertheless, I repeat my analysis using forecasts for fiscal yearend dates that are on or after June 1999 and find similar results.

Table 4 reports the results of estimating Equation (1) for earning forecast revisions at the parent firm-analyst level. The forecast revisions after one period decrease by roughly 0.0005 units

at this level as the parent's exposure to *Iverson* increases by one standard deviation. This magnitude is equivalent to 5% of the standard deviation of the dependent variable. The downward adjustment of earning forecasts continues for at least four periods (i.e., 120 days) after the event date where a one standard deviation increase in exposure to the shock lowers forecast revisions by 0.0025 units (a five-fold increase) or roughly 10% of the dependent variable's standard deviation.

[Insert Table 4 about here]

I repeat the same analysis after aggregating the parent firm-analyst level data to the level of the parent firm. In other words, I first calculate the consensus forecasts in each period by taking the average of the analyst-level forecasts and calculate forecast revisions as before. The results are reported in Panel B of Table 4. As a result of the same change in the exposure to *Iverson* as in Panel A, parent level earnings forecast revisions after one period decrease by roughly 6% of their standard deviation, albeit statistically insignificantly. Similarly to Panel A, the downward adjustment of earnings forecasts continues and reach roughly 15% of the dependent variable's standard deviation after four periods, which is statistically significant.

Finally, I repeat the analysis in Panel A and Panel B of Table 4 around the initial District Court decision date on November 5, 1997. The results are reported in Panel C and Panel D of Table 4, respectively. While individual analysts do revise their earning forecasts in the four periods after the initial decision date, parent level consensus estimates do not change significantly. This is also consistent with and mirrors the lack of stock price response to the initial District Court decision reported in Panel B of Table 3.

Figure 5 illustrates the temporal evolution of the forecast revisions around *Iverson* decision date. I measure forecast revisions relative to four event periods before the shock to better track their pre-shock evolution. This figure plots the differential impact on earnings forecast revisions

for parents exposed to the shock compared to unexposed parents. Reassuringly, there is no pre-trend before the shock. Consistent with an anticipation effect, analysts start to downward adjust their earning forecasts for exposed parents between event period -1 and the decision date. The downgrading of earnings forecasts continues for at least four periods after the decision date.

[Insert Figure 5 about here]

Taken together, the presented evidence on the impact on stock prices and earnings forecasts point to a significant erosion of shareholder value subsequent to *Iverson*.

6.3. Effect of Executive Personal Liability on Realized Cash Flow Levels

In the previous subsection, I found that the market anticipates a diminishing of cash flows in parent firms exposed to *Iverson*. Here, I ask whether this prediction was actually realized. Specifically, I use detailed firm level data and directly examine the evolution of cash flows in exposed parents during the years around the shock.

Panel A of Table 5 reports the results of estimating Equation (2) with profitability as the dependent variable. Parents with a one standard deviation higher exposure to *Iverson* have between 0.4 to 0.6 percentage points lower ROAs after the shock. This magnitude corresponds to 4%-6% of the standard deviation of the dependent variable. I then replace ROA with profit margin and repeat the analysis. The same increase in exposure to *Iverson* lowers profit margin by 0.6 to 1 percentage points, equivalent to 4% to 8% of the dependent variable's standard deviation.

[Insert Table 5 about here]

To pin down what drives the reduced cash flows, I then turn to an examination of the core components of profitability: sales and costs. Panel B of Table 5 reports the results. I find that exposure to *Iverson* reduces sales significantly in exposed parents after the shock. Specifically, a one standard deviation increase in exposure to *Iverson* lowers the ratio of sales to total assets by

roughly 2%, corresponding to 4% of the dependent variable's standard deviation. The lowered sales is consistent with my hypothesis about reduced production as a means of managing pollution in affected plants.

Moving to costs, I find that exposure to *Iverson* increases total costs per unit of sales post shock. A one standard deviation increase in exposure to *Iverson* increases costs-to-sales by roughly 0.4%, or 4% of the dependent variable's standard deviation. Breaking down total costs into its constituents, I find that this cost increase is mainly driven by an increase in the cost of goods sold rather than sales, general, and administrative expenses.

It is noteworthy, however, that while costs increase per unit of sale for exposed firms, I find no significant impact on costs scaled by assets (untabulated). This suggests that the key driver of the deterioration of cash flows, as measured by ROA, is reduced sales as opposed to increased costs. This is also in line with the Proposition III of the stylized model in Appendix B.

6.4. Effect of Executive Personal Liability on Realized Cash Flow Volatility

In addition to diminishing cash flow levels, stronger environmental liability of executives can also increase the volatility of cash flows. When executives face heightened personal accountability for environmental violations, firms may need to allocate more resources toward compliance, legal defenses, and risk mitigation, leading to higher and less predictable costs. Additionally, executives may adopt more conservative investment strategies, delaying or avoiding projects with potential environmental risks, which could disrupt revenue generation. Increased regulatory scrutiny and the potential for lawsuits or fines can also create sudden, unanticipated expenses. As a result, firms may experience fluctuations in profitability, leading to greater cash flow volatility.

To study cash flow volatility, I need to deviate from the specification used in the analysis of cash flow levels. Specifically, I calculate the volatility of annual cash flows before and after *Iverson*, separately for each firm, requiring at least three non-missing annual observations to calculate volatility. This procedure collapses the firm-year sample to one observation for each firm, which I then examine using the specification in Equation (3).

[Insert Table 6 about here]

My findings support an increase in cash flow volatility following *Iverson*, as reported in Table 6. A one standard deviation increase in the parent firms' exposure to *Iverson* increases cash flow volatility by 8%-17%, corresponding to roughly 8%-15% of the standard deviation of the dependent variable.

6.5. Effect of Executive Personal Liability on Executive Compensation

An increase in the personal environmental liability risk for corporate executives increases the cost of retaining skilled executives affected by the shock. Specifically, the increased risk of being an executive shrinks the supply of executives in the affected areas while the demand remains the same, or possibly increases (e.g., if the shock necessitates more executives managing corporate pollution). This supply-demand imbalance consequently drives up executive compensation for the executives exposed to the shock.

Studying the compensation of plant executives *located* in the Ninth Circuit is challenging due to data unavailability. Therefore, I focus on parent firms and study the effect of *Iverson* on the evolution of executive compensation in parents with a high exposure to the shock. As elsewhere in the paper, exposure to *Iverson* is measured as the share of a parent's plants or total emissions located in the Ninth Circuit.

Table 7 reports the results of estimating Equation (4). In panel A, I examine CEO compensations. CEOs are studied separately because they are the highest ranking executive officers in a corporation, holding the highest authority, and thereby most likely to be targeted by environmental litigations. I primarily focus on non-salary compensations because changes in such compensations are more justifiable and feasible in the short term. Based on the estimates in Panel A of Table 7, after the shock, a one standard deviation increase in the parent firms' either exposure measures to *Iverson* increases the level of CEOs' non-salary compensation by about 15%, equivalent to 10% of its standard deviation. No such effect is observed for salary payments. To make sure the increasing effect on non-salary compensations is not offset by a decrease in salary payments, I also study total compensations and confirm a comparable increase as a result of exposure to the shock.

[Insert Table 7 about here]

I then turn to examining director compensations. Predicting the effect on director compensations is trickier. This is because directors are often more distanced than CEOs from the company's operations, unless also serving as an executive. Therefore, they are better able to prove lack of knowledge about the corporation's environmental misconducts in legal disputes. Corroboratively, I find no significant change in the total compensation of directors in response to *Iverson* in Panel B of Table 7.

In the next section, I will delve deeper into the mechanisms driving the reduction in cash flows. Specifically, I start with the impact on corporate pollution. I then examine the channels driving the impact on pollution, namely adjusted scale of production, increased abatement activities, and strategically transferring emissions to geographic regions unaffected by the legal shock.

7. Effect of Executive Personal Liability on Pollution

To make corporations environmentally compliant, an effective way is to hold their executives accountable for any environmental violations of the corporate. While there are debates surrounding whether this is a fair approach vis-à-vis corporate executives, there is little debate regarding its socio-environmental merits. To minimize the possibility of legal charges, executives who fear personal accountability will lead their corporations toward a more environmentally friendly behavior. As such, pollution is expected to decrease upon strengthening executives' personal liability for corporate pollution. In this section, I study the impact of *Iverson* on toxic emissions, followed by an in-depth analysis of the key channels.

7.1. Effect on Toxic Emissions

I start my analysis of toxic emissions at the plant-chemical-year level. To remind the reader, Iverson primarily targets emissions released into water and air. This is due the exclusive reference to the "responsible corporate officer" in the Clean Water Act and Clean Air Act in their definition of the individuals who can be held liable corporate environmental violations. Therefore, in my baseline regression, I estimate Equation (5) for water and air emissions. The second column of Panel A in Table 8 reports the baseline specification as outlined in Equation (5). Plants located in the Ninth Circuit experience a statistically significant 8% drop in their emissions post shock compared to unaffected plants. This magnitude is equivalent to 2% of the dependent variable's standard deviation.

[Insert Table 8 about here]

In Panel B of Table 8, I take a closer look at the media to which the emissions are released. In the first column, I aggregate all on-site emissions released into various media. In the subsequent three columns, I break down emissions by each individual medium. I estimate Equation (5) for

each case separately. Reassuringly, *Iverson* has no impact on ground pollution. The other three columns show results similar to Panel A, both in statistical significance and economic magnitude.[18]

The above findings are robust to comparing across the treated and non-treated subsidiaries within the same parent firms by including firm-year fixed effects. However, it is noteworthy that these fixed effects are highly demanding due to the following reason: Roughly half of the firm-years in my sample have either one or two subsidiaries in the TRI database. As such, parent firm-year fixed effects are highly collinear with the treatment interaction variable at the plant level. Hence, I am careful not to interpret these robustness results rigorously.

Figure 6 presents the temporal evolution of the main coefficient of interest in Table 7 around *Iverson* (Column 2 of Panel A). Crucially to my identification, there is no difference between toxic emissions in treated and control plants before the shock. Only around the decision year do the emissions start to drop in the treated plants. Emissions in treated plants remain significantly lower for at least five years after the shock compared to the control group.

[Insert Figure 6 about here]

To further understand the effect of *Iverson* on pollution, I split the sample based on the effect of chemicals on human health and repeat the pollution regressions using emissions released into water and air. Using the IRIS data released by EPA, I split chemicals into two groups: those with documented human harm and thus classified by IRIS and those not classified by IRIS. The results, reported in Appendix Table 4, show a similar decrease in pollution across both groups of chemicals.

[18] While the coefficient magnitude for water emissions is seemingly one third of those in columns 1 and 3, this variable also has a standard deviation which is smaller by a similar proportion. Therefore, the economic magnitude of the effect remains the same for the first three columns of Panel B.

Next, I aggregate the plant-chemical level emissions to parent firm-chemical level. At this level, I examine how parent-level emissions evolve after *Iverson* in firms with higher exposure to the shock. This is a crucial complement to the previous analysis of emissions at the plant-chemical level due to the following reason: The main analysis of this paper examines the impact of executive liability on shareholder wealth at the parent firm level. As I will show later in the paper, however, while parents decrease their emissions in the geographic regions that are affected by the shock, they can increase their emissions in unaffected regions. To the extent that these two effects offset each other, aggregate pollution at the parent level may or may not decrease.

Table 9 reports the emission regressions at the parent level for various pollution media. Similar to the results at the plant-chemical level, total on-site emissions also decrease at the aggregate parent firm-chemical level. Notably, this decrease is also primarily due to a decrease in water and air emissions, as opposed to ground emissions. As reported in Panel A, at this level, a one standard deviation increase in parent firms' exposure to *Iverson* decreases water and air emissions by roughly 4%. This magnitude corresponds to about 1% of the dependent variable's standard deviation. My inferences are qualitatively the same if I scale emissions with the parent firm's total assets, sales, or the count of plants (Panel B).

[Insert Table 9 about here]

7.2. Channels Driving the Pollution Reduction

So far, I have documented a significant decrease in toxic emissions in plants, and their parent firms, that are affected by the shock to the executives' personal environmental liability. In the next step, I dig deeper into how this effect materialized.

7.2.1. Reducing Operation Scale

Toxic emissions are a direct consequence of a plant's operations. As such, firms can decide to scale down their production to manage pollution. This can be the case if, for instance, the firm cannot afford the exorbitant costs of pollution abatement. Reducing the production of goods and services that lead to environmental harm is desirable from a socio-environmental viewpoint. However, it has negative economic consequences. These include reduced sales and lost market share for the affected businesses, diminishing cash flows accruing to shareholders. Furthermore, the reduced supply of goods and services can also drive prices up, ultimately hurting consumers.

The first two columns of Table 10 report the results of estimating Equation (5) with production ratio as the dependent variable. Reported by plants to EPA, production ratio measures the growth in the scale of an activity or production that causes the emission of a specific chemical. At the plant-chemical-level, I begin with examining the impact of strengthened executive liability on the production ratio using all chemicals available in TRI. Subsequent to the shock, treated plants reduce their production ratio by roughly 2.2 percentage points more than the control plants. This magnitude is equivalent to about 4% of the standard deviation of the dependent variable.

[Insert Table 10 about here]

I further examine the same effect using the sample of chemicals that are primarily released into water and air. This is motivated by Iverson's exclusive focus on water and air emissions while ground emissions remain unaffected. The aim is to ascertain that the reduction in production ratio is not driven by chemicals that solely concern ground emissions. Unfortunately, unlike in emission data reported by TRI, the production ratio is not broken down by the respective medium. Therefore, for each plant-chemical-year, I measure the propensity of the chemical to be released into water or air by the average share of its emissions released into water or air over the past three years.

Restricting the sample to plant-chemicals for which this propensity is above median, I find an even stronger reduction in production ratio as reported in the second column of Table 10.

7.2.2. Increasing Investment in Abatement Technologies

Investing in abatement technologies is another way through which plants can moderate their pollution without reducing production. Such investments are known to be exorbitantly costly as they often involve significant restructuring of operations and acquiring expensive technologies.[19] Plants report their abatements attempts to EPA in various forms. These include, for instance, adopting more accurate recordkeeping procedures classified as an "operating" abatement. Among the various possible forms of pollution abatement, the one most preferred by EPA is "process" abatement. Process abatements target the source of pollution and modify the production process in a way that less pollution is produced, as opposed to better managing the pollution that is already produced. Examples include investing in solar energy to replace pollutive fossil fuels or replacing the old and pollutive machinery with new and environmentally efficient equipment. Therefore, following the literature, I study process-related pollution abatements resulting from *Iverson* (Appel and Akey (2021) and Bellon (2023)).

Columns 3 through 4 of Table 10 report the results of estimating Equation (5) for process-related abatements. Focusing on all plant-chemical-year observations (Column 3), I find no evidence of increased process-related abatements in the affected plants post shock. However, restricting to plant-chemical-year observations that most likely concern chemicals released into water or air, I find a 0.7% higher probability of investing in process-related abatements after

[19] According to the 2005 Pollution Abatement Costs and Expenditures (PACE) published by EPA, abatement capital expenditures accounted for about 4.5% of new capital expenditures across all industries. Furthermore, abatement operating costs accounted for roughly 0.4% of the total value of shipments.

Iverson for plants located the Ninth Circuit, compared to unaffected plants. This increase corresponds to roughly 4% of the dependent variable's standard deviation.

7.2.3. Reallocating Pollution to Unaffected Plants Within the Parent Firm

Multi-plant parent firms whose subsidiaries are located both inside and outside of the Ninth Circuit also have the option to manage their exposure to *Iverson* through strategically relocating their pollutive operations outside the Ninth Circuit. However, parents should strike a balance between the costs of relocating their pollutive operations with the added benefits of scaping the personal environmental liability of executives. One major cost of this pollution shifting strategy is that of losing access to the supply chain network which the firm previously operated in within the Ninth Circuit. Therefore, to balance the feasibility and cost effectiveness of pollution shifting, exposed parents are most likely to transfer their pollution to outside the Ninth Circuit, but close enough for the firm to be able to preserve its position in the old supply chain network. As such, I conjecture that the destination plants receiving the shifted pollution should be mainly located in the states nearby, but not within, the Ninth circuit.

To test this hypothesis, I split US states into three mutually exclusive groups: The states "treated" by *Iverson*, states "adjacent" to the treated region, and the "other" states outside the treated and adjacent groups. Figure 7 presents the states in each group. I mechanically pick the adjacent states as those sharing common border with the Ninth Circuit.[20] My prediction is that subsequent to *Iverson*, plants located in the "adjacent" states and owned by parents with high exposure to the shock experience an increase in their pollution, both compared to plants of highly exposed parents in the "other" states as well as plants owned by unexposed parent in "adjacent" states.

[20] My inferences remain highly consistent if I alternatively define adjacent plants as those located within a 100, 200, 300, or 400 KM distance outside the Ninth Circuit border.

[Insert Figure 7 about here]

Next, I estimate Equation (6) using data at the plant-chemical-year level and report the results in Table 11. After *Iverson*, a one standard deviation increase in a parent firm's exposure to the shock increases the pollution of its plants in adjacent states by 6%, equivalent to roughly 2% of the dependent variable's standard deviation. On the other hand, the same increase in parents' exposure to *Iverson* decreases the pollution of Ninth Circuit plants by roughly 2%. Hence, notably, the average increasing effect on the adjacent plants is nearly triple the decreasing effect on the Ninth Circuit plants. Parents' exposure to *Iverson* has no moderating impact on the pollution of plants in other states post shock.

[Insert Table 11 about here]

A key question at this step is whether this pollution shifting behavior within the exposed parent firms can entirely wipe out the effect of *Iverson* at the aggregate parent level. The answer, as I show in Table 9, is no. Indeed, exposed parents still experience a significant drop in their toxic emissions even in presence of the pollution shifting documented in this section. Therefore, the strategic transfer of emissions to unaffected plants can at best be a partial solution for parents to avoid the environmental liabilities imposed by *Iverson* on their executives.

7.2.1. Off-Site Pollution Transfer

Finally, I examine whether the reduction in on-site toxic emissions is realized through an increase in off-site disposals. As an alternative method for disposing toxic wastes, plants may choose to transfer their pollution off-site. This includes sending toxic wastes to be recycled, used in power generation, disposed, or released in a better controlled process compared to on-site emissions. If this is the case, then it is likely that the on-site reduction of emissions is offset by an increase in off-site transfers, which would leave the overall pollution unchanged.

Therefore, I end my analysis of toxic emissions with an examination of how off-site transfers evolve in the Ninth Circuit subsequent to *Iverson*. In untabulated results, I find that off-site transfers in Ninth Circuit plants also decrease post shock, with an economic magnitude very similar to on-site emissions. Hence, I reject off-site transfers as a mechanism for reducing on-site emissions after *Iverson*.

8. Value Implications of Executives' Non-Environmental Liabilities

My findings so far underscore the value implications of executives' environmental liabilities. In this section, I test the validity of this value effect outside the environmental domain. To this end, I exploit a 2022 amendment to Delaware's General Corporation Law which allows Delaware firms to shield executives from certain liabilities related to their fiduciary duties. Specifically, conditional on shareholder approval, firms can amend their charters and add provisions exculpating executives from liabilities for monetary damages regarding breaches of fiduciary duties. If personal liability of executives is value destroying, this legal shock that relieves Delaware executives from certain personal liabilities must enhance firm value.

To test this hypothesis, I examine the evolution of risk-adjusted stock returns for Delaware incorporated public firms around three key dates: Senate Bill 273, which amended the Delaware General Corporation Law to extend exculpation provisions to corporate officers, progressed through key legislative stages in mid-2022. The bill was introduced to the Delaware General Assembly on April 28, 2022. It passed the Senate on May 12, 2022, signaling initial legislative approval. The bill eventually passed the House on June 14, 2022.[21]

[Insert Table 12 about here]

[21] The bill was signed into law by Delaware governor on July 27, 2022, and became effective on August 1, 2022.

As reported in Table 12, firms incorporated in Delaware experienced a sizeable and statistically significant risk-adjusted increase in their equity value around the legal shock. In a short window ending 5 days after each of the first two event dates above (initial introduction to Senate and passage by Senate), Delaware firms gained on roughly one percentage points higher returns. There are no differential returns around the third date (passage by the House) which is consistent with the market having already incorporated the value relevant information into prices in the preceding two events. These evidence extend the main findings of this paper regarding the value implications of executive personal liability beyond the environmental domain, albeit suggestively.

9. Robustness Tests

In this section, I investigate the robustness of my main findings. I begin with replacing parent firms' time varying exposure to Iverson by their exposure measured in 1998 and kept constant throughout the sample period. This analysis addresses concerns about firms endogenously managing their exposure to the shock after Iverson. As reported in Appendix Table 5, my main inferences that are based on parent firms' exposure to the shock are robust to using this constant exposure measure. In untabulated results, I confirm that the inferences remain the same if I allow exposures to be time-varying before 1998 and kept fixed afterwards.

Turning to the plant-level analysis, I examine the robustness of my main findings to studying plants within a short distance from the Ninth Circuit border. The plants that are located on the two sides of the border are expected to be subject to the same local economic and environmental conditions, and thereby comparable, but they are treated differently by Iverson. As such, I can better isolate the impact of the shock to executive personal liability. Appendix Table 6 reports the main plant-level analysis replicated for this restricted sample of plants, located within

a 100 km distance from the Ninth Circuit border. The inferences remain unchanged. Appendix Figure 1 presents the location of the plants used in this analysis. In untabulated results, I find that the impact on toxic emissions remains robust if I instead study plants within a 200 km or 500 km distance from the border. However, such long distances are not aligned with the core purpose of this exercise which is studying plants subject to the same local conditions.

10. Conclusion

I study the economic consequences of increasing executives' personal liability. In my main analysis, I use the Ninth Circuit Court of Appeal's decision in *United States v. Iverson (1998)* as an exogenous shock to executives' personal environmental liability in the Ninth Circuit. I primarily find that parent firms exposed to the shock through their Ninth Circuit subsidiaries experience an immediate and persisting drop in their equity market value relative to unexposed parents. Analysts revise their earnings forecast for the exposed parent immediately after the shock. Hence, a key factor driving this destruction of shareholder value is the downward adjustment by stock market participants of the cash flow potential of exposed parent firms. I verify that realized cash flows are lower for parents with a high exposure to the Ninth Circuit after the shock. The lower cash flow is driven by both a reduction in sales and an increase in costs. Furthermore, the shock to executive liability increases the volatility of cash flows post shock.

I then delve deeper into the mechanisms through which parent firms experience a reduction in their cash flows in years following the shock. Beginning with an in-depth analysis of toxic emissions, I find that plants affected by the shock significantly reduce their pollution after *Iverson*. The mechanisms driving this reduction in toxic emissions is threefold: (1) Affected plants reduce the scale of their pollutive production post shock. The reduction in pollutive production can either reduce the entire outputs or enforce cleaner and more expensive production. (2) Affected plants

also increase investments in process-related abatement technologies. (3) Parent firms with high exposure to the shock strategically relocate their pollution from the affected plants to their plants located outside, but close to, the Ninth Circuit. Aggregating pollution across subsidiaries, I find that toxic emissions also decrease in the aggregate for parent firms with high exposure to the shock.

Taken together, my findings address a consequential economic aspect of corporate law. Holding executives personally accountable for corporate legal violations will make corporations more legally compliant which is a socially beneficial outcome. However, the improved compliance comes at a cost that is paid by, and therefore hurts, shareholders. The findings presented in this paper shed light on the optimal level of corporate executives' personal liability. Investors and creditors can exploit these findings in their valuations. Furthermore, my findings can be used by policy makers to improve environmental governance.

Appendix A

The Responsible Corporate Officer Doctrine and Its Application to Environmental Law

A.1. The Responsible Corporate Officer Doctrine (RCOD)

Before the inception of the Responsible Corporate Officer Doctrine (RCOD), corporate executives could only be held personally liable under criminal law for criminal acts that the officer directed, authorized, ratified, or personally undertook. This standard of liability was broadened after the RCOD emerged from two U.S. Supreme Court decisions, *United States v. Dotterweich (1943)* and *United States v. Park (1972).* Both *Dotterweich* and *Park* involved prosecutions of corporate officers under the Federal Food, Drug, and Cosmetic Act (FDCA). In its decision, the Supreme Court ruled that under FDCA provisions, there are no requirements for the defendant to *knowingly* violate the statute. Instead, the mere authority to prevent a violation - by virtue of the executive's position - was sufficient to impose liability. Consequently, corporate officers could be held liable even if they neither participated in nor were aware of the violations, as long as they occupied a position of responsibility or oversight that could have prevented or corrected the infractions.

Although the RCOD was initially developed in response to a FDCA violation, the language adopted by the legislator makes it applicable to other legal disputes involving public safety. Further clarifying the applicability of the RCOD in the public safety context, the Supreme Court defended its decision in *United States v. Park* by stating:

"[the decision is] no more stringent than the public has a right to expect of those who voluntarily assume positions of authority in business enterprises whose services and products affect the health and well-being of the public that supports them."

A.2. The Application of RCOD to Environmental Law

The applicability of the RCOD to environmental statutes has historically been ambiguous. On the one hand, the RCOD applies in cases where a corporate executives has authority over and responsibility for an enterprise that has violated laws protecting public safety. Similar to FDCA, environmental statutes such as the Clean Water Act (CWA) and Clean Air Act (CAA) are also considered public health and safety statutes, implying that that RCOD can be applied in environmental jurisprudence. Congress even explicitly incorporated the term "responsible corporate officer" into the definitions of persons subject to liability under both CWA and CAA.

On the other hand, unlike FDCA, most environmental statutes (e.g., CWA) require the government to prove the defendant's criminal knowledge. This is at odds with the RCOD in which the mere authority is sufficient to hold corporate executives liable. It is noteworthy that this was not an issue in the Supreme Court's ruling in *Dotterweich* and *Park* because FDCA is a strict liability statute, meaning that a defendant could be held liable regardless of what their intent or mental state was when committing the crime.

Given the coexistence of knowledge requirement and the mention of "responsible corporate officer" in environmental statutes, courts *may* apply the RCOD to imply a knowledge requirement merely from a corporate executive's position or responsibility. However, there are serious controversies around the application of RCOD in environmental statutes, and historical evidence show that courts avoided applying the RCOD to environmental cases. Critics contend that courts should not permit the conviction of corporate officers unless the government satisfies its burden of proving that the officer possessed the culpable state of mind required under the specific environmental statutes at issue.

Appendix B

Stylized Model of Executive Personal Environmental Liability and Empirical Predictions

In this section, I describe a stylized model that formulates the main economic intuition of the empirical analysis. The setting includes three players: principal (i.e., firm/shareholders), agent (i.e., executive), and regulator. The regulator imposes the personal liability regime $\theta \in [0,1]$ with higher θ indicating stronger personal liability burden. In response, the executive chooses the pollution management effort $e(p,\theta) \in [0,1]$ where p is the probability of inspection by the regulator. Intuitively, the executive is expected to exert more effort if the personal liability regime is strong (θ is high). Similarly, the executive will exert more effort if the probability of inspection by the regulator, and hence environmental litigation, is higher (p is high). The inspection probability is stochastic with $p = \overline{p} + \epsilon$ and $\epsilon \sim (0, \sigma_\varepsilon^2)$. This randomness reflects real-world unpredictability of environmental inspections.

If violation is found upon inspection, the court imposes liability penalty of $L\big(1-\phi(e)\big)$ on the executive where $\phi(e) \in [0,1]$ captures the degree of pollution avoidance resulting from effort. Pollution avoidance is increasing in effort ($\phi'(e) > 0$) and there is diminishing return to effort ($\phi''(e) < 0$). The probability of a being held liable is $p\theta\big(1-\phi(e)\big)$.

I what follows, I will formally examine how strengthening the personal liability regime (i.e., increasing θ) affects the executive's pollution management effort as well as firm outcomes.

B.1. Executive Optimization Problem

The executive maximizes his payoff U:[22]

[22] The linear functional form used to formulate utility is equivalent to assuming risk-neutrality for the executive which has been adopted to enhance model tractability. This assumption does not affect qualitative comparative statics which

$$U(e) = \omega + \beta e - \frac{1}{2}ke^2 - p\theta L\big(1 - \phi(e)\big)^2$$

In the utility function above, $\omega + \beta e$ measures the compensation offered by the principal to the executive: ω is a fixed wage and βe rewards the executive for his compliance-enhancing efforts ($\beta > 0$). The second component ($-\frac{1}{2}ke^2, k > 0$) captures the convex cost of effort to the executive. The third component captures the expected liability penalty.

The executive chooses e such that $U(e)$ is maximized. The first order condition yields:

$$\frac{\partial U}{\partial e} = \frac{\partial\left[\omega + \beta e - \frac{1}{2}ke^2 - p\theta L\big(1 - \phi(e)\big)^2\right]}{\partial e}$$

$$= \beta - ke + 2p\theta L\big(1 - \phi(e)\big)\phi'(e) = F(e, \theta, p) = 0$$

To see how the optimal effort e changes with the strength of personal liability regime θ, I must calculate the derivative $\frac{de}{d\theta}$. To this end, starting from $F(e, \theta, p) = 0$, I take derivatives of both sides with respect to θ:

$$\frac{\partial F}{\partial e}.\frac{de}{d\theta} + \frac{\partial F}{\partial \theta} = 0$$

Therefore,

$$\frac{de}{d\theta} = -\frac{\frac{\partial F}{\partial \theta}}{\frac{\partial F}{\partial e}} = -\frac{2pL\big(1 - \phi(e)\big)\phi'(e)}{-k + 2p\theta L\big(1 - \phi(e)\big)\phi''(e) - 2p\theta L\big(\phi'(e)\big)^2}$$

The numerator of the ratio above is positive (all multiplied components are positive) and the denominator is negative (it is the sum of four negative components). Therefore, $\frac{de}{d\theta} > 0$.[23]

are even stronger under risk aversion. To emphasize, risk neutrality does not mean the executive ignores liability risk. Rather, it means they respond only to the expected mean payoffs and are indifferent to the variance. Thus, higher expected penalties induce more compliance effort. Risk aversion would further strengthen these incentives.

[23] It is noteworthy that since $e = e(p, \theta)$, and both p and θ are exogenous and independent, we have $\frac{de}{d\theta} = \frac{\partial e}{\partial \theta} > 0$.

Proposition I: Stronger personal liability for pollution induces higher pollution management effort by executives.

Similarly,

$$\frac{de}{dp} = -\frac{\frac{\partial F}{\partial p}}{\frac{\partial F}{\partial e}} = -\frac{2\theta L\big(1-\phi(e)\big)\phi'(e)}{-k+2p\theta L\big(1-\phi(e)\big)\phi''(e)-2p\theta L\big(\phi'(e)\big)^2} > 0.^{24}$$

Proposition II: Higher probability of environmental inspection induces higher pollution management effort by executives.

B.2. Implications for Firm Output

Consider the firm chooses output q to maximize cash flows π, taking compliance effort e as determined by the executive:

$$\pi = R(q) - V(q,e) - F$$

$R(q)$ indicates revenues, $V(q,e)$ indicates variable costs determined by output level and effort, and F indicates fixed costs of production. Revenue is increasing and concave in output ($R' > 0, R'' < 0$). Cost is increasing in output and effort ($V_q > 0, V_e > 0$). The first order condition yields:

$$R'(q) - \frac{\partial V(q,e)}{\partial q} = 0$$

Taking total derivatives with respect to θ:

$$\frac{d\left[R'(q) - \frac{\partial V(q,e)}{\partial q}\right]}{d\theta} = R''(q)\frac{dq}{d\theta} - \frac{\partial^2 V(q,e)}{\partial q^2}\cdot\frac{dq}{d\theta} - \frac{\partial^2 V(q,e)}{\partial e \partial q}\cdot\frac{de}{d\theta} = 0$$

Solving for $\frac{dq}{d\theta}$:

[24] It is noteworthy that since $e = e(p,\theta)$, and both p and θ are exogenous and independent, we have $\frac{de}{dp} = \frac{\partial e}{\partial p} > 0$.

$$\frac{dq}{d\theta} = \frac{\frac{\partial^2 V(q,e)}{\partial e \partial q}}{R''(q) - \frac{\partial^2 V(q,e)}{\partial q^2}} \cdot \frac{de}{d\theta}$$

Assuming higher compliance effort e increases the marginal cost of production, the numerator of the ratio above is positive. Both components of the denominator are expectedly negative (downward sloping marginal revenue and upward sloping marginal cost), making the denominator negative. Finally, from the first proposition, $\frac{de}{d\theta} > 0$. Therefore, $\frac{dq}{d\theta} < 0$.

Notably, the model does not provide any clear prediction on how stronger personal liability regimes affect costs. Formally,

$$\frac{dV(q,e)}{d\theta} = \frac{\partial V}{\partial q} \cdot \frac{dq}{d\theta} + \frac{\partial V}{\partial e} \cdot \frac{de}{d\theta}$$

The first term above is negative ($\frac{\partial V}{\partial q} > 0, \frac{dq}{d\theta} < 0$) while the second term is positive ($\frac{\partial V}{\partial e} > 0, \frac{de}{d\theta} > 0$). Hence, the sign of $\frac{dV}{d\theta}$ remains unclear, depending on which of the two terms dominate.

Proposition III: Firm output is decreasing in personal liability. Costs can be either increasing, decreasing, or constant in personal liability.

B.3. Implications for Firm Cash Flows

I then turn to calculating $\frac{d\pi}{d\theta}$ to examine how cash flows π vary with personal liability regime θ:

$$\frac{d\pi}{d\theta} = R'(q).\frac{dq}{d\theta} - \frac{\partial V(q,e)}{\partial q} \cdot \frac{dq}{d\theta} - \frac{\partial V(q,e)}{\partial e} \cdot \frac{de}{d\theta}$$

$$= \left[R'(q) - \frac{\partial V(q,e)}{\partial q}\right] \cdot \frac{dq}{d\theta} - \frac{\partial V(q,e)}{\partial e} \cdot \frac{de}{d\theta}$$

The term in the brackets measures the marginal return to output minus the marginal cost. For firms that operate on or below their efficient scale, this term is non-negative. This is a realistic

assumption for real-world firms. The second component in the expression above is the product of a strictly negative term ($-\frac{\partial V(q,e)}{\partial e} < 0$) and a strictly positive term ($\frac{de}{d\theta} > 0$, see Proposition I). Therefore, $\frac{d\pi}{d\theta} < 0$.

Proposition IV: Cash flow level is decreasing in personal liability.

B.4. Implications for Cash Flow Volatility

In the current model, compliance effort e depends on stochastic enforcement probability $p = \overline{p} + \epsilon$ with $\epsilon \sim (0, \sigma_\varepsilon^2)$. Subsequently, e determines output q and costs V, introducing randomness into cash flows. Formally:

$$\pi = R(q(e(p,\theta))) - V(q(e(p,\theta)), e(p,\theta)) - F$$

The variance of π, calculated through the delta method, is obtained as follows:

$$Var(\pi) \approx \left(\frac{\partial \pi}{\partial p}\right)^2 . \sigma_\varepsilon^2 = \left(\frac{\partial \pi}{\partial e} . \frac{\partial e}{\partial p}\right)^2 . \sigma_\varepsilon^2$$

To examine the effect of stronger personal liability regimes on cash flow volatility, I take total derivative with respect to θ:

$$\frac{dVar(\pi)}{d\theta} = 2\left(\frac{\partial \pi}{\partial e} . \frac{\partial e}{\partial p}\right) . \frac{d}{d\theta}\left(\frac{\partial \pi}{\partial e} . \frac{\partial e}{\partial p}\right) . \sigma_\varepsilon^2$$

$$= 2\left(\frac{\partial \pi}{\partial e} . \frac{\partial e}{\partial p}\right) . \left[\frac{d}{d\theta}\left(\frac{\partial \pi}{\partial e}\right) . \frac{\partial e}{\partial p} + \frac{\partial \pi}{\partial e} . \frac{d}{d\theta}\left(\frac{\partial e}{\partial p}\right)\right] . \sigma_\varepsilon^2$$

Under reasonable assumptions, the above derivative has a positive sign, indicating that cash flow risk is increasing in θ. To illustrate, note that $\frac{\partial \pi}{\partial e} < 0$, i.e., profit is decreasing in effort.[25]

[25] Following from the π formula in Section B.2.,

$$\frac{\partial \pi}{\partial e} = \left[R'(q) - \frac{\partial V(q,e)}{\partial q}\right] . \frac{\partial q}{\partial e} - \frac{\partial V(q,e)}{\partial e} .$$

The term inside the bracket is positive (see section B.3.). Similar to the argument in Section B.2., $\frac{\partial q}{\partial e}$ is negative. Formally:

Moreover, from Proposition II, $\frac{\partial e}{\partial p} > 0$, i.e., effort is increasing in inspection probability. Therefore, the multiplier outside the bracket is negative. Turning to the higher order derivatives inside the bracket, $\frac{d}{d\theta}\left(\frac{\partial \pi}{\partial e}\right)$ is expectedly negative. In other words, the diminishing return to effort is amplified in stronger personal liability regimes. Furthermore, $\frac{d}{d\theta}\left(\frac{\partial e}{\partial p}\right)$ is expectedly positive. In other words, the responsiveness of effort to inspection probability is strengthened in stronger liability regimes. Taken together:

$$\frac{dVar(\pi)}{d\theta} \approx (-).(+).[(-).(+) + (-).(+)] > 0$$

Proposition V: Cash flow volatility is increasing in the strength of personal liability.

B.5. Implications for Executive Compensation

Executive compensation is modeled as:

$$C(e) = \omega + \beta e$$

Taking derivatives with respect to θ:

$$\frac{dC}{d\theta} = \beta.\frac{de}{d\theta}$$

Using Proposition I, $\frac{dC}{d\theta}$>0.

Proposition VI: Executive compensation is increasing in personal liability. The increase occurs only through the variable component of compensation designed to compensate the executive for compliance efforts.

$$\frac{\partial q}{\partial e} = \frac{\frac{\partial^2 V(q,e)}{\partial e \partial q}}{R''(q) - \frac{\partial^2 V(q,e)}{\partial q^2}} < 0$$

Finally, $\frac{\partial V(q,e)}{\partial e} < 0$ (see section B.2.). Therefore, $\frac{\partial \pi}{\partial e} < 0$.

B.6. Implications for Firm Value

Firm value is the discounted value of future cash flows. Formally:

$$Value \propto \frac{\pi}{Var(\pi)}$$

Therefore,

$$\frac{dValue}{d\theta} \propto \frac{Var(\pi).\frac{d\pi}{d\theta} - \pi.\frac{dVar(\pi)}{d\theta}}{Var(\pi)^2}$$

Using Proposition IV ($\frac{d\pi}{d\theta}$<0) and Proposition V ($\frac{dVar(\pi)}{d\theta} > 0$), the derivative above is negative.

Proposition VII: Firm value is decreasing in personal liability.

B.7. Implications for Pollution

Suppose pollution P is a function of output q and effort e such that $\frac{\partial P}{\partial q} > 0$ and $\frac{\partial P}{\partial e} < 0$. Specifically, pollution is increasing in output and decreasing in compliance effort. Taking total derivative with respect to θ:

$$\frac{dP}{d\theta} = \frac{\partial P}{\partial q}.\frac{dq}{d\theta} + \frac{\partial P}{\partial e}.\frac{de}{d\theta}$$

Combining previous findings in Proposition I and Proposition III, $\frac{dP}{d\theta}$ is the sum of two negative terms. Therefore, $\frac{dP}{d\theta} < 0$.

Proposition IIX: Pollution level is decreasing in personal liability.

References

Abraham, Kenneth S., 1988, Environmental liability and the limits of insurance. Colum. *L. Rev. 88*, 942-988.

Aguir, Iness, and Wael Aguir, 2020, Director and officer liability protection and firm value: Unintended consequences, *Finance Research Letters 32*, 101177.

Akey, Pat, and Ian Appel, 2021, The limits of limited liability: Evidence from industrial pollution, *The Journal of Finance 76*, 5-55.

Arlen, Jennifer, 1994, The potentially perverse effects of corporate criminal liability, *Journal of Legal Studies 23*, 833-867.

Becker, Randy A., Wayne B. Gray and Jordan Marvakov, 2021, NBER-CES Manufacturing Industry Database, *National Bureau of Economic Research*.

Bellon, Aymeric, 2021, Fresh start or fresh water: The impact of environmental lender liability, Working paper.

Bernstein, Shai, 2015, Does going public affect innovation?, *The Journal of finance*, 70, 1365-1403.

Brehm, John, and James T. Hamilton, 1996, Noncompliance in environmental reporting: Are violators ignorant, or evasive, of the law?, American Journal of Political Science, 444-477.

Brook, Yaron, and Ramesh KS Rao, 1994, Shareholder wealth effects of directors' liability limitation provisions, *Journal of Financial and Quantitative Analysis 29*, 481-497.

Carhart, Mark M., 1997, On persistence in mutual fund performance, *Journal of Finance* 52, 57-82.

Chalmers, John MR, Larry Y. Dann, and Jarrad Harford, 2002, Managerial opportunism? Evidence from directors' and officers' insurance purchases, *The Journal of Finance 57*, 609-636.

Donelson, Dain C., and Christopher G. Yust, 2014, Litigation risk and agency costs: Evidence from Nevada corporate law, *The Journal of Law and Economics 57*, 747-780.

Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3-56.

Fama, Eugene F., and Kenneth R. French, 2015, A five-factor asset pricing model, *Journal of Financial Economics* 116, 1-22.

Greenberg, Joshua D., and Ellen C. Brotman, 2014, Strict vicarious criminal liability for corporations and corporate executives: Stretching the boundaries of criminalization, *American Criminal Law Review 51*, 79-98.

Heitz, Amanda, Youan Wang, and Zigan Wang, 2023, Corporate political connections and favorable environmental regulatory enforcement, *Management Science 69*, 7838-7859.

Holmstrom, Bengt, 1979, Moral hazard and observability, *Bell journal of economics*, 74-91.

Holmstrom, Bengt, and Paul Milgrom, 1987, Aggregation and linearity in the provision of intertemporal incentives, *Econometrica: Journal of the Econometric Society*, 303-328.

Hwang, Joon Ho, and Byungmo Kim, 2018, Directors' and officers' liability insurance and firm value, *Journal of Risk and Insurance 85*, 447-482.

Kang, Qiang, Qiao Liu, and Rong Qi, 2010, The Sarbanes-Oxley act and corporate investment: A structural assessment, *Journal of Financial Economics 96*, 291-305.

Kempf, Elisabeth, Alberto Manconi, and Oliver Spalt, 2017, Distracted shareholders and corporate actions, *Review of Financial Studies 30*, 1660-1695.

Koudijs, Peter, Laura Salisbury, and Gurpal Sran, 2021, For richer, for poorer: bankers' liability and bank risk in New England, 1867 to 1880, *The Journal of Finance 76*, 1541-1599.

Laufer, William S., 1999, Corporate Liability, Risk Shifting, and the Paradox of Compliance, *Vanderbilt Law Review* 52, 1341-1420.

Lin, Chen, Micah S. Officer, Thomas Schmid, and Hong Zou, 2019, Is skin in the game a game changer? Evidence from mandatory changes of D&O insurance policies, *Journal of Accounting and Economics 68*, 101225.

Linck, James S., Jeffry M. Netter, and Tina Yang, 2009, The effects and unintended consequences of the Sarbanes-Oxley Act on the supply and demand for directors, *Review of Financial Studies 22*, 3287-3328.

Masulis, Ronald W., and Syed Walid Reza, 2015, Agency problems of corporate philanthropy, *Review of Financial Studies 28*, 592-636.

Masulis, Ronald W., Sichen Shen, and Hong Zou, 2020, Director liability protection and the quality of outside directors, working paper.

Mirrlees, James A., 1976, The optimal structure of incentives and authority within an organization, *Bell Journal of Economics*, 105-131.

Morellec, Erwan, 2004, Can managerial discretion explain observed leverage ratios?, *Review of Financial Studies 17*, 257-294.

Naaraayanan, S. Lakshmi, and Kasper Meisner Nielsen, 2021, Does personal liability deter individuals from serving as independent directors?, *Journal of Financial Economics 140*, 621-643.

Ohlrogge, Michael, 2023, Bankruptcy claim dischargeability and public externalities: Evidence from a natural experiment, *American Law and Economic Review,* Forthcoming.

Polinsky, A. Mitchell, and Steven Shavell, 1993, Should employees be subject to fines and imprisonment given the existence of corporate liability?, *International Review of Law and Economics 13*, 239-257.

Schoenherr, David, 2017, Managers' personal bankruptcy costs and risk-taking, Working paper.

Shive, Sophie A., and Margaret M. Forster, 2020, Corporate governance and pollution externalities of public and private firms, *Review of Financial Studies*,*33*, 1296-1330.

Siegelman, Peter, 2003, Adverse selection in insurance markets: an exaggerated threat. *Yale LJ 113*, 1223-1282.

Van Bekkum, Sjoerd, 2016, Inside debt and bank risk, *Journal of Financial and Quantitative Analysis 51*, 359-385.

Wei, C. and Yermack, D., 2011, Investor reactions to CEOs' inside debt incentives, *Review of Financial Studies 24*, 3813-3840.

Wei, Chenyang, and David Yermack, 2022, To pollute or not to pollute: Political connections and corporate environmental performance, *Journal of Corporate Finance 74*, 102214.

Xu, Qiping, and Taehyun Kim, 2022, Financial constraints and corporate environmental policies, *Review of Financial Studies 35*, 576-635.

Table 1
Summary Statistics

This table presents descriptive statistics for the main variables used in this paper. Variables are defined in Appendix Table 1.

Panel A: Pooled summary statistics

	Mean	Standard deviation	25th percentile	Median	75th percentile
Plant variables					
- On-site emissions into water, air, and ground (1000 pounds)	8.08	34.41	0.00	0.25	11.49
- On-site emissions into water and air (1000 pounds)	6.26	25.93	0.00	0.21	9.38
- On-site emissions into water (1000 pounds)	0.07	0.53	0.00	0.00	0.00
- On-site emissions into air (1000 pounds)	5.47	22.70	0.00	0.13	7.90
- On-site emissions into ground (1000 pounds)	0.21	1.71	0.00	0.00	0.00
- Production ratio	1.07	0.56	1.00	1.12	1.43
- Dummy (process abatement)	0.03	0.17	0.00	0.00	0.00
Parent firm exposure to *Iverson*					
- Share of the parent's emissions in Ninth Circuit (%, plant-chemical level)	8.33	19.17	0.05	5.45	26.48
- Share of the parent's emissions in Ninth Circuit (%, parent firm level)	11.23	28.26	0.00	0.32	49.80
- Share of the parent's plants in Ninth Circuit (%, plant-chemical level)	11.32	17.76	5.56	14.29	26.67
- Share of the parent's plants in Ninth Circuit (%, parent firm level)	14.25	28.31	0.00	14.29	50.00
Stock returns around December 11, 1998					
- CAR(-1,0)	-0.44	3.34	-0.33	1.39	2.95
- CAR(-1,+1)	-0.22	4.55	0.00	2.11	4.44
- CAR(-1,+5)	-1.61	6.95	-1.72	2.30	6.90
- CAR(-1,+10)	-2.42	10.02	-2.24	3.36	9.01
Earning forecast revision around December 11, 1998					
- After 1 period (parent-analyst level)	-0.0029	0.0098	0.0000	0.0000	0.0000
- After 2 periods (parent-analyst level)	-0.0063	0.0161	0.0000	0.0000	0.0017
- After 3 periods (parent-analyst level)	-0.0080	0.0204	0.0000	0.0000	0.0040
- After 4 periods (parent-analyst level)	-0.0094	0.0236	-0.0013	0.0000	0.0053
- After 1 period (parent level)	-0.0028	0.0091	-0.0002	0.0000	0.0015
- After 2 periods (parent level)	-0.0058	0.0157	-0.0020	0.0000	0.0035
- After 3 periods (parent level)	-0.0073	0.0198	-0.0025	0.0000	0.0064
- After 4 periods (parent level)	-0.0084	0.0235	-0.0027	0.0007	0.0077

Panel A continued					
Parent firm outputs					
- ROA	0.041	0.099	0.052	0.091	0.136
- Profit margin	0.019	0.142	0.039	0.070	0.110
- Sales/Assets	0.159	0.500	0.182	0.476	0.741
- Total cost/Sales	-0.137	0.114	-0.132	-0.083	-0.039
- COGS/Sales	-0.414	0.272	-0.352	-0.237	-0.151
- SG&A/Sales	-1.844	0.686	-1.769	-1.358	-0.995
- Volatility of ROA	0.064	0.077	0.039	0.074	0.141
- Volatility of profit margin	0.087	0.185	0.035	0.077	0.166
- Total compensation (CEO, $1,000's)	3,748.52	3,941.07	2,280.47	4,678.46	8,971.66
- Salary compensation (CEO, $1,000's)	646.35	269.17	611.38	835.29	1,002.23
- Non-salary compensation (CEO, $1,000's)	3,090.70	3,785.96	1,664.84	3,865.82	8,044.47
- Total compensation (directors, $1,000's)	2,942.37	3,518.23	1,631.78	3,471.43	7,150.65
- Salary compensation (directors, $1,000's)	535.62	272.57	495.00	700.00	946.06
- Non-salary compensation (directors, $1,000's)	2,397.89	3,356.30	1,116.35	2,761.09	6,359.69
Aggregate variables at industry-year level					
- 1992 share of emissions in the Ninth Circuit (%)	8.41	12.22	4.11	9.75	20.56
- Industry pollutiveness	8.36	8.54	6.00	9.00	17.00
- Shipment value ($M)	26,817.67	33,117.32	14,635.00	36,180.80	64,417.80
- Shipment value / 1992 employment ($1000 per employee)	234.74	197.65	180.29	275.50	457.61
- Value added ($M)	13,256.13	16,540.78	7,418.00	18,671.60	30,561.50
- Value added / 1992 employment ($1000 per employee)	112.92	91.26	92.26	128.36	196.53
- Hours worked (millions)	169.54	204.19	102.10	221.10	373.80
- Hours worked / 1992 employment (1000's per employee)	1.39	0.43	1.44	1.69	1.89
- Emissions into water and air (1000 pounds)	10,352.40	22,231.59	1,575.30	7,593.55	32,078.76
- Emissions into water and air / 1992 employment (pounds per employee)	140.45	391.98	18.42	77.63	298.47
- Emissions into water and air / current employment (pounds per employee)	152.52	425.11	18.52	76.08	333.46
- Emissions into water and air / hours worked (pounds per 1000 hours)	103.52	291.24	12.98	48.70	220.73
- Emissions into water and air / shipment value (pounds per $1000)	0.40	0.82	0.10	0.36	1.18
Aggregate variables at industry-state-year level					
- Industry pollutiveness	2.34	4.65	0.00	3.00	8.00
- Δ Establishment count	5.93	37.33	0.75	7.06	29.98
- Δ Establishment count / 1992 employment (per 1000 employees)	2.16	15.93	0.17	4.67	15.38
Aggregate variables at industry-state-chemical-year level					
- On-site emissions into water, air, and ground (1000 pounds)	11.75	56.18	0.00	0.09	11.47
- On-site emissions into water and air (1000 pounds)	7.94	36.58	0.00	0.05	8.24
- On-site emissions into ground (1000 pounds)	0.65	5.04	0.00	0.00	0.00

Panel B: Treated vs. control plants (1997)						
	Unconditional			Conditional on covariates		
	Treated	Control	P-value of difference	Treated	Control	P-value of difference
- log of on-site emissions into water, air, and ground	2.422	2.550	0.014	0.007	-0.001	0.760
- log of on-site emissions into water and air	2.362	2.481	0.021	0.021	-0.002	0.329
- log of on-site emissions into water	0.303	0.339	0.057	0.012	-0.001	0.179
- log of on-site emissions into air	2.274	2.363	0.076	0.015	-0.002	0.470
- log of on-site emissions into ground	0.196	0.218	0.181	-0.028	0.003	0.002
- Production ratio	1.223	1.168	0.000	0.004	0.000	0.611
- Process abatement	0.052	0.036	0.001	-0.001	0.000	0.840

Table 2
The Macroeconomic Effects of *Iverson*

This table uses the OLS regressions to examine the macroeconomic effects of Iverson using SIC3 industries. Panel A and Panel B use industry-year level data in the manufacturing sector. Panel C uses data at industry-state-chemical-year level using industries available in the Toxic Release Inventory from EPA. Panel D uses industry-state-year level data using private industries in the County Business Pattern. Industry pollutiveness is measured in 1992 and defined in Appendix Table 1. Share of emissions in Ninth Circuit is also measured in 1992 using on-site emissions. Ninth Circuit is a dummy variable taking the value of one for states located in the Ninth Circuit. The sample period runs from 1994 through 2003. Post is a dummy variable taking the value of one on and after 1999. Fixed effects and controls are reported in each panel. Standard errors are clustered at the SIC2-year level in Panel A and Panel B, and by circuit in Panel C and Panel D. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Aggregate output

	Dependent variable is					
	ln of …			… scaled by 1992 employment		
	Shipment value	Value added	Hours worked	Shipment value	Value added	Hours worked
	(1)	(2)	(3)	(4)	(5)	(6)
1992 share of emissions in Ninth Circuit	-0.3796***	-0.2795**	-0.3700***	-114.9853***	-21.5666	-0.3226***
× ln(1+ Industry pollutiveness) × Post	(-3.74)	(-2.59)	(-4.33)	(-4.09)	(-1.56)	(-3.09)
Dual and single combinations of interaction components	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects						
SIC3 industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Sample level	Industry-Year	Industry-Year	Industry-Year	Industry-Year	Industry-Year	Industry-Year
Industries included	Manufacturing	Manufacturing	Manufacturing	Manufacturing	Manufacturing	Manufacturing
Observations	1,365	1,365	1,365	1,365	1,365	1,365
R-squared	0.988	0.985	0.989	0.951	0.898	0.882

Panel B: Aggregate pollution

	Dependent variable is				
	ln (1+emissions into water and air)	Emissions into water and air scaled by 1992 employment	Current employment	Hours worked	Shipment value
	(1)	(2)	(3)	(4)	(5)
1992 share of emissions in Ninth Circuit × ln(1+ Industry pollutiveness) × Post	-1.1828***	-536.4768**	-382.3416**	-257.1793**	-0.4946
	(-3.04)	(-2.49)	(-2.03)	(-2.11)	(-1.36)
Dual and single combinations of interaction components	Yes	Yes	Yes	Yes	Yes
Fixed effects					
SIC3 industry	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Sample level	Industry-Year	Industry-Year	Industry-Year	Industry-Year	Industry-Year
Industries included	Manufacturing	Manufacturing	Manufacturing	Manufacturing	Manufacturing
Observations	1,365	1,365	1,365	1,365	1,365
R-squared	0.961	0.949	0.962	0.965	0.952

Panel C: Emissions at industry-state-chemical-year level

	Dependent variable is ln(1+emissions into …)		
	Water, air, and ground	Water and air	Ground
	(1)	(2)	(3)
Ninth Circuit × Post	-0.0217**	-0.0199***	-0.0089
	(-2.48)	(-3.38)	(-1.30)
Lagged emissions	Yes	Yes	Yes
Fixed effects			
SIC3 industry × State	Yes	Yes	Yes
SIC3 industry × Chemical	Yes	Yes	Yes
SIC3 industry × Year	Yes	Yes	Yes
Chemical × Year	Yes	Yes	Yes
Sample level	Industry-State-Chemical-Year	Industry-State-Chemical-Year	Industry-State-Chemical-Year
Industries included	In Toxic Release Inventory	In Toxic Release Inventory	In Toxic Release Inventory
Observations	876,883	876,883	876,883
R-squared	0.774	0.780	0.677

Panel D: Net business creation		
	Dependent variable is	
	Δ Establishment count	Δ (Establishment count/1992 employment)
	(1)	(2)
Ninth Circuit	-1.6016***	-0.5000***
× ln(1+ Industry pollutiveness) × Post	(-5.38)	(-4.40)
Fixed effects		
SIC3 industry × Year	Yes	Yes
State × Year	Yes	Yes
State × SIC3 industry	Yes	Yes
Sample level	Industry-State-Year	Industry-State-Year
Industries included	In County Business Pattern	In County Business Pattern
Observations	133,100	133,100
R-squared	0.621	0.464

Table 3
Cumulative Abnormal Returns Around *Iverson*

This table uses the OLS regression described in Equation (1) to study the effect of Iverson on cumulative abnormal returns of parent firms exposed to the shock. Panel A and Panel B report the results for cumulative abnormal returns around December 11, 1998 (the Ninth Circuit decision date), and November 5, 1997 (the District Court decision date), respectively. Columns 1-4 in each panel use as the exposure to Iverson the share of parent firms' water and air on-site emissions that are located in the Ninth Circuit. Columns 5-8 in each panel use as the exposure to Iverson the share of parent firms' plants that are located in the Ninth Circuit. All regressions include a constant not reported for brevity. Variables are further defined in Appendix Table 1. Robust standard errors are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Market response to the Ninth Circuit Court's decision on December 11, 1998

	Dependent variable is							
	CAR (-1,0)	CAR (-1,+1)	CAR (-1,+5)	CAR (-1,+10)	CAR (-1,0)	CAR (-1,+1)	CAR (-1,+5)	CAR (-1,+10)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of the parent's emissions in Ninth Circuit	-1.5514***	-2.3016***	-3.1437***	-6.0761***				
	(-3.02)	(-3.27)	(-3.54)	(-3.83)				
Share of the parent's plants in Ninth Circuit					-1.7712***	-2.1948***	-2.8879***	-6.0151***
					(-3.53)	(-3.13)	(-3.05)	(-3.83)
Observations	786	786	786	786	786	786	786	786
R-squared	0.015	0.018	0.015	0.026	0.020	0.017	0.012	0.026

Panel B: Market response to the District Court of Washington's decision on November 5, 1997

	Dependent variable is							
	CAR (-1,0)	CAR (-1,+1)	CAR (-1,+5)	CAR (-1,+10)	CAR (-1,0)	CAR (-1,+1)	CAR (-1,+5)	CAR (-1,+10)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of the parent's emissions in Ninth Circuit	-0.3820	-0.6721	-1.1684	-1.1059				
	(-1.16)	(-1.50)	(-1.43)	(-1.11)				
Share of the parent's plants in Ninth Circuit					-0.1986	-0.7903	-1.6660*	-1.1988
					(-0.51)	(-1.62)	(-1.84)	(-1.11)
Observations	823	823	823	823	823	823	823	823
R-squared	0.001	0.003	0.003	0.002	0.000	0.004	0.006	0.002

Table 4
Earning Forecast Revisions Around *Iverson*

This table uses the OLS regression described in Equation (1) to study the effect of Iverson on analysts' revision of their earnings forecasts for parent firms exposed to the shock. Panel A report the results for forecast revisions at the firm-analyst level around December 11, 1998 (the Ninth Circuit decision date). Panel B report the results for forecast revisions at the firm level around December 11, 1998. Panel C report the results for forecast revisions at the firm-analyst level around November 5, 1997 (the District Court decision date). Panel D report the results for forecast revisions at the firm level around November 5, 1997. Columns 1-4 in each panel use as the exposure to Iverson the share of parent firms' water and air on-site emissions that are located in the Ninth Circuit. Columns 5-8 in each panel use as the exposure to Iverson the share of parent firms' plants that are located in the Ninth Circuit. All regressions include a constant not reported for brevity. Variables are further defined in Appendix Table 1. Robust standard errors are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Analysts' forecast revision around the Ninth Circuit Court's decision on December 11, 1998
Dependent variable is: Earning forecast revision at parent-analyst level

	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of the parent's emissions in Ninth Circuit	-0.0016***	-0.0037***	-0.0074***	-0.0088***				
	(-3.19)	(-4.26)	(-5.90)	(-5.88)				
Share of the parent's plants in Ninth Circuit					-0.0015***	-0.0026***	-0.0048***	-0.0069***
					(-3.11)	(-3.18)	(-4.00)	(-4.69)
Observations	5,786	5,710	5,611	5,531	5,786	5,710	5,611	5,531
R-squared	0.002	0.004	0.010	0.007	0.002	0.002	0.004	0.007

Panel B: Analysts' forecast revision around the Ninth Circuit Court's decision on December 11, 1998
Dependent variable is: Earning forecast revision at parent level

	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of the parent's emissions in Ninth Circuit	-0.0018	-0.0062**	-0.0097***	-0.0125***				
	(-1.14)	(-2.27)	(-2.67)	(-2.79)				
Share of the parent's plants in Ninth Circuit					-0.0017	-0.0038	-0.0075**	-0.0119***
					(-1.13)	(-1.58)	(-2.10)	(-2.67)
Observations	682	682	679	677	682	682	679	677
R-squared	0.003	0.012	0.019	0.020	0.003	0.005	0.011	0.020

Panel C: Analysts' forecast revision around the District Court of Washington's decision on November 5, 1997
Dependent variable is: Earning forecast revision at parent-analyst level

	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of the parent's emissions in Ninth Circuit	-0.0006	-0.0001	-0.0016*	-0.0028***				
	(-1.26)	(-0.23)	(-1.72)	(-2.76)				
Share of the parent's plants in Ninth Circuit					-0.0005	-0.0008	-0.0025***	-0.0038***
					(-1.08)	(-1.37)	(-2.92)	(-3.82)
Observations	5,318	5,318	5,243	5,119	5,318	5,318	5,243	5,119
R-squared	0.000	0.000	0.001	0.005	0.000	0.000	0.003	0.005

Panel D: Analysts' forecast revision around the District Court of Washington's decision on November 5, 1997
Dependent variable is: Earning forecast revision at parent level

	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)	After 1 period (30 days)	After 2 periods (60 days)	After 3 periods (90 days)	After 4 periods (120 days)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of the parent's emissions in Ninth Circuit	-0.0010	-0.0001	-0.0002	0.0002				
	(-0.70)	(-0.04)	(-0.10)	(0.08)				
Share of the parent's plants in Ninth Circuit					-0.0009	-0.0003	-0.0011	-0.0010
					(-0.61)	(-0.17)	(-0.49)	(-0.37)
Observations	652	652	652	652	652	652	652	652
R-squared	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.000

Table 5
The Effect of *Iverson* on the Realized Profitability of Exposed Parents

This table uses the OLS regression described in Equation (2) to study the effect of Iverson on the cash flows of parent firms exposed to the shock at the firm-year level. Panel A reports the results for profitability as the dependent variable. Profitability is measured by ROA (Columns 1 and 3) or profit margin (columns 2 and 4). Panel B reports the results for sales and costs. Columns 1 and 2 in each panel use as the exposure to Iverson the share of parent firms' water and air on-site emissions that are located in the Ninth Circuit. Columns 3 and 4 in each panel use as the exposure to Iverson the share of parent firms' plants that are located in the Ninth Circuit. All regressions control for the parent firm's log of total assets, log of age, and log of total count of plants. Regressions also control for the direct (not interacted) effect of exposure to Iverson not reported for brevity. Post is a dummy variable taking the value of one on and after 1999. Variables are further defined in Appendix Table 1. Standard errors are cluster by SIC2 industry-year. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Profitability Dependent variable is:				
	ROA (Net income/Assets)	Profit margin (Net income/Sales)	ROA (Net income/Assets)	Profit margin (Net income/Sales)
	(1)	(2)	(3)	(4)
Share of the parent's emissions in Ninth Circuit × Post	-0.0197* (-1.93)	-0.0310** (-2.36)		
Share of the parent's plants in Ninth Circuit × Post			-0.0283*** (-2.59)	-0.0534*** (-3.60)
Controls				
Parent's assets, age, and count of plants	Yes	Yes	Yes	Yes
Components of the interaction	Yes	Yes	Yes	Yes
Fixed effects				
Parent firm	Yes	Yes	Yes	Yes
Parent's SIC2 industry × Year	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes
Observations	8,171	8,170	8,171	8,170
R-squared	0.596	0.632	0.596	0.633

Panel B: Components of profitability Dependent variable is:								
	ln(Sales /Assets)	ln(Total cost /Sales)	ln(COGS /Sales)	ln(SG&A /Sales)	ln(Sales /Assets)	ln(Total cost /Sales)	ln(COGS /Sales)	ln(SG&A /Sales)
Share of the parent's emissions in Ninth Circuit × Post	-0.1063***	0.0200**	0.0286**	0.0256				
	(-3.28)	(2.46)	(2.22)	(1.21)				
Share of the parent's plants in Ninth Circuit × Post					-0.0909**	0.0248***	0.0216*	0.0123
					(-2.32)	(2.76)	(1.77)	(0.52)
Controls								
Parent's assets, age, and count of plants	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Components of the interaction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects								
Parent firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent's SIC2 industry × Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,170	8,168	8,168	7,997	8,170	8,168	8,168	7,997
R-squared	0.869	0.788	0.933	0.957	0.868	0.788	0.933	0.957

Table 6
The Effect of *Iverson* on Cash Flow Volatility in Exposed Parents

This table uses the OLS regression described in Equation (3) to study the effect of Iverson on the cash flow volatility of parent firms exposed to the shock. Cash flow volatilities are measured using ROA (Columns 1 and 3) and profit margin (Columns 2 and 4). A minimum of three annual observations is required to calculate volatility. Columns 1 and 2 use as the exposure to Iverson the share of parent firms' water and air on-site emissions that are located in the Ninth Circuit. Columns 3 and 4 in each panel use as the exposure to Iverson the share of parent firms' plants that are located in the Ninth Circuit. All regressions control for the parent firm's log of total assets, log of age, and log of total count of plants. Variables are further defined in Appendix Table 1. Standard errors are cluster by SIC2 industry. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is: ln(volatility of …)			
	ROA	Profit margin	ROA	Profit margin
	(1)	(2)	(3)	(4)
Share of the parent's emissions in Ninth Circuit	0.2850*	0.3516*		
	(1.82)	(1.74)		
Share of the parent's plants in Ninth Circuit			0.4558**	0.6113***
			(2.65)	(3.39)
Controls				
Lagged dependent variable	Yes	Yes	Yes	Yes
Parent's assets, age, and count of plants	Yes	Yes	Yes	Yes
Fixed effects				
Parent's SIC2 industry	Yes	Yes	Yes	Yes
Parent headquarters circuit	Yes	Yes	Yes	Yes
Observations	658	658	658	658
R-squared	0.295	0.333	0.300	0.340

Table 7
The Effect of *Iverson* on Executive Compensation in Exposed Parents

This table uses the OLS regression described in Equation (4) to study the effect of Iverson on executive and director compensation at the firm-individual-year level. Panel A reports the results for CEO compensation and Panel B report the results for all director compensations. The sample period ranges from 1994 to 2003, inclusive. Columns 1-3 in each panel use as the exposure to Iverson the share of parent firms' water and air on-site emissions that are located in the Ninth Circuit. Columns 4-6 in each panel use as the exposure to Iverson the share of parent firms' plants that are located in the Ninth Circuit. Post is a dummy variable taking the value of one on and after 1999. All regressions control for parent firm's log of total assets, log of age, and log of total count of patents. Regressions also control for the direct (not interacted) effect of exposure to Iverson not reported for brevity. Variables are further defined in Appendix Table 1. Standard errors are clustered at the SIC2 industry-year level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: CEO compensation

	Dependent variable is					
	ln(Total compensation)	ln(Non-salary compensation)	ln(Salary compensation)	ln(Total compensation)	ln(Non-salary compensation)	ln(Salary compensation)
	(1)	(2)	(3)	(4)	(5)	(6)
Share of the parent's emissions in Ninth Circuit × Post	0.2809**	0.4982**	-0.0690			
	(2.20)	(2.41)	(-1.52)			
Share of the parent's plants in Ninth Circuit × Post				0.3087*	0.5495**	0.0032
				(1.87)	(2.14)	(0.05)
Controls						
Components of the interaction	Yes	Yes	Yes	Yes	Yes	Yes
Parent firm's assets, age, and count of plants	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects						
Parent firm	Yes	Yes	Yes	Yes	Yes	Yes
Individual	Yes	Yes	Yes	Yes	Yes	Yes
SIC2 industry × Year	Yes	Yes	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes	Yes	Yes
Size group × Year	Yes	Yes	Yes	Yes	Yes	Yes
CEO age × Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,195	4,195	4,215	4,195	4,195	4,215
R-squared	0.873	0.843	0.933	0.873	0.843	0.933

Panel B: Director compensation						
	Dependent variable is					
	ln(Total compensation)	ln(Non-salary compensation)	ln(Salary compensation)	ln(Total compensation)	ln(Non-salary compensation)	ln(Salary compensation)
	(1)	(2)	(3)	(4)	(5)	(6)
Share of the parent's emissions in Ninth Circuit × Post	0.0522	0.2109	-0.1050**			
	(0.55)	(1.20)	(-2.18)			
Share of the parent's plants in Ninth Circuit × Post				0.0543	0.1294	-0.1009*
				(0.51)	(0.74)	(-1.95)
Controls						
Components of the interaction	Yes	Yes	Yes	Yes	Yes	Yes
Parent firm's assets, age, and count of plants	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects						
Parent firm	Yes	Yes	Yes	Yes	Yes	Yes
Individual	Yes	Yes	Yes	Yes	Yes	Yes
SIC2 industry × Year	Yes	Yes	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes	Yes	Yes
Size group × Year	Yes	Yes	Yes	Yes	Yes	Yes
Director age × Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,090	8,090	8,116	8,090	8,090	8,116
R-squared	0.870	0.834	0.888	0.870	0.834	0.888

Table 8
The Effect of *Iverson* on Toxic Emissions, Plant Level Regressions

This table uses the OLS regression described in Equation (5) to study the effect of Iverson on toxic emissions at the plant-chemical-year level. Panel A reports the results on emissions released into water and air. Panel B reports the results for emissions released into various pollution media, as noted. The sample period ranges from 1994 to 2003, inclusive. Ninth Circuit is a dummy variable taking the value of one for plants located in the Ninth Circuit. Post is a dummy variable taking the value of one on and after 1999. All regressions include the lag of the dependent variable as control. Variables are further defined in Appendix Table 1. Standard errors are clustered at the plants' circuit level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: On-site emissions released into water and air
Dependent variable is: ln(1+On-site emissions released into water and air)

	(1)	(2)	(3)
Ninth Circuit × Post	-0.0618*	-0.0841***	-0.0586**
	(-2.03)	(-4.68)	(-2.57)
Controls			
Lagged emissions	No	Yes	Yes
Fixed effects			
Plant	Yes	Yes	Yes
Chemical × Year	Yes	Yes	Yes
SIC2 industry × Year	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	
Parent firm × Year			Yes
Observations	590,613	561,917	564,292
R-squared	0.331	0.797	0.802

Panel B: On-site emissions broken down by pollution medium
Dependent variable is: ln(1+On-site emissions released into …)

	Water, Air, and Ground (total on-site)	Water	Air	Ground
	(1)	(2)	(3)	(4)
Ninth Circuit × Post	-0.0898***	-0.0280***	-0.0846***	-0.0046
	(-5.29)	(-3.24)	(-5.29)	(-0.73)
Controls				
Lagged emissions	Yes	Yes	Yes	Yes
Fixed effects				
plant	Yes	Yes	Yes	Yes
Chemical × Year	Yes	Yes	Yes	Yes
SIC2 industry × Year	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes
Observations	561,917	561,917	561,917	561,917
R-squared	0.792	0.756	0.802	0.693

Table 9
The Effect of *Iverson* on Toxic Emissions, Parent Level Regressions

This table uses the OLS regression described in Equation (5) to study the effect of Iverson on toxic emissions at the firm-chemical-year level. The dependent variable is log of one plus on-site emissions released into various pollution media, as noted. Columns 1-3 use as the exposure to Iverson the share of parent firms' water and air on-site emissions that are located in the Ninth Circuit. Columns 4-6 use as the exposure to Iverson the share of parent firms' plants that are located in the Ninth Circuit. Post is a dummy variable taking the value of one on and after 1999. All regressions control for the parent firm's log of total assets, log of age, and log of total count of plants. Regressions also control for the direct (not interacted) effect of exposure to Iverson not reported for brevity. All regressions include the lag of the dependent variable as control. The sample period ranges from 1994 to 2003, inclusive. Variables are further defined in Appendix Table 1. Standard errors are clustered at the parent firm's circuit level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: unscaled pollution

	Dependent variable is ln(1+On-site emissions released into …)					
	Water, Air, and Ground (total on-site)	Water and air	Ground	Water, Air, and Ground	Water and air	Ground
	(1)	(2)	(3)	(4)	(5)	(6)
Share of the parent's emissions in Ninth Circuit × Post	-0.1586**	-0.1959***	-0.0106			
	(-3.11)	(-4.13)	(-0.42)			
Share of the parent's plants in Ninth Circuit × Post				-0.1868**	-0.1847***	-0.0703**
				(-3.04)	(-3.53)	(-2.96)
Controls						
Lagged emissions	Yes	Yes	Yes	Yes	Yes	Yes
Parent firm's assets, age, and count of plants	Yes	Yes	Yes	Yes	Yes	Yes
Components of the interaction	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects						
Parent firm	Yes	Yes	Yes	Yes	Yes	Yes
Chemical × Year	Yes	Yes	Yes	Yes	Yes	Yes
SIC2 industry × Year	Yes	Yes	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	200,082	200,082	200,082	200,082	200,082	200,082
R-squared	0.814	0.819	0.730	0.814	0.819	0.730

Panel B: scaled pollution						
	Dependent variable is					
	Ln(1+On-site emissions released into water and air scaled by …)					
	Number of plants	Sales	Assets	Number of plants	Sales	Assets
	(1)	(2)	(3)	(4)	(5)	(6)
Share of the parent's emissions in Ninth Circuit × Post	-0.1255***	-0.0320*	-0.0292*			
	(-3.30)	(-2.07)	(-1.83)			
Share of the parent's plants in Ninth Circuit × Post				-0.1229*	-0.0497**	-0.0514**
				(-2.15)	(-2.78)	(-2.55)
Controls						
Lagged emissions	Yes	Yes	Yes	Yes	Yes	Yes
Parent firm's assets, age, and count of plants	Yes	Yes	Yes	Yes	Yes	Yes
Components of the interaction	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects						
Parent firm	Yes	Yes	Yes	Yes	Yes	Yes
Chemical × Year	Yes	Yes	Yes	Yes	Yes	Yes
SIC2 industry × Year	Yes	Yes	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	200,082	199,938	199,987	200,082	199,938	199,987
R-squared	0.820	0.850	0.843	0.820	0.850	0.843

Table 10
The Effect of *Iverson* on Production Ratio and Process Abatement

This table uses the OLS regression described in Equation (5) to study the effect of Iverson on production ratio and process-related abatements at the plant-chemical-year level. The sample period ranges from 1994 to 2003, inclusive. Ninth Circuit is a dummy variable taking the value of one for plants located in the Ninth Circuit. Post is a dummy variable taking the value of one on and after 1999. Dependent variable is either production ratio (Columns 1 and 2) or a dummy variable indicating process-related abatements (Column 3 and 4). All chemicals are examined in Columns 1 and 3. Columns 2 and 4 restrict to chemicals that are primarily released into water or air identified as follows: For each plant-chemical-year, I calculate the average share of the chemical that was released into water and air in the focal plant-chemical pair in the preceding three years. Values above median indicate plant-chemical-years that are released into water or air with a high probability in the current year. All regressions include the lag of the dependent variable as well as the lag of on-site emissions into water and air as control. Variables are further defined in Appendix Table 1. Standard errors are clustered at the plants' circuit level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is			
	Production ratio		Dummy (process-related abatement)	
	All chemicals	Chemicals primarily released into water and air	All chemicals	Chemicals primarily released into water and air
	(1)	(2)	(3)	(4)
Ninth Circuit × Post	-0.0226**	-0.0301**	-0.0007	0.0073**
	(-2.28)	(-3.10)	(-0.21)	(2.31)
Controls				
Lagged emissions (water and air)	Yes	Yes	Yes	Yes
Lagged dependent variable	Yes	Yes	Yes	Yes
Fixed effects				
Plant	Yes	Yes	Yes	Yes
Chemical × Year	Yes	Yes	Yes	Yes
SIC2 industry × Year	Yes	Yes	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes	Yes	Yes
Observations	218,170	163,521	218,170	163,521
R-squared	0.280	0.283	0.420	0.426

Table 11
Pollution Reallocation within Parent Firms

This table uses the OLS regression described in Equation (6) to study strategic pollution shifting from plants in the Ninth Circuit to plants owned by the same parents in adjacent states. Dependent variable is the log of one plus on-site emissions released into water or air. Column 1 use as the exposure to Iverson the share of parent firms' water and air on-site emissions that are located in the Ninth Circuit. Column 2 uses as the exposure to Iverson the share of parent firms' plants that are located in the Ninth Circuit. The sample period ranges from 1994 to 2003, inclusive. Ninth Circuit is a dummy variable taking the value of one for plants located in the Ninth Circuit. Adjacent states is a dummy variable taking the value of one for plants located in New Mexico, Utah, Wyoming, South Dakota, and North Dakota. Other states is a dummy variable taking the variable of one for plants located in states outside the Ninth Circuit and excluding adjacent states. Post is a dummy variable taking the value of one on and after 1999. All regressions include the lag of the dependent variable as control. Regressions also control for dual and single combinations of the components of the triple interactions, not tabulated for brevity. Variables are further defined in Appendix Table 1. Standard errors are clustered at the plants' circuit level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is ln(1+On-site emissions released into water and air)	
	(1)	(2)
Ninth Circuit × Share of the parent's emissions in Ninth Circuit × Post	-0.0972***	
	(-6.19)	
Adjacent states × Share of the parent's emissions in Ninth Circuit × Post	0.3273***	
	(5.54)	
Other states × Share of the parent's emissions in Ninth Circuit × Post	-0.0633	
	(-1.23)	
Ninth Circuit × Share of the parent's plants in Ninth Circuit × Post		-0.1366***
		(-4.97)
Adjacent states × Share of the parent's plants in Ninth Circuit × Post		0.3766***
		(3.53)
Other states × Share of the parent's plants in Ninth Circuit × Post		-0.1152*
		(-2.19)
Controls		
Dual and single combinations of interaction components	Yes	Yes
Lagged emissions	Yes	Yes
Fixed effects		
Plant	Yes	Yes
Chemical × Year	Yes	Yes
SIC2 industry × Year	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes
Observations	558,814	558,814
R-squared	0.798	0.798

Table 12
Market Reaction to Delaware's 2022 Amendment to Delaware General Corporation Law

This table uses the OLS regression to study the effect of the 2022 amendment to Delaware General Corporation Law on risk adjusted cumulative abnormal returns. Returns are adjusted for risk using Fama-French five-factor model. Columns 1 and 2 report the results for cumulative abnormal returns around April 28, 2022 (introduction to Senate). Columns 3 and 4 report the results for cumulative abnormal returns around May 12, 2022 (passage by Senate). Columns 5 and 6 report the results for cumulative abnormal returns around June 14, 2022 (passage by the House). The main explanatory variable is a dummy that indicates whether the firm is incorporated in Delaware. All regressions include a constant not reported for brevity. Variables are further defined in Appendix Table 1. Robust standard errors are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is cumulative abnormal returns around …					
	Introduction of the bill to Senate on April 28, 2022		Passage by the Senate on May 12, 2022		Passage by the House on June 14, 2022	
	CAR(-1,+1)	CAR(-1,+5)	CAR(-1,+1)	CAR(-1,+5)	CAR(-1,+1)	CAR(-1,+5)
	(1)	(2)	(3)	(4)	(5)	(6)
Incorporated in Delaware	0.3756**	0.7042**	0.8264***	1.3988***	0.1504	-0.2878
	(2.09)	(2.24)	(3.58)	(4.10)	(0.85)	(-0.84)
Observations	2,703	2,703	2,682	2,682	2,659	2,659
R-squared	0.001	0.001	0.003	0.005	0.000	0.000

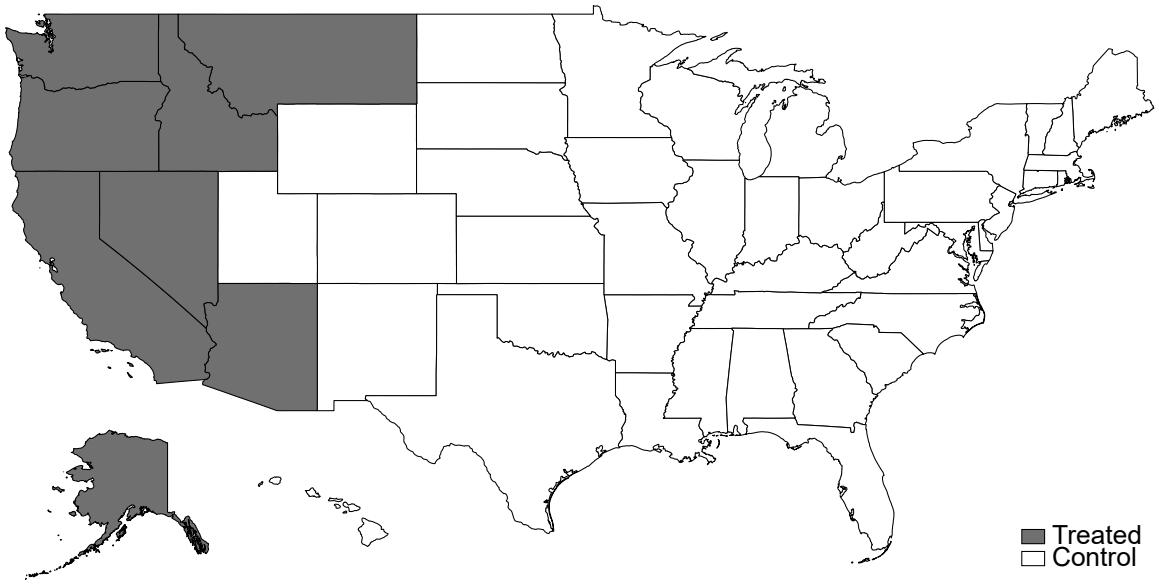


Figure 1
The *Iverson* Shock, Treatment and Control Groups

This map shows the states in the treatment and control groups. The treatment group is the set of states located in the Ninth Circuit. The control group is the set of states located outside the Ninth Circuit.

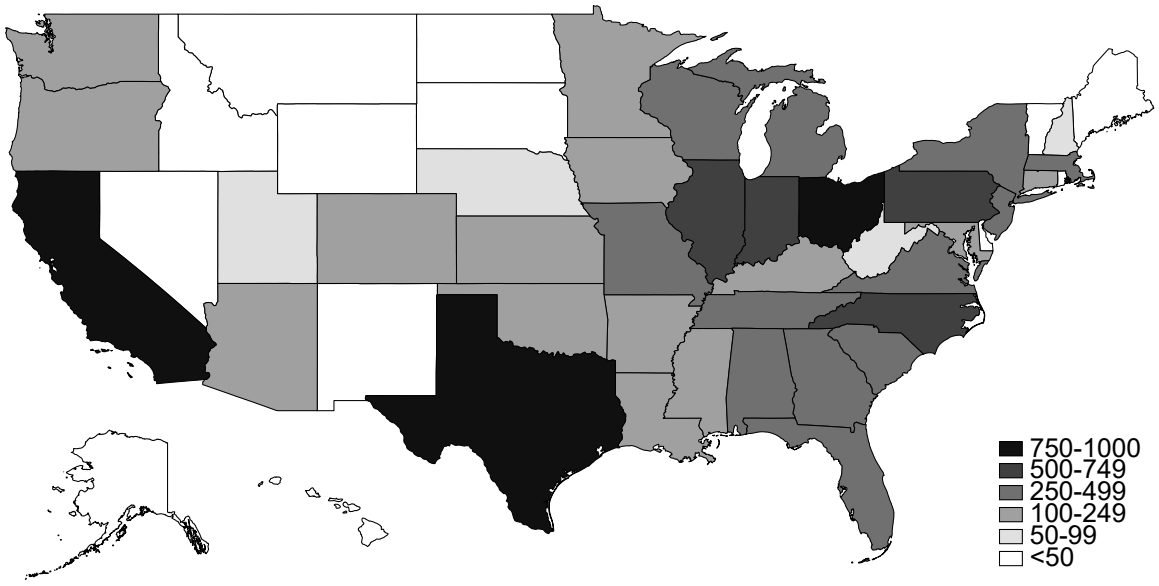
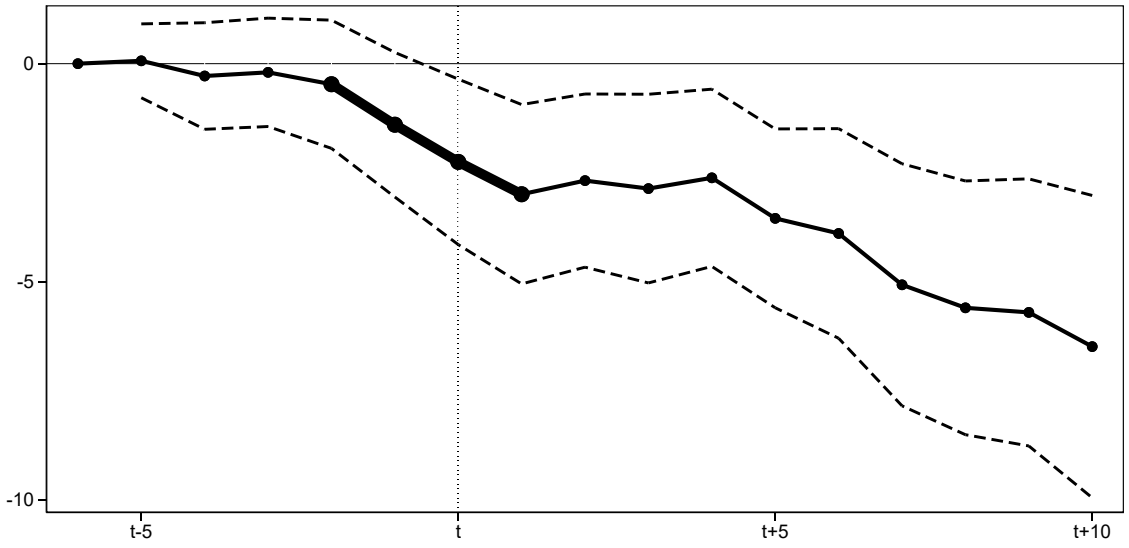


Figure 2
Distribution of TRI Plants Owned by Publicly Traded Parent Firms Across the U.S.

This map shows, in bins, the count of distinct plants reported in TRI owned by publicly traded US firms in each U.S. state. The map corresponds to the baseline sample period in this study, 1994 to 2003.

Panel A: Exposure Measured Using the Share of Parent's Emissions in Ninth Circuit



Panel B: Exposure Measured Using the Share of Parent's Plants in Ninth Circuit

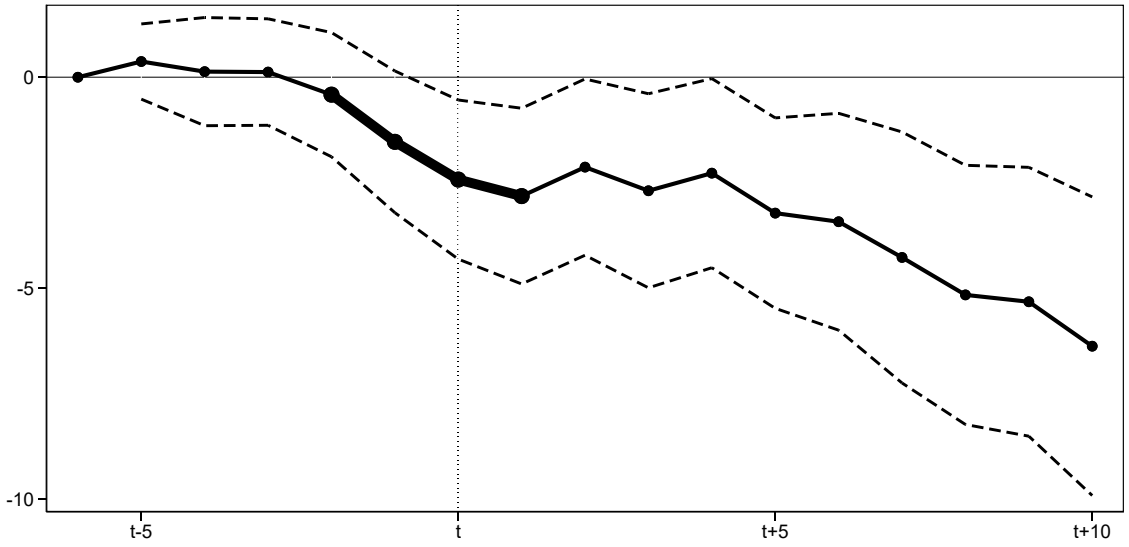


Figure 3
Daily Cumulative Abnormal Returns Around *Iverson* Decision Date

This figure shows the coefficient dynamics for cumulative abnormal returns around the *Iverson* decision. The sample is at the firm-event day level. The dependent variable is the cumulative abnormal return on each event day since day -5 up to 10 days after *Iverson*. Returns are adjusted for risk using Fama-French five-factor model. The figure is constructed by regressing CARs on 16 separate sets of interaction variables between the parent firm's exposure to *Iverson* and 16 indicators for event days -5 through +10. The regression also includes 16 dummies for each event day:

$$\mathrm{CAR}[-5, \mathrm{j}]_{\mathrm{f}} = \sum_{\mathrm{j}=-5}^{+10} \alpha_{\mathrm{j}} \times \mathrm{exposure}_{\mathrm{f}} \times \mathbb{I}(\text{event day} = \mathrm{j}) + \sum_{\mathrm{j}=-5}^{+10} \beta_{\mathrm{j}} \times \mathbb{I}(\text{event day} = \mathrm{j})$$

In the above equation, f and j refer to firm and event day, respectively. This graph plots the α coefficients along with 95% confidence intervals. Exposure to *Iverson* is measured using the share of the parent firm's water and air on-site emissions in the Ninth Circuit (Panel A) and the share of plants located in the Ninth Circuit (Panel B). The thick line indicates the evolution of CARs during the [-1,+1] window.

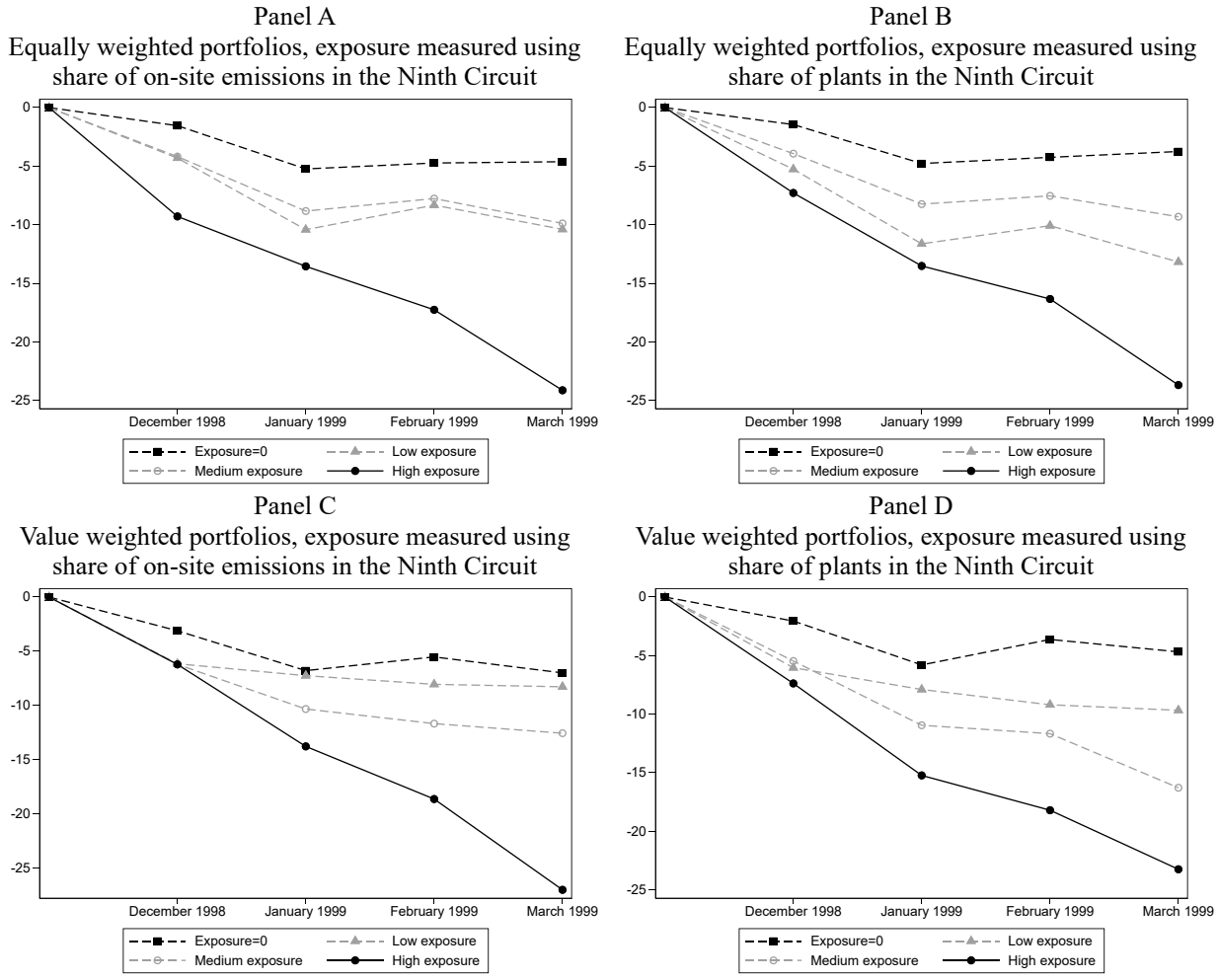


Figure 4
Monthly Cumulative Abnormal Returns on Portfolios Sorted on Exposure to *Iverson*

This figure shows the monthly cumulative abnormal returns of portfolios sorted on exposure to *Iverson*. Exposure to *Iverson* is measured using the share of the parent firm's water and air on-site emissions in the Ninth Circuit (Panel A and Panel C) and the share of plants located in the Ninth Circuit (Panel B and Panel D), both in 1998. For every portfolio, monthly returns are first adjusted for risk using Fama-French five-factor model with factor loadings estimated over 60 monthly returns during 1993 through 1997. The risk adjusted monthly returns are then accumulated to calculate the monthly cumulative abnormal returns.

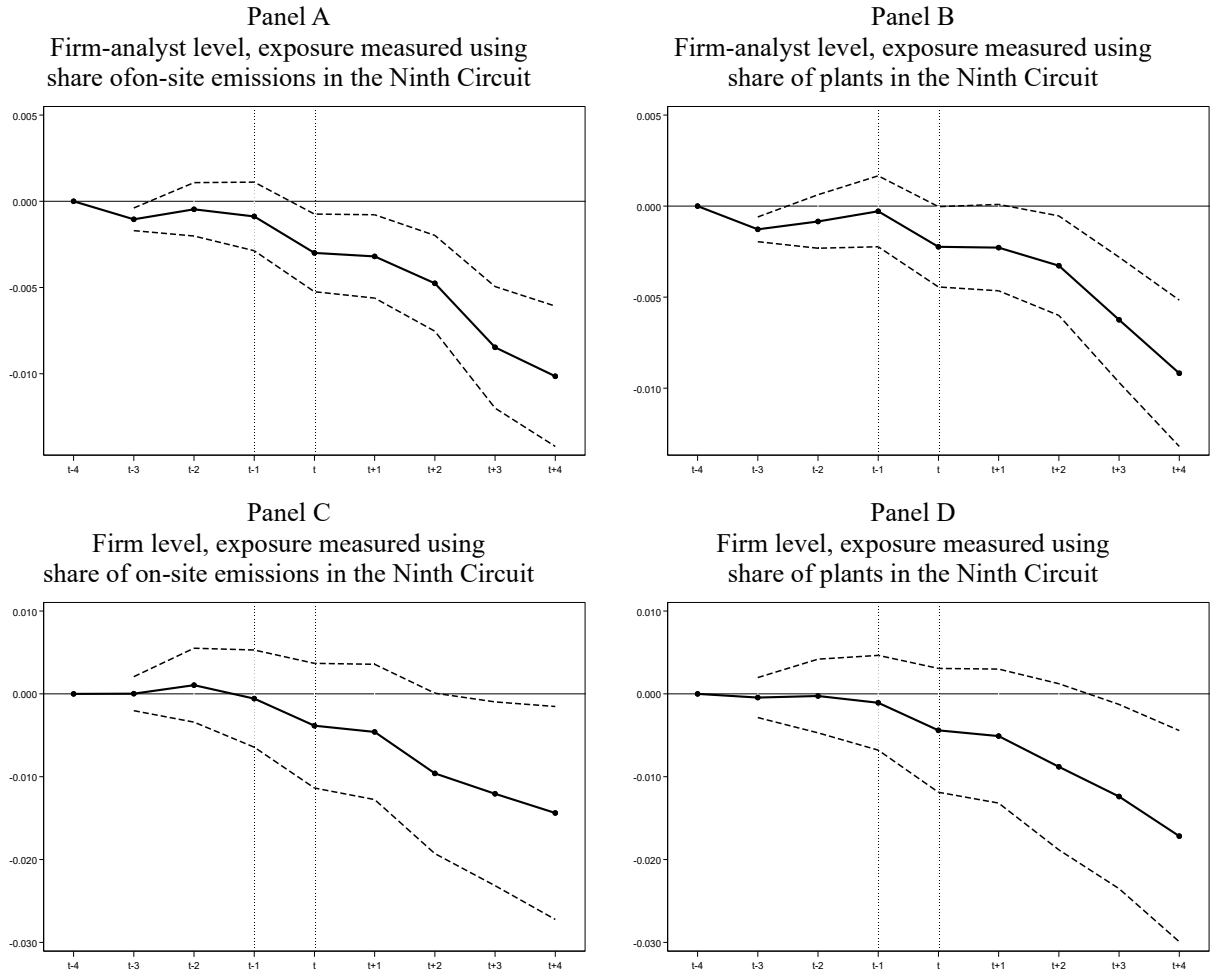


Figure 5
Earnings Forecast Revisions Around *Iverson* Decision Date

This figure shows the coefficient dynamics for analysts' earnings forecast revisions around the *Iverson* decision. Panel A presents the graph at the parent firm-analyst level, measuring exposure to *Iverson* by the share of on-site emissions located in the Ninth Circuit. Panel B presents the graph at the parent firm-analyst level, measuring exposure to *Iverson* by the share of plants located in the Ninth Circuit. Panel C presents the graph at the parent firm level, measuring exposure to *Iverson* by the share of on-site emissions located in the Ninth Circuit. Finally, Panel D presents the graph at the parent firm level, measuring exposure to *Iverson* by the share of plants located in the Ninth Circuit. The dependent variable is the earnings forecast revisions in each of the event periods surrounding *Iverson* relative to the event period t-4. Each event period is equivalent to 30 calendar days measured relative to the *Iverson* decision date. The figure is constructed by regressing forecast revisions on 8 separate sets of interaction variables between the parent firm's exposure to *Iverson* and 8 indicators for event periods -3 through +4. The regression also includes 8 dummies for each event period. Specifically:

$$\text{Forecast Revision}[-4,\text{j}]_{\text{f or f,analyst}} = \sum_{\text{j}=-3}^{+4} \alpha_{\text{j}} \times \text{exposure}_{\text{f}} \times \mathbb{I}(\text{event period} = \text{j}) + \sum_{\text{j}=-3}^{+4} \beta_{\text{j}} \times \mathbb{I}(\text{event period} = \text{j})$$

In the above equation, *j*, *f*, and *analyst* indicate event period, firm, and analyst, respectively. This graph plots the α coefficients along with 95% confidence intervals.



Figure 6
Effect of *Iverson* on On-site Water and Air Emissions, Coefficient Dynamics

This figure shows the coefficient dynamics for water and air emissions around the *Iverson* decision. The sample is at the plant-chemical-year level. The figure is constructed by regressing the log of one plus on-site emissions into water or air on nine separate sets of interaction variables: Interactions between a dummy variable indicating whether the plant is located in the Ninth Circuit and nine indicators for years 1994 through 1996 and 1998 through 2003. This graph plots the coefficients on these nine interactions along with 95% confidence intervals. The regression includes fixed effects for plant, chemical-year, and SIC2 industry-year.

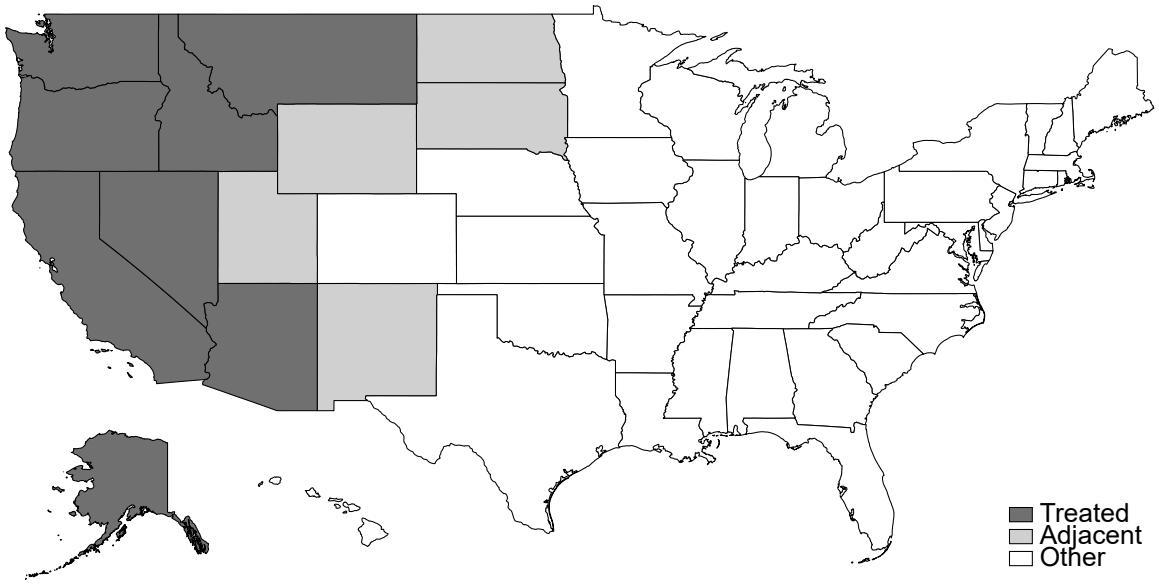


Figure 7
Parent Firm Pollution Reallocation; Treated, Adjacent, and Other Groups

This map shows the classification of states used in the analysis of parent firms' pollution shifting after *Iverson*. The states in dark gray are the "treated" states located in the Ninth Circuit. The states in light gray are considered "adjacent" to the Ninth Circuit due to sharing common border with it. The remainder of the states are considered as "other" states.

Appendix Table 1
Variable Definitions

Variables used in the analysis of shareholder value	
Name	Definition
- CAR	Cumulative abnormal returns during various windows around the event date. Event date is either December 11, 1998, or November 5, 1997. Before accumulating, daily returns are adjusted for risk using Fama-French five factor model. To estimation of the risk model is based on 100 trading days ending 10 days before the event. Event windows start from one day before the event and continue until 0, 1, 5, and 10 trading days after the event. The corresponding CAR variables are CAR(-1,0), CAR(-1,+1), CAR(-1,+5), and CAR(-1,+10), respectively.
- Earnings forecast revision	The difference between earning forecasts N periods after the event date and the earning forecast one period before the event date. Each period is equivalent to 30 calendar days. Event date is either December 11, 1998, or November 5, 1997. EPS forecasts are first scaled by stock price and converted to earning yields. At the parent firm level, the consensus forecast is measured as the mean of the forecasts across all analysts. The forecast revision is calculated using the consensus forecasts.
Parent firm's exposure to *Iverson*	
Name	Definition
- Share of the parent's emissions in Ninth Circuit	Ratio of the on-site emissions released in the Ninth Circuit to total on-site emissions. Only emissions into water and air are used. Emissions are aggregated across all chemicals at the parent firm-year level.
- Share of the parent's plants in Ninth Circuit	Ratio of the count of plants located in the Ninth Circuit to total count of plants owned by the parent firm.
Variables used in the analysis of toxic emissions	
Name	Definition
- On-site emissions	The on-site emissions into various pollution media (i.e., water, air, and ground) as denoted in the variable name. On-site emissions are denoted in pounds and summed up with one before taking logarithms. This variable is either measured at the plant-chemical-year level or aggregated at the parent firm-chemical-year level. Water on-site emissions are emissions indicated as released into water by TRI. Air on-site emissions are emissions indicated by TRI as released into fugitive and stack air. Ground on-site emissions are total on-site emissions minus water and air on-site emissions.
- Production ratio	The ratio of the level of the plant's production in current year to the production level in the prior year. This variable is directly adopted from EPA's Pollution Prevention dataset and reported separately for each plant-chemical-year pair.
- dummy (process-related abatements)	A dummy variable indicating if the plant has invested in any process-related abatement activities in the current year. This variable is directly adopted from EPA's Pollution Prevention dataset and reported separately for each plant-chemical-year pair.

Parent firm's outputs	
Name	Definition
- ROA	NI/AT from Compustat
- Profit margin	NI/SALE from Compustat
- Sales to assets	SALE/AT from Compustat
- Total Cost/Sales	(COGS+SG&A)/SALE from Compustat
- COGS/Sales	COGS/SALE from Compustat
- SG&A/Sales	XSGA/SALE from Compustat
- Total compensation	TDC1 from Execucomp
- Salary compensation	SALARY from Execucomp
- Non-salary compensation	TDC1 – SALARY from Execucomp
- Volatility of ROA	Volatility of annual ROA, calculated for 1994-1998 and 1999-2003, and requiring at least three non-missing observations in each period.
- Volatility of profit margin	Volatility of annual profit margin, calculated for 1994-1998 and 1999-2003, and requiring at least three non-missing observations in each period.
Industry variables	
Name	Definition
- Industry pollutiveness	The count of chemicals in which a SIC3 industry is considered highly pollutive. Industry pollutiveness is measured using 1992 data. To evaluate whether an industry is highly pollutive in a specific chemical, I calculate its per-plant emissions in that chemical. The industry is considered highly pollutive in that specific chemical if it is among the top quintile of polluters.
- Shipment value	VSHIP from NBER-CES Manufacturing Industry Database
- Value added	VADD from NBER-CES Manufacturing Industry Database
- Hours worked	PRODH from NBER-CES Manufacturing Industry Database
- Δ Establishment count	The annual change in the count of establishments in a SIC3 industry-state pair from County Business Pattern.

Appendix Table 2
Industries of Plants in TRI Data

This table presents the industries of plants included in the TRI data and owned by publicly traded firm for the sample period of this study, 1994 through 2003. For each industry, the table also reports the average annual share of plants belonging to that industry.

SIC2 industry	Industry name	Average share of plants (%)
28	Chemicals and Allied Products	17.1590
34	Fabricated Metal Products, Except Machinery and Transportation Equipment	11.0268
37	Transportation Equipment	9.5271
36	Electronic and Other Electrical Equipment and Components, Except Computer Equipment	8.0236
33	Primary Metal Industries	7.9648
35	Industrial and Commercial Machinery and Computer Equipment	7.9252
20	Food and Kindred Products	7.7530
30	Rubber and Miscellaneous Plastics Products	6.4250
26	Paper and Allied Products	4.0458
32	Stone, Clay, Glass, and Concrete Products	3.3510
24	Lumber and Wood Products, Except Furniture	3.0334
38	Measuring, Analyzing, and Controlling Instruments; Photographic, Medical, and Optical Goods; Watches and Clocks	2.4265
51	Wholesale Trade - Nondurable Goods	2.2416
29	Petroleum Refining and Related Industries	2.1172
25	Furniture and Fixtures	1.9108
27	Printing, Publishing, and Allied Industries	1.2210
22	Textile Mill Products	1.1931
39	Miscellaneous Manufacturing Industries	1.1374
49	Electric, Gas, and Sanitary Services	0.4696
10	Metal Mining	0.2345
21	Tobacco Products	0.1994
73	Business Services	0.1661
31	Leather and Leather Products	0.1400
23	Apparel and Other Textile Products	0.0977
12	Coal Mining	0.0644
87	Engineering, Accounting, Research, and Management Services	0.0634
50	Wholesale Trade - Durable Goods	0.0319
44	Water Transportation	0.0159
45	Transportation by Air	0.0131
14	Mining and Quarrying of Nonmetallic Minerals, Except Fuels	0.0067
75	Automotive Repair, Services, and Parking	0.0035
76	Miscellaneous Repair Services	0.0034
16	Heavy Construction, Except Building	0.0032
2	Agriculture Production - Livestock and Animal Specialties	0.0032
42	Motor Freight Transportation and Warehousing	0.0019

Appendix Table 3
Persistence of Cumulative Abnormal Returns in Long Run

This table replicates the results in Panel A of Table 3 for CARs in longer windows. Variables are further defined in Appendix Table 1. Robust standard errors are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Market response to the Ninth Circuit Court's decision on December 11, 1998

	Dependent variable is					
	CAR (-1,+30)	CAR (-1,+60)	CAR (-1,+90)	CAR (-1,+30)	CAR (-1,+60)	CAR (-1,+90)
	(1)	(2)	(3)	(5)	(6)	(7)
Share of the parent's emissions in Ninth Circuit	-7.0687***	-14.8601***	-17.7696**			
	(-2.59)	(-3.21)	(-2.35)			
Share of the parent's plants in Ninth Circuit				-9.3131***	-18.2798***	-23.3762***
				(-3.38)	(-3.74)	(-2.95)
Observations	786	786	786	786	786	786
R-squared	0.012	0.019	0.013	0.021	0.029	0.023

Appendix Table 4
Breaking Down the Effect of Iverson on Emissions in Harmful and Non-classified Chemicals

This table replicates the analysis of Panel A's second Column in Table 8. conditional on chemicals' level of human harm. Variable definitions and regression specifications are identical to those in Table 8. Column 1 restricts the sample of plant-chemical-years to chemicals listed on the Integrated Risk Information System (IRIS) as harmful to humans. Column 2 restricts to the remainder of the chemicals not included in the IRIS. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is	
	ln(1+On-site emissions released into water and air)	
	Harmful chemicals	Non-classified chemicals
	(1)	(2)
Ninth Circuit × Post	-0.0866***	-0.0834***
	(-5.07)	(-3.49)
Controls		
Lagged emissions	Yes	Yes
Fixed effects		
Plant	Yes	Yes
Chemical × Year	Yes	Yes
SIC2 industry × Year	Yes	Yes
Parent headquarters circuit × Year	Yes	Yes
Observations	311,454	249,709
R-squared	0.793	0.794

Appendix Table 5
Robustness to Using Parent Firms' 1998 Exposures to *Iverson*

This table replicates the key firm-level results using 1998 exposures to the Ninth Circuit, instead of time varying exposures. Panel A and Panel B correspond to Table 5. Panel C and Panel D correspond to Table 9. Panel E corresponds to Table 11. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: The effect on profitability

Dependent variable is:	ROA (Net income/Assets)	Profit margin (Net income/Sales)	ROA (Net income/Assets)	Profit margin (Net income/Sales)
	(1)	(2)	(3)	(4)
Share of the parent's emissions in Ninth Circuit in 1998 × Post	-0.0204*	-0.0248*		
	(-1.92)	(-1.82)		
Share of the parent's plants in Ninth Circuit in 1998 × Post			-0.0322***	-0.0517***
			(-3.02)	(-3.59)
Observations	7,167	7,166	7,167	7,166
R-squared	0.573	0.603	0.573	0.603

Panel B: The effect on components of profitability

Dependent variable is:	ln(Sales /Assets)	ln(Total cost /Sales)	ln(COGS /Sales)	ln(SG&A /Sales)	ln(Sales /Assets)	ln(Total cost /Sales)	ln(COGS /Sales)	ln(SG&A /Sales)
Share of the parent's emissions in Ninth Circuit in 1998 × Post	-0.1165***	0.0087	0.0186	0.0128				
	(-3.98)	(0.95)	(1.53)	(0.64)				
Share of the parent's plants in Ninth Circuit in 1998 × Post					-0.0759**	0.0180*	0.0144	0.0132
					(-1.99)	(1.84)	(1.23)	(0.59)
Observations	7,166	7,166	7,166	7,002	7,166	7,166	7,166	7,002
R-squared	0.860	0.779	0.931	0.955	0.859	0.779	0.931	0.955

Panel C: The effect on parent firms' unscaled pollution						
Dependent variable is						
	ln(1+On-site emissions released into …)					
	Water, Air, and Ground (total on-site)	Water and air	Ground	Water, Air, and Ground	Water and air	Ground
	(1)	(2)	(3)	(4)	(5)	(6)
Share of the parent's emissions in Ninth Circuit in 1998 × Post	-0.1804**	-0.1874***	-0.0482			
	(-2.52)	(-3.30)	(-1.27)			
Share of the parent's plants in Ninth Circuit in 1998 × Post				-0.1249**	-0.1158**	-0.0954**
				(-2.53)	(-2.79)	(-2.83)
Observations	186,583	186,584	186,585	186,586	186,587	186,588
R-squared	0.816	0.822	0.733	0.816	0.822	0.733
Panel D: The effect on parent firms' scaled pollution						
Dependent variable is						
	Ln(1+On-site emissions released into water and air scaled by …)					
	Number of plants	Sales	Assets	Number of plants	Sales	Assets
	(1)	(2)	(3)	(4)	(5)	(6)
Share of the parent's emissions in Ninth Circuit in 1998 × Post	-0.1255**	-0.0333	-0.0229			
	(-2.53)	(-1.72)	(-1.04)			
Share of the parent's plants in Ninth Circuit in 199 × Post				-0.0607	-0.0346**	-0.0301*
				(-1.28)	(-2.57)	(-2.08)
Observations	186,583	186,445	186,510	186,583	186,445	186,510
R-squared	0.825	0.855	0.849	0.825	0.855	0.849

Panel E: Pollution shifting within parent firms		
	Dependent variable is	
	ln(1+On-site emissions released into water and air)	
	(1)	(2)
Ninth Circuit × Share of the parent's emissions in Ninth Circuit in 1998 × Post	-0.1517***	
	(-7.89)	
Adjacent states × Share of the parent's emissions in Ninth Circuit in 1998 × Post	0.1879*	
	(2.08)	
Other states × Share of the parent's emissions in Ninth Circuit in 1998 × Post	-0.0541	
	(-0.98)	
Ninth Circuit × Share of the parent's plants in Ninth Circuit in 1998 × Post		-0.0538
		(-1.76)
Adjacent states × Share of the parent's plants in Ninth Circuit in 1998 × Post		0.3345***
		(4.42)
Other states × Share of the parent's plants in Ninth Circuit in 1998 × Post		-0.0699
		(-1.34)
Observations	534,448	534,448
R-squared	0.800	0.800

Appendix Table 6
Robustness to Plants Close to the Border of Ninth Circuit

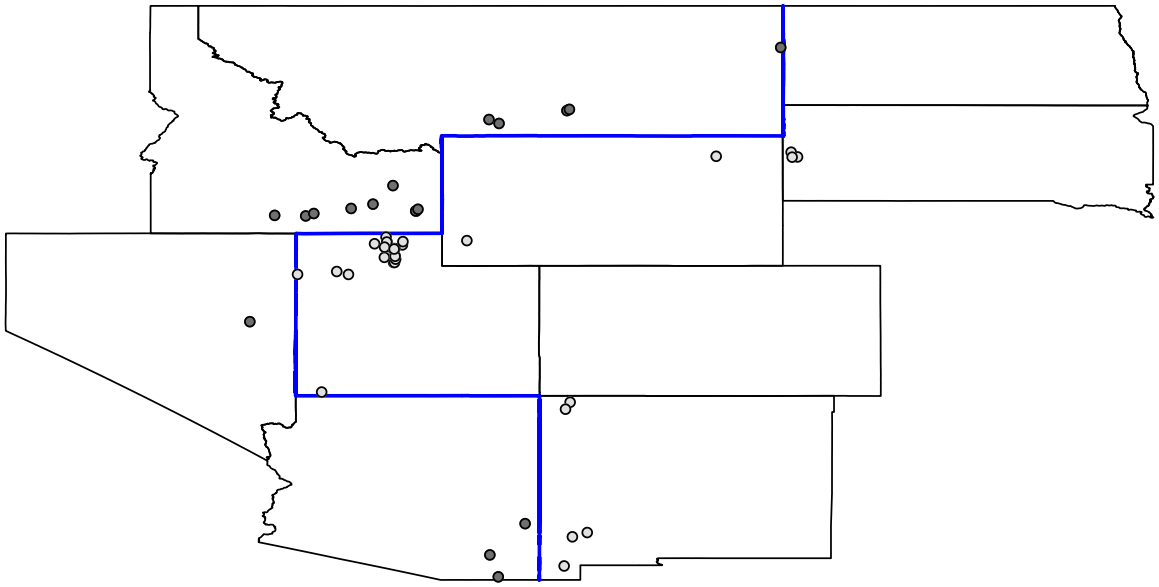
This table replicates the main plant-level results, limiting to plants that are located within a 100 km distance around the Ninth Circuit border. The specification in Columns 1 through 3 of Panel A correspond to that of Panel B of Table 8. Columns 4 and 5 of Panel A correspond to Columns 1 and 3 of Table 10, respectively. The specification in Panel B corresponds to that of Table 11. Standard errors are clustered by circuit-SIC2 industry pairs. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Emissions, production, and abatement

	Dependent variable is				
	ln(1+on-site emissions released into …)				
	Water, Air, and Ground (total on-site)	Water and air	Ground	Production ratio	Process-related abatement
	(1)	(2)	(3)	(4)	(5)
Ninth Circuit × Post	-2.1498***	-2.2129***	0.3600	-0.4299***	0.0856**
	(-4.52)	(-4.42)	(1.04)	(-5.29)	(2.55)
Observations	3,235	3,235	3,235	1,105	1,105
R-squared	0.822	0.839	0.811	0.672	0.774

Panel B: Pollution shifting

	Dependent variable is	
	ln(1+On-site emissions released into water and air)	
	(1)	(2)
Ninth Circuit × Share of the parent's emissions in Ninth Circuit × Post	3.1796	
	(1.45)	
Adjacent plants × Share of the parent's emissions in Ninth Circuit × Post	9.9481**	
	(2.90)	
Ninth Circuit × Share of the parent's plants in Ninth Circuit × Post		-7.7232**
		(-2.50)
Adjacent plants × Share of the parent's plants in Ninth Circuit × Post		9.1404**
		(2.85)
Observations	3,199	3,199
R-squared	0.839	0.840



Appendix Figure 1
Treated and Control Plants Located Close to the Ninth Circuit Border

This figure presents the treated and control plants located within a 100 km distance from the Ninth Circuit border which is highlighted in bold. The dark gray and light gray circles indicate the treated and control plants, respectively.