Fresh Start or Fresh Water: The Impact of Environmental Lender Liability

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Abstract

This paper investigates how the environmental liability of lenders affects debtors' behavior. I use U.S. Census Bureau micro-data and the passage of the Lender Liability Act as a novel identification strategy to answer this question. Firms increase on-site pollution, cut investment in abatement technology, and incur 17.54% more environmental regulatory violations when secured lenders become less responsible for the cleanup cost of their collateral. This lower environmental compliance slightly benefits employment, but does not change wages or production. Overall, reduced lender liability lessens banks' incentives to influence the environmental practices of their debtors with limited benefit on economic growth.

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1 Introduction

The traditional role of lenders is to provide capital to firms and ensure that loans are repaid (Freixas and Rochet (2008)). However, a recent and popular view suggests that financial intermediaries have a critical role in promoting better environmental practices.[1] Should lenders be responsible for correcting societies' negative externalities, and if so, does it create any economic distortion? To be precise, lenders' environmental responsibility means that lenders incur a cost —lower deposits or fewer clients, legal liabilities, or a utility cost to the bank's owner— if their debtors implement non-sustainable environmental practices. In this paper, I focus on one type of cost: the legal liability that lenders face if their debtors pollute.

According to a "financial constraint channel," the model of Pitchford (1995) shows that reducing environmental lender liability decreases the cost of capital and therefore leads to additional investment in abatement activities that lower pollution levels. This decrease in the cost of capital can also promote investment, which fosters economic growth. Given these alleged benefits, legal systems in developed countries protect lenders from the environmental liability attached to their collateral (PRI, UNEP FI, The Generation Foundation (2021)).

At the same time, lower environmental lender liability lessens lenders' incentives to screen and monitor the environmental compliance of their debtors' collateral (Balkenborg (2001), Heyes (1996), Shavell (1997)), thus leading to reduced investment in abatement activities and more pollution, supporting an "influence channel." Consistent with this channel, stricter environmental lender liability rules are often advocated to promote the influence of lenders on debtors' Environmental, Social, and Governance (ESG) policies (United Nations Environment Programme (2015)).

[1]Recent works suggest that corporations have a role to take into account the wellbeing of other stakeholders (Bénabou and Tirole (2010), Hart and Zingales (2017)). Several examples in the popular press support this idea for banks. For example, "Banks are demanding much stricter environmental criteria when financing shipping companies" (Shipping industry faces ESG heat from lenders, Reuters, October 7, 2021). Moreover, "The biggest U.S. banks are at risk of becoming regulators' enforcement arm for climate matters and other social issues" (Wall Street risks becoming regulators' 'ESG police,' analysts say, Bloomberg, October 26, 2021).

This paper aims to understand which of these two channels dominates empirically and how they interact with production choices. To overcome the endogeneity of legal regimes to environmental outcomes and firms' activities, I use a novel identification strategy relying on a federal law that overruled the opposite liability standards made by courts. Specifically, the Asset Conservation Lender Liability and Deposit Insurance Protection Act (Lender Liability Act, henceforth) of 1996 –one of the most important milestones in US environmental finance law– clarified when and how lenders that use collateralized debt can be subject to environmental liabilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In the United States, environmental spills by bankrupt entities are handled by the Environmental Protection Agency (EPA) under CERCLA, which requires all *responsible parties* to pay for the subsequent environmental cleanup. CERCLA liability is strict, unbounded, joint, and several, implying that one party with a modest contribution to the environmental spill may be required to pay for the entire cleanup, representing $30 million on average in 1995 (Porter (1995)).[2]

Prior to the Lender Liability Act of 1996, the 11th Circuit Court adjudicated in *United States v. Fleet Factors Corp (11th Cir. 1990)* that any lender holding a security interest in a facility with the capacity to influence the environmental practices of their debtors could be held responsible for environmental cleanup costs. After the Lender Liability Act of 1996, this "capacity-to-influence" test was explicitly suppressed, and only lenders using collateralized debt and interacting with their debtors on a day-to-day basis were exposed to CERCLA liability. Lenders and debtors are subject to the circuit court interpretation regarding CERCLA liabilities where the secured asset is located rather than where the debt contract is signed, making forum shopping irrelevant in this context. Therefore, I compare facilities in the 11th Circuit, where lenders that use collateralized

[2]There is a lingering problem of contaminated areas in the United States. One US resident out of six lives within three miles of a toxic site and is directly exposed to the negative health impacts of pollution. However, federal cleanup programs have decreased by 48% between 1999 and 2020, thus leading to fewer cleanup actions, which were on average divided by 5.9 in the same period (Environment America Research and Policy Center (2021)). At the same time, the risks they pose to local communities and environmental systems have grown higher because of climate change. Climate change causes more severe and intense floods and hurricanes, increasing the risks of having both toxic chemicals moving from contaminated sites to nearby communities and new environmental spills.

debt were more exposed to CERCLA liability, to other facilities in the United States in a difference-in-differences specification around the Lender Liability Act of 1996.[3]

The empirical specifications are estimated using micro-data from the Environmental Protection Agency (EPA) matched to confidential US Census micro-datasets. This novel matching of datasets provides detailed information at the year-facility-chemical level, such as the total amount of toxic releases, environmental violations, abatement investment, production, and stack-air emissions. It also serves as the most reliable source of information on employment, payroll, legal status, ownership structure between plants and an establishment's input costs and quantity. This dataset allows me to both study a rich set of outcomes and improve the identification strategy by including a large set of controls and fixed effects. In particular, I account for industrial, chemical, and legal status time-trends as well as differential usages of chemicals by plants if these usages remain constant during the time-period.

Using the novel natural experiment and dataset, I show that contrary to the theoretical predictions of Pitchford (1995), environmental practices deteriorated in the treated group compared to the control group after 1996. Specifically, for the average facility in my sample, firms in the treated group, where lenders experienced a reduction in the environmental liability of their collateral after 1996, increased on-site pollution by 13.7% and were 17.54% more likely to incur at least one environmental violation compared to firms in the control group.

Several tests show that a drop in production did not drive these worsened environmental practices. I estimate a precise and statistically non-significant zero effect of environmental lender liability on two distinct production measures. Moreover, the magnitudes of the baseline effects remain constant when I account flexibly for an establishment's input quantities and costs as well as real output. Next, I find evidence that process-related abatement activities were reduced by 36.64%, providing direct evidence that treated firms decreased their efforts to reduce pollution.

[3]According to the principle of *stare decisis*, US courts follow the precedents set by other courts. Circuit courts of Appeals have binding authority over their circuit, which implies that lower courts must follow the interpretation they provide.

I then estimate a precise and statistically non-significant zero effect for pollution outcomes that were not regulated under CERCLA —such as stack-air emissions— and therefore not impacted by the reform. This placebo test rules out an explanation where a higher production scale would have mechanically increased all types of pollution. The result is also inconsistent with the view that environmental enforcement would have become stricter after 1996 for the states located in the 11th Circuit, as this would have led to an increase in all types of pollution, not just the types regulated under CERCLA.

How can lenders influence debtors to adopt cleaner practices? Lenders influence their debtors through a pricing and a contractual channel, as shown by an extensive literature. The pricing channel consists in asking for a higher interest rate if the firm pollutes or a lower interest rate if the firm is cleaner (Balkenborg (2001), Heyes (1996), and Shavell (1997)). Consequenlty, firms that pollute have an incentive to reduce pollution, as it will reduce their cost of capital. The contractual channel involves the writing of stricter or additional environmental covenants to directly influence debtors' environmental practices. Such covenants are typical in lending contracts. For instance, Choy et al. (2021) document that US banks write covenants stipulating that debtors should carry out remedial actions, conduct environmental audits, or disclose environmental events.

Several different cross-sectional tests support the view that the effects on pollution outcomes were driven by lenders' influence, consistent with both a pricing and a contractual channel.[4] First, as shown theoretically in Balkenborg (2001), lenders' influence should be more potent when they have more bargaining power. Intuitively, lenders with high bargaining power can increase interest rates or include additional environmental covenants in the debt contract. I proxy bargaining power with the firm's initial leverage, as firms with greater leverage cannot completely switch away from

[4]As with most papers using US databases from the 1990s, I lack comprehensive and high quality contractual data on firms' credit with their banks or suppliers. Chaney, Sraer, and Thesmar (2012), Schmalz, Sraer, and Thesmar (2017), and Adelino, Schoar, and Severino (2015)—among others— measure different sensitivities of investment to local housing price variations according to whether a firm has some characteristics – such as a high level of real estate capital– that make it more likely to have more financing coming from collateralized loans. I adopt a similar approach in this paper. Specifically, I study the cross-sectional responses to the Lender Liability Act for firms that have some characteristics leading us to expect, according to economic theory, a higher treatment effect if the channel were driven by lenders' influence.

debt and are more exposed to their lenders' actions. The choice of this proxy is in line with Gilje, Loutskina, and Murphy (2020), who show that firms with greater leverage are more likely to be subject to lenders' influence. Consistent with the theoretical prediction of Balkenborg (2001) that lenders' influence should increase when lenders have higher bargaining power, the effects on pollution outcomes are stronger for firms with high initial leverage.

Second, in equilibrium, lenders' influence should be stronger when they face a higher expected cost for their debtors' pollution, as predicted by Balkenborg (2001). Lenders that face higher costs if their debtors pollute have stronger incentive to increase the cost of capital (pricing channel) and write additional and stricter environmental covenants (contractual channel) for these firms. These expected costs paid by lenders are higher when firms are close to filing for bankruptcy (CERCLA liability is only created when a firm is bankrupt) and when debtors use more toxic chemicals, which are more likely to create more critical contamination, leading to higher liabilities. I find that the effects on pollution outcomes are more substantial both for firms with a lower Z-score, e.g., those close to filing for bankruptcy, and for those using more toxic chemicals. These tests are consistent with the view that lenders have a greater level of influence over debtors with higher environmental lender liabilities.

Third, lenders' influence should be higher for debtors with some signals of bad environmental practices, as shown theoretically in Lewis and Sappington (2001). I use two proxies for higher environmental risks: whether the firm is experiencing a minor environmental contamination, as in the theoretical model of Lewis and Sappington (2001), and the age of the facility. Old facilities are more prone to leakages, as they have been eroded by past production and time. As stated by Barclays[5] in its first "key considerations" to evaluate the environmental risks of a firm: "How long has the site been used for this purpose? The contamination risk increases with time." In line with stronger lenders' influence when debtors have signals of higher environmental risks, the effects on pollution are more substantial for firms that are currently experiencing a minor environmental contamination or for establishments that are older. Overall, these distinct cross-sectional tests

[5]Environmental and Social Risk Briefing (ESRB), Barclays, Version 6.0 March 2015, page 18

support the view that the observed effects are driven by lenders' influence efforts, either through a contractual or an influence channel(s).

I then quantify the incidence of this decreased environmental compliance on employment and wages. Understanding this incidence is part of an important and controversial debate on whether environmental regulation imposes costly job transitions for workers at regulated firms or creates a demand for workers to comply with the additional tasks created by the regulation.[6] Consistent with a trade-off between protecting the environment and job creation, firms that are less influenced by their secured lenders to adopt better environmental practices experience an increase in employment of 2.08%, with no significant impact on wages. As capital investment in pollution-reduction projects contracted and production remained the same, the results support a substitution of labor at the expense of capital.

The identifying assumption of the difference-in-differences specification is that treated and untreated firms would have evolved similarly in the absence of the legal change, conditional on the fixed effects and time-varying controls. While this assumption cannot be directly tested, I present several pieces of evidence suggesting that this assumption is likely to be met empirically. Specifically, I plot a dynamic event study to show that the effects are not driven by a pre-trend before 1996. I then show that 12 variables defined at the state level and capturing economic activity, tax systems, and government fiscal health did not evolve differently after 1996 for the states in the treated group, thus ruling out an explanation that the results are driven by a salient and concomitant state-level macroeconomic shock.

I run several robustness tests to ensure the validity of the results. Specifically, I report coefficients from 368 different regressions that explore all the possible combinations of controls and fixed effects to transparently show how a specific set of controls affects the results, in a way similar to the specification curves of Simonsohn, Simmons, and Nelson (2019) and Cookson (2018). I then

[6]For examples of this debate of environmental regulation on job creation in the popular press, see for instance "Biden's Big Bet: Tackling Climate Change Will Create Jobs, Not Kill Them" (The New York Times, July 2021), "Joe Biden's climate-friendly energy revolution: What it will take to fight rising temperatures" (The Economist, February 2021).

replicate the results with different measures of pollution and distinct approaches to constructing the sample.

Overall, the findings are consistent with the view that increasing secured lenders' environmental liability aligns the incentives between lenders and local communities to minimize both the probability of environmental toxic releases and the economic distortions on production caused by better environmental practices. It suggests, contrary to the conventional view held by US regulators and practitioners,[7] that lenders that use collateralized debt have the technology to influence their debtors to implement more environmentally friendly practices while minimizing the economic distortions caused to production. While a complete welfare analysis is outside the scope of this paper, the results are consistent with the idea that stronger environmental lender liability promotes sustainable growth.

This paper contributes to the literature on limited liability. It presents the first empirical evidence of lending theories on vicarious liability,[8] studying environmental safety decisions and production outcomes when a lender is liable for the actions of another party. This literature is mostly theoretical, with papers predicting either positive (Heyes (1996), Shavell (1997)), negative (Pitchford (1995)), or ambiguous effects (Boyer and Laffont (1997), Balkenborg (2001)) of increased liability on environmental safety, depending on parameters—such as the extent of contractual completeness—that are difficult to measure. The closest empirical paper on vicarious liability is Akey and Appel (2021), which addresses how the exposure of parent companies to the environmental liabilities of their subsidiaries shape their environmental and production outcomes. In contrast, my paper examines how lenders that use collateralized debt (instead of parent companies) impact their debtors (instead of their subsidiaries) when their environmental liability changes. Parent companies differ from lenders in several important dimensions. Specifically, parent companies have formal control rights over their subsidiaries, contrary to lenders. Lenders are more

[7] See for instance BMO Asset Management in the context of ESG engagement: "a hurdle for greater activism among fixed-income investors is that bonds don't give investors formal ownership rights as stocks do" in *UK Pushes Bond Investors to Take Up More Corporate Activism* (Bloomberg, 11/24/2020)

[8] Naaraayanan and Nielsen (2021) study the role of vicarious liabilities in the context of board of directors.

exposed to asymmetric information when they contract with their debtors, while parent companies have more information.

This paper also relates to studies that examine how environmental claims are treated in bankruptcy (Wittry (2021), Boomhower (2019)). Specifically, Ohlrogge (2020) and Chen et al. (2022) analyze how the dischargeability of RCRA (Resource Conservation and Recovery Act) cleanup claims in Chapter 11 bankruptcy affects environmental decision outcomes. However, I depart from these papers in several ways. I study cleanups conducted by the EPA under the CERCLA statutes instead of RCRA as in Ohlrogge (2020) and Chen et al. (2022). The dischargeability of environmental claims concerns all debt structures, while in my setting, I am able to isolate the effect of collateralized debt. Moreover, the non-dischargeability of environmental cleanup claims is fundamentally different from environmental lender liability. More specifically, the non-dischargeability of environmental cleanup claims in bankruptcy implies that banks' raw payoffs cannot be negative when assets are foreclosed upon, contrary to CERCLA liability, where any lender using collateralized debt faces unbounded costs if found liable for the cleanup cost. Finally, the use of US Census Bureau data allows me to investigate whether the effects on pollution are driven by changes in production and quantify the impact on employment and wages.

This paper also adds to the economic literature using administrative data to estimate the distortions of major US federal environmental regulations on employment. The papers by Walker (2011, 2013) are most similar according to this dimension. In contrast, Walker studies the impact on labor outcomes following the amendments to the Clean Air Act, while I study, for the first time, the impact on labor outcomes of the 1996 amendment to CERCLA, which regulates hazardous waste instead of air releases.

This paper also augments the literature on the role of collateral constraints, which investigates how the ability to pledge collateral affects the *level* of production, employment, technology and business creation (Haselmann, Pistor, and Vig (2010), Vig (2013), Gilje, Loutskina, and Murphy (2020), Mann (2018), Ersahin (2020), Aretz, Campello, and Marchica (2020), Ersahin, Irani, and Waldock (2021), Fonseca and Van Doornik (2021)). This paper suggests that legal aspects affecting the liquidation value of collateral –namely exposure to environmental liabilities– also impact the *type* of production; that is, whether production is made in a specific way, in our case using more environmentally friendly practices.

Finally, this paper contributes to the literature on sustainable finance. Recent papers have investigated how lenders that communicate as being sustainable affect their debtors' environmental behaviors (Houston and Shan (2022), and Kacperczyk and Peydró (2021)), following a literature that studied related questions for shareholders (Chu and Zhao (2019), Naaraayanan, Sachdeva, and Sharma (2019), Brandon et al. (2020), Bellon (2020), Krueger, Sautner, and Starks (2020)).[9] In contrast, this paper takes a legal definition of environmental responsibility and focuses on a setting where this responsibility changes for lenders. This approach mitigates the concern that lenders' environmental commitments and debtors' environmental outcomes are jointly affected by an omitted variable, such as future environmental regulations. In another departure from this literature, this paper considers the joint impact of lenders' influence through a change in the cost of capital and direct engagements through covenants, while previous papers study these questions independently, even though banks apply both approaches. Finally, other works have studied how broad differences in legal systems affect corporate social responsibility (Liang and Renneboog (2017)). The results of this paper highlight the role of environmental liability rules in explaining the relationship between legal systems and corporate social responsibility.

2 Institutional Background

In this section, I present the natural experiment. Subsection 2.1 provides a broad overview of the two main federal statutes that govern environmental regulation in the United States, and subsections 2.2 to 2.4 detail the shocks used in the empirical analysis.

[9]Other factors affecting corporate environmental behaviors include supply chains (Schiller (2018)), CEO preferences (Di Giuli and Kostovetsky (2014), Li, Xu, and Zhu (2021)), financial constraints (Bartram, Hou, and Kim (2021), Xu and Kim (2022), De Haas and Popov (2019), Levine et al. (2019), Bartram, Hou, and Kim (2021), and Cohn and Deryugina (2018)) and competition (Grinstein and Larkin (2020)).

2.1 The Regulation of Pollution in the United States

In 1976, the US Congress passed the Resource Conservation and Recovery Act of 1976 (RCRA). This regulation establishes a set of rules to handle how corporations in the United States manage their hazardous waste. It regulates how hazardous waste should be transported, treated and stored. The RCRA also increases the record-keeping and reporting requirements of facilities handling hazardous waste. Congress directed the EPA (Environmental Protection Agency) to enforce the set of RCRA's rules, where their agents carried out on-site inspections and prosecuted any environmental mismanagement. The RCRA has been called the "cradle to grave" system, as it gives a comprehensive legal framework on how to handle hazardous waste, from generation to disposal.

However, the RCRA does not provide any legal tools to undertake remedial actions against toxic waste sites created before 1976 or address toxic releases from bankrupt entities. These concerns grew particularly relevant at the end of the 1970s, with increasing media attention and public awareness on these matters following the discovery of polluted sites at Love Canal in Niagara Falls (New York) and the "Valley of the Drums" in Sheperdsville (Kentucky). To address these issues, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, (CERCLA, also known as "Superfund"), which President Carter signed on December 11, 1980.[10]

CERCLA provides several tools for the EPA to perform clean of contaminated sites and seeks repayment from *"Potentially Responsible Parties" (PRPs)*. The EPA can carry out the cleanup and ask a PRP to reimburse the expenses. Alternately, the EPA can initiate a court order or issue a unilateral order to compel a PRP to perform the cleanup. Finally, the EPA can enter into a settlement under which one or several PRPs participate in the cleanup.

[10] Whether the two main federal statutes —RCRA and CERCLA— that aim to prevent the release of hazardous waste and contamination have achieved their goals is unclear. In the section D in the online appendix, I characterize this problem in the United States. In short, cleaning up contaminated areas is costly, but federal financing has dropped in the last 20 years despite the many positive social benefits of such actions. The future risks of contamination have increased through the influence of climate change, urbanization, and greater local government indebtness.

As a central tenet, PRPs are liable for the cleanup costs of releasing of a hazardous substance. The principle that governs who is a PRP is that polluters should pay. Polluters generally encompass four types of agents. the current owner and operator, the past owner and operators of the site, the transporters, and the generator that "arranged for disposal or treatment" of the substances at the site. Current owners or operators can also be liable for the environmental liabilities of their past owners, even if they are not directly responsible for the environmental damage. The reason for such a responsibility is to avoid regulatory loopholes that would enable an owner to escape their liabilities by transferring all their current assets to a newly created company.

The liability that CERCLA imposes on PRPs is strict, joint, several and retroactive, as construed by courts and accepted by Congress in the 1986 amendments to CERCLA. Strict liability implies that a PRP is responsible even if it complies with all existing environmental regulations, such as the RCRA, which stipulates how hazardous waste should be handled, stored and treated. Joint and several liabilities mean that a PRP that has contributed minimally to a chemical spill can be responsible for the totality of the cleanup[11]. CERCLA liability is retroactive in the sense that any hazardous release of a toxic substance before 1980 is exposed to CERCLA liability.

There is no limit on the potential liability imposed by CERCLA, despite the high cost of remedial actions. For example, the average cleanup cost in 1995 amounted to approximately $25 to $30 million (Porter (1995)). CERCLA can impose other types of costs, such as punitive damages, in case an order is issued and the PRP does not comply. These punitive damages are capped at $50 million.

The EPA has limited resources and faces a large number of contaminated sites in the United States. Consequently, it carries out remedial actions at sites that present the most significant human and environmental damage risks. These sites are recorded in the National Priorities List (NPL). In April 2021, there were 1,374 sites on this list, with an average score of 43.5. Figure A.5 in the

[11] Unless it is established that apportionment is appropriate. See for instance *United States v. A&F Materials Co. (S.D. I11. 1984)*

online appendix shows each location. The process made by EPA to detect, assess, and decide how to include a site is described in appendix on page xiv.

2.2 The initial secured creditor exemption

The 1980 statute of CERCLA is vague and imprecise[12] on whether secured lenders are excluded from environmental liabilities. The statute excludes "a person, who, without participating in the management of a vessel or facility, holds indicia of ownership primarily to protect his security interest in the vessel or facility." Secured lenders that hold an indicia of ownership cannot be considered as an owner or operator and are subject to environmental liabilities if they do not participate in management activities, which is known as the "secured lender exemption." Several interpretations on the meaning of "participating in the management" have been given by courts.

One of the first court cases to provide an interpretation of the secured lender exemption is *United States v. Mirabile (E.D. Pa. Sept 4, 1985).* Given the importance of this District Court judgment, I expose the facts, the procedural history and the court's rationale for its decision in the online appendix section F. In summary, the court found that secured lenders were not responsible for the environmental cleanup costs as long as they did not interact with the day-to-day production aspects of a business. The day-to-day production aspects of a business include "the participation in operational, production or waste disposal activities" and differ from the financial aspects of a business, such as providing financial advice to a company. The ability to influence and participate indirectly in the financial management of the company was not sufficient to find a secured lender liable.

Several courts adopted a standard close to the Mirabile case before 1996. Figure 1 shows the states where courts adjudicated that some actual participation in the day-to-day aspects of a business was necessary for a secured lender liable to be liable for the cleanup cost of their collateral. In *Hill v. East Asiatic Co. (In re Bergsoe Metal)*, the Court of Appeals did not develop an inter-

[12]"The statutory definition of owner or operator, however, provides courts with little guidance in determining who may be liable as an owner or operator" Madden (1990)

pretation of what constitutes “actual participation in management”. However, it highlighted that “whatever the precise parameters of ’participation,’ there must be some actual management of the facility before a secured creditor will fall outside the exception,” thus rejoining the interpretation of Mirabile.

2.3 Fleet Factors and “capacity to influence”

A radically different interpretation of the secured creditor exemption in US environmental law that I exploit in the identification strategy is the “capacity to influence” test decided in *United States v. Fleet Factors Corp (11th Cir. 1990)*. Given the importance of this judgment, section G of the online appendix contains a case study of the court ruling, where I explore the facts, the procedural history and the court’s rationale for the decision.

Notably, the Court of Appeals for 11$^{\text{th}}$ Circuit stipulated that any lender that has the ability to influence the management team is liable for the cleanup cost in case of environmental contamination by hazardous waste. Actual participation in the activity of the debtor was not required for a lender to be found liable, contrary to *Mirabile*. Secured creditors were responsible if they “could affect hazardous waste disposal decisions if it [they] so chose.” Lenders usually influence how corporations operate their facilities through the use of covenants and on-site inspections, to ensure that the value of their collateral is protected. The judgment implies that such monitoring activities would expose lenders to environmental liability “by participating in the financial management of a facility to a degree indicating a capacity to influence the corporation’s treatment of hazardous wastes.” This new understanding represented a major shift in the way lenders could be held responsible: “the court enunciated a radical new standard for determining lender liability under CERCLA” (Madden (1990)).

Part of the reason why the decision was such a “radical new standard” is that the appeal was held by a quorum of the appellate court panel. Judge Robert S. Vance was a member of the panel but passed away on December 16, 1989. One of the judges was a senior US district judge sitting by designation. As a result, only one member of the ruling committee was a regular judge from the 11th Circuit Court of Appeals.

Following Fleet Factors, the EPA issued a lender liability rule to limit the extent of CERCLA liability (57 Fed.Reg. 18,344 (April 29, 1992)). As soon as the rule was issued, states and chemical manufacturers' associations filed a petition to review it. The rule was vacated in *Kelley v. EPA (D.C. Cir.)* on the grounds that the EPA has no authority to adjudicate the extent of CERCLA liability and that this right is given only to courts.[13]

According to the principle of *stare decisis*, courts in the US follow the precedents set by other courts. Circuit court of Appeals have binding authority over their circuit, which implies that lower courts must follow the interpretation they provide. Moreover, almost all circuits have adopted the "law of the circuit," which implies that a judgment made by a circuit court is binding for the subsequent circuits judgments. Therefore, lenders were facing different environmental liability risks according to the location of a plant before 1996.

2.4 The 1996 federal law

Congress clarified the scope of CERCLA liabilities for secured lenders in the Asset Conservation Lender Liability and Deposit Insurance Protection Act (Lender Liability Act, henceforth) of 1996. The statute was passed on September 30, 1996, but was first introduced in February 1995. The federal statute brought important clarifications on what it means to "participate in management," which was initially included in the 1980 version of CERCLA and later interpreted by courts.

The statute explicitly removed the interpretation given by Fleet Factors that a secured lender can be held liable if they have the ability to influence its debtors, as "participate in management [...] (ii) does not include merely having the capacity to influence, or the unexercised right to control, vessel or facility operations." Financial and administrative function were explicitly defined to make clear the distinction from environmental compliance activities: "The term 'financial or administrative

[13] The case was handled by the United States Court of Appeals for the District of Columbia Circuit, which is the main appelate court for administrative law and therefore "decided the fate of the EPA [rule]" (Harkins Jr (1993)).

function' includes a function such as that of a credit manager, accounts payable officer, accounts receivable officer, personnel manager, comptroller, or chief financial officer, or a similar function."

Moreover, the amendment clarifies what actions can lead to CERCLA liabilities for lenders. If a lender has a secured claim against a vessel or a facility, then the lender will be considered as participating in management if the entity:

> *(I) exercises decision making control over the environmental compliance related to the vessel or facility, such that the person has undertaken responsibility for the hazardous substance handling or disposal practices related to the vessel or facility; or*
>
> *(II) exercises control at a level comparable to that of a manager of the vessel or facility, such that the person has assumed or manifested responsibility.*

Overall, a lender is responsible as soon as it takes part in any day-to-day activities of a facility, that are unrelated to financial or administrative functions, but include environmental compliance activities.

The amendment also lists the activities that do not lead to CERCLA liability for lenders and constitute a "safe harbor."[14] Broadly speaking, the tasks can be delineated into two main aspects. They include activities necessary for lenders to ensure that the collateral value is preserved, such as (1) including in the loan an environmental covenant or warranty; (2) physically inspecting or

[14]"(38) "participate in management" (...) (B) does not include— (i) performing an act or failing to act prior to the time at which a security interest is created in a vessel or facility; (ii) holding a security interest or abandoning or releasing a security interest; (iii) including in the terms of an extension of credit, or in a contract or security agreement relating to the extension, a covenant, warranty, or other term or condition that relates to environmental compliance; (iv) monitoring or enforcing the terms and conditions of the extension of credit or security interest; (v) monitoring or undertaking one or more inspections of the vessel or facility; (vi) requiring a removal action or other lawful means of addressing a discharge or substantial threat of a discharge of oil in connection with the vessel or facility prior to, during, or on the expiration of the term of the extension of credit; (vii) providing financial or other advice or counseling in an effort to mitigate, prevent, or cure default or diminution in the value of the vessel or facility; (viii) restructuring, renegotiating, or otherwise agreeing to alter the terms and conditions of the extension of credit or security interest, exercising forbearance; (ix) exercising other remedies that may be available under applicable law for the breach of a term or condition of the extension of credit or security agreement; or (x) conducting a removal action under section 1321(c) of this title or under the direction of an on-scene coordinator appointed under the National Contingency Plan, if such actions do not rise to the level of participating in management under subparagraph (A) of this paragraph and paragraph (26)(A)(vi);"

monitoring a facility; and (3) providing advice or requiring the borrower to prevent a release or address a threat of releases. Moreover, lenders are exempt from CERCLA liabilities if they make decisions related to the life-cycle of the loan, such as (1) restructuring or renegotiating a credit agreement, (2) taking actions following a breach of a secured loan agreement and (3) "holding a security interest or abandoning or releasing a security interest." The latter implies that the way the bank manages its portfolio of credits has no impact on its exposure to environmental liabilities.

In 1997, the EPA issued a document explaining the Asset Conservation Lender Liability and Deposit Insurance Protection Act of 1996 for lenders' liabilities and provided additional examples of the practices that trigger lenders' liabilities.

Overall, the history of CERCLA provides a unique empirical setting to study the role environmental lender liability. The Lender Liability Act of 1996 had a more important impact on facilities in the 11th circuit, which were more subject to environmental lender liability, than facilities in other circuits. In the next section, I present the datasets that are used to exploit this empirical setting.

3 Datasets, variables and descriptive statistics

In the section A of the online appendix, I detail the data sources, how the datasets are linked together, how the variables are constructed, and present several data validation exercices. In short, I exploit five main confidential datasets from the US Census Bureau, that I link together using the establishment or firm identifiers. Next, I exploit four main datasets from the EPA, which I merge using their administrative identifiers or the chemical numbers. There is no existing linkage between the administrative identifiers of EPA databases and the ones from the US Census Bureau. Therefore, I perform several fuzzy-matching steps to connect the environmental datasets from the EPA to the BR from the Census Bureau. I then provide several tests to validate the quality of the dataset, by showing, for instance, that pollution monotically increases in the establishment production.

As described in section A.2 of the online appendix, several measures of pollution and environmental compliance are used in the paper. Specifically, log(on-site CERCLA pollution+1)$_{cit}$ is the log of the on-site pollution minus air pollution that does not expose the facility to CERCLA liabilities, for facility i, in year t and for the toxic component c. The reason I exclude air pollution is that this type of waste does not expose the owner of the facility to CERCLA liability. I also rely on the variable $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, that is a dummy variable taking the value 100 if on-site CERCLA pollution is strictly positive and zero otherwise. A firm with an RCRA environmental violation means that the firm has not abided by all regulations that aim at minimizing the probability of an environmental contamination. To capture this dimension, I construct $\mathbb{1}$(RCRA environmental violation)$_{it}$ is a dummy variable taking the value 100 if the establishment has at least one RCRA environmental violation and zero otherwise.

There is a total of 3,400 establishments from 1,200 firms between 1992 and 1999. The treated group is made of 250 establishments. Table 1 reports the descriptive statistics of the full sample. The average facility in our sample is large: it employs 590.9 workers who are paid on average $37,510 per year; it invests $44,770,000 in building and other structures, and it generates $243,700,000 of real output per year. The average firm in the sample uses a significant amount of debt but is not close to bankruptcy, as the leverage ratio is equal to 0.7439 and the average Z-score is 3.54. Moreover, the average firm has a Tobin's Q of 1.719.

The average pollution generated is significant. For a given chemical, a firm generates 29,000 pounds of on-site waste per year. A bit less than one-third (10,500) is regulated under CERCLA and the remainder is released through the air. Almost half of these chemicals are toxic, as they cause cancer. A total of 5.7% of facilities in the sample report investing in process-related abatement technology, and 11.9% of observations in the firm-year sample have at least one environmental violation.

4 Empirical design

4.1 Empirical specifications

The baseline specification for chemical-level outcomes is in line with previous works that use the TRI database. Namely, I estimate by ordinary least squares (OLS) the following equation:[15]

$$\begin{aligned} Y_{cit} = \quad & \text{CAS FE}_c \times \text{Facility FE}_i + \text{CAS FE}_c \times \text{Year FE}_t + \text{Legal status FE}_i \times \text{Year FE}_t \\ & + \text{NAICS FE}_i \times \text{Year FE}_t + \text{Firm-level controls}_{it} + \text{Post}_t \times \text{Group}_i + \varepsilon_{cit} \end{aligned} \tag{1}$$

I also estimate triple difference-in-differences to perform cross-sectional tests, where I decompose the main effect according to a variable in 1995:

$$\begin{aligned} Y_{cit} = \quad & \text{CAS FE}_c \times \text{Facility FE}_i + \text{CAS FE}_c \times \text{Year FE}_t + \text{Legal status FE}_i \times \text{Year FE}_t \\ & + \text{NAICS FE}_i \times \text{Year FE}_t + \text{Firm-level controls}_{it} + \text{Post}_t \times \text{Group}_i + \text{Post}_t \times \text{Cross}_i \\ & + \text{Post}_t \times \text{Cross}_i \times \text{Group}_i + \varepsilon_{cit} \end{aligned} \tag{2}$$

Some variables are available at the facility-year level. Therefore, for these outcomes, I estimate instead a slightly different equation defined as follows:

$$\begin{aligned} Y_{it} = \quad & \text{Facility FE}_i + \text{Legal status FE}_i \times \text{Year FE}_t + \text{NAICS FE}_i \times \text{Year FE}_t \\ & + \text{Firm-level controls}_{it} + \text{Post}_t \times \text{Group}_i + \varepsilon_{cit} \end{aligned} \tag{3}$$

where Y_{cit} is the outcome of interests defined at the chemical, year, and facility level. Similarly, Y_{it} is the outcome defined at the facility-year level. I consider three chemical-level outcomes: (1) $\mathbb{1}(\text{Process-related abatement})_{cit}$, (2) Production ratio_{cit}, and (3) log(on-site CERCLA

[15] A recent literature has shown econometric biases when using a difference-in-differences specification with two-way fixed effects estimators with multiple treatments (De Chaisemartin and d'Haultfoeuille (2020), Borusyak and Jaravel (2017)). This problem does not arise here, because the treatment takes place for one specific group and time. Indeed, the empirical design used in this paper does not have a staggered structure, where different groups receive different treatments at different times.

pollution+1)$_{cit}$. I consider the following facility-year level outcomes: log(emp)$_{it}$, log(wages)$_{it}$, log(Q)$_{it}$ and $\mathbb{1}$(RCRA environmental violation)$_{it}$.

The specifications are estimated with many fixed effects. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. It groups chemicals that are identical under the same fixed effect. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect, and NAICS FE$_i$ is a fixed effect at the two-digit NAICS code. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the variable lfo from the LBD. CAS FE$_c$ $\times$ Year FE$_t$ controls for any different trends that happen at the component level. It captures time-varying aggregate technological and economic shocks that affect the common usage of a chemical. SIC FE$_i$ $\times$ Year FE$_t$ captures any trend in the usage of a component that is similar for an industry. CAS FE$_c$ $\times$ Facility FE$_i$ controls for the fact that each facility could have a specific usage of a component that is constant over time. Finally, Legal status FE$_i$ $\times$ Year FE$_t$ controls for any differential trend between firms with different legal statuses.

Firm-level controls$_{it}$ include 12 time-varying controls defined at the firm level, which are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity (ROE), the tangibility ratio, Tobin's Q, and total firms liability.[16]

The main coefficient of interest is the interaction Post$_t$ $\times$ Group$_i$. Post$_t$ is a dummy that takes the value one after 1996 and zero otherwise. Group$_i$ is a dummy that takes the value one for plants located in the 11th Circuit and zero otherwise. The direct inclusion of Post$_t$ and Group$_i$ are omitted because they are absorbed respectively by Year FE$_t$ and Facility FE$_i$. If the treatment is conditionally exogenous, then the interaction term Post$_t$ $\times$ Group$_i$ measures the causal impact of the Lender Liability Act of 1996 among plants in our treated group. The treatment is at the Circuit

[16]For a small fraction of observations, some variables are missing. To obtain the same number of observations when the controls are included, I input the missing observation by the firm average. If this quantity is missing, then I set the value equals to zero. I verify that the results are robust without the inclusion of these controls.

level. Therefore, the standard errors are clustered at this level as in Akey and Appel (2021). As shown in the robustness section, the results remain similar with different levels of clustering and when the standard errors are computed using a bootstrapping approach or different clusterings at the firm or chemical-level.

In equation 2, I perform a triple difference-in-differences where I decompose the baseline average treatment effect with another group Cross_i. This allows me to investigate whether the effect is stronger for firms with some specific characteristics, such as high initial leverage or more environmental liability risks. Notice that the inclusion of Cross_i, Post_t, $\text{Cross}_i \times \text{Group}_i$ are omitted, because they are strictly collinear with the fixed effects.

4.2 Common trend assumption: Contemporaneous shock?

One important hypothesis of the empirical design —that the treatment is conditionally exogenous— can be expressed as the common trend assumption (Angrist and Pischke (2008)). It means that the difference in outcomes between plants located in the 11th Circuit and the others would have been the same before and after 1996 without the law change. While this assumption is not directly testable, one way in which it could be violated is if a major regional macroeconomic shock affected plants located in the 11th Circuit after 1996 but not plants outside of the 11th Circuit.

Table A.1 in the online appendix shows that 12 variables defined at the state level do not generate a statistically significant and economically meaningful difference between states in the 11th Circuit after 1996 and the others. Specifically, column (1) focuses on whether tax variables, namely state corporate, income tax, sales tax, personal income tax, and property taxes predict the variable $\text{Post}_t \times \text{Group}_i$. Column (2) focuses on state-level employment and economic growth variables (employment insurance (in level), the unemployment insurance rate, the unemployment insurance base wage, the state level gross domestic product, and the unemployment rate), and column (3) replicates the exercise with state-level variables that capture the state financial health, such as its total and general revenues, and the state budget balance. No coefficient is statistically significant at the 10% threshold, and the magnitudes are economically small. Columns (4) to (7) combine the variables in different ways, and the results remain the same. Overall, this exercise supports the view that there is no salient state-level macroeconomic shock that affected our treated group after 1996 differently than our control group.

4.3 Balance tests

Observationally equivalent control and treated groups before the treatment are not a necessary condition for identification in a difference-in-differences specification (Yagan (2015)), but strengthens the credibility of an empirical design. Therefore, table 2 investigates how the treated and control groups differ according to observable characteristics before 1994 (included), that is before the treatment happened. Two stylized facts emerged. First, consistent with the notion that firms in the 11th Circuit face more scrutiny by lenders, they have lower pollution and better environmental compliance outcomes on average. Specifically, on-site CERCLA pollution_{cit} is two times greater for firms in the control group than firms in the treated group, but the difference is not statistically significant. Firms in the treated group invest more in abatement activities (1.59 percentage points more), and the number of other liabilities (including environmental ones) is almost two times lower. The differences are statistically significant. Interestingly, this cross-sectional pattern holds for regulated pollution exclusively. In particular, firms have almost the same amount of air pollution, is not regulated under CERCLA: 22,290 pounds for the treated group and 21,020 for the control group.

Second, firms in the treated and control groups have similar non-environmental outcomes before the treatment. In particular, they have the same Tobin's Q, ROE, ROA, capital intensity, cash flow, cash holding, cost of capital, tangibility ratio, leverage, and production ratio. This finding is consistent with the notion that the cross-sectional variation in lender liability standards as adjudicated by Federal Circuit Courts is not driven by firms' characteristics.

5 Impact of lenders' liability on environmental and safety efforts

In this section, I investigate empirically the relationship between environmental lender liability and pollution. This relationship is is theoretically ambiguous. In section C of the online appendix, I review the economic theories on this question. In short, the relationship depends on parameters that are difficult to observe, such as the extent to which lenders and debtors can write perfect contracts, how much information can be observed by lenders, lenders' bargaining power, and the distribution of the environmental liabilities with regard to the number of tasks required to reduce pollution.

5.1 Dynamic event studies

I use event studies to investigate whether there is a pre-trend before the shock between the treated and control groups for the outcomes of interest.

I start by plotting the raw average per year of both the treated and control groups with respect to a reference year. That is, I take the raw averages of the dependent variable for each year or group and then subtract the raw average in 1994 (the reference year). This method implies that the plotted raw average is equal to 0 in 1994 for both the treated and control groups. Doing so makes the reading of the figures easier and allows me to visually inspect the existence of a pre-trend.

Panels A of figures 2 and 4 contain the normalized raw averages for the following pollution measures: $\log(\text{on-site CERCLA pollution+1})_{cit}$ and $\mathbb{1}(\text{RCRA environmental violation})_{it}$. As can be observed, all the confidence intervals overlap before 1995. Small changes can be observed while the law was being voted on (between 1995 and 1996), and then a significant increase in pollution is observed after 1996 for the treated group, that is stable and significant, consistent with the view that lower environmental lender liability leads to higher pollution outcomes.

Although the raw averages presented show indirect evidence of an absence of a pre-trend and a sharp effect localized after the shock, these raw averages do not control for any type of heterogeneity between the control and treatment groups. Therefore, I estimate the dynamic event window of equation 1, that is, I replace the variable $\text{Post}_t \times \text{Group}_i$ of equations 1 by $\sum_{\substack{j=1992 \\ j \neq 1994}}^{1999} \gamma_j 1_{t=j} \times \text{Group}_i$. $1_{t=j}$ is a dummy variable that takes the value one if the year t is equal to j and zero otherwise. γ_j represents the conditional average difference in the outcome variable Y_{cit} for equation 1 between our treated and control groups during year j with respect to 1994.

Panels B of figures 2 and 4 plot the estimated γ_j for the following measures of pollution: log(on-site CERCLA pollution+1)$_{cit}$ and $\mathbb{1}$(RCRA environmental violation)$_{it}$. As can be observed, there is no pre-trend before 1995. The increase grows stronger in 1996 and 1997, when the law was passed and communication about it to the public ended. Overall, the dynamic graphs suggest that the effect is not driven by the existence of a pre-trend and support the view that the increase in pollution took place when the law was passed.

5.2 Net effect and economic magnitudes

Column (1) of Table 3 reports the results of equation 1 when the dependent variable is log(on-site CERCLA pollution+1)$_{cit}$. There is a statistically significant increase in such pollution for plants located in our treated group after 1996 compared to the other plants. The coefficient is equivalent to 0.132 when all the controls and fixed effects are included. This result means that the reform has increased on-site pollution by 13.2% in our treated group (11th Circuit) compared to the other Circuits.

Column (2) of Table 3 replicates the same exercise of estimating variations of equation 1, except that the dependent variable is now equal to the $\mathbb{1}$(on-site CERCLA pollution+1)$_{cit}$. It captures an extensive margin of on-site CERCLA pollution. The coefficient is equivalent to 2.105, which implies that facilities located in the 11th Circuit released 2.105 percentage points more chemicals on-site. As on average, firms release 12% of their chemicals on-site, this finding represents an increase of 17.54% for the average firm in the sample.

Finally, Column (3) of Table 3 reports the firm-level regression of equation 3 where the dependent variable is $\mathbb{1}$(RCRA environmental violation)$_{it}$, which takes the value 100 if the facility has committed at least one RCRA violation. The coefficient with all the fixed effects and controls is equal to 2.521, which means that after the new statute of 1996, plants in the treated group are 2.521 percentage points more likely to incur at least one environmental violation than those in the other states. Given that the average rate of firms with at least one environmental violation is equal to 11.9%, this is equal to an increase representing 21.2% of the average rate of environmental violations.

5.3 Sensitivity analysis of the inclusion and exclusion of controls

Tables 3 relies on several assumptions regarding the specification choices, namely how I include the controls and fixed effects. It is important to evaluate how sensitive the results are to different combinations of controls. To evaluate this sensitivity comprehensively, I adopt the approach suggested by Simonsohn, Simmons, and Nelson (2019) and plot the specification curves of equation 1 for the environmental outcomes. This approach allows me to investigate the range of estimates that can be obtained with the controls and examine whether they are statistically significant.

The specification curve plots the results of 32 different regressions with different controls and fixed effects when a plant-CAS fixed effect is included. I include a plant-CAS fixed effect to make the specification consistent with the way the sample is constructed. Indeed, firms do not report chemicals that they do not use. As a result, if a chemical is never reported, then whether it is reported as a zero over the whole period or not is irrelevant because the plant-CAS fixed effect absorbs these cases.

Figure 5 plots the specification curve for each environmental outcome. Specifically, Panel A of figure 5 depicts 16 point estimates of the coefficient $\text{Post}_t \times \text{Group}_i$ from equation 1 when the fixed effects and controls vary for the dependent variable log(on-site CERCLA pollution+1)$_{cit}$. All the coefficients are positive and statistically significant. They range from 0.13 to 0.19, implying a reduction of 13% to 19% of on-site releases. Finally, Panel C of figure 5 shows the specification curve when the dependent variable of equation 1 is $\mathbb{1}(\text{RCRA environmental violation})_{it}$. All the coefficients are statistically significant. They are however negative when no time-trend control is included in the regression. When a time trend is included, the coefficients are always positive and range from 2.52 to 2.77, implying an increase of 21.17% to 23.27% in the sample baseline rate of RCRA environmental violations. These exercises support the view that the results are robust to the inclusion or exclusion of controls.

Overall, this section shows that reducing the responsibility of lenders for the environmental cleanup of their debtors under CERCLA negatively impacts the environmental practices of their debtors, as firms increase their on-site releases both on the extensive and intensive margins and incur more environmental violations.

6 Is the impact on environmental practices driven by a change in production?

The increase in pollution found in the previous section is consistent with three economic mechanisms that I distinguish here. The first mechanism is that these deteriorated environmental practices are driven by increased production, which mechanically increases toxic releases. Indeed, protecting lenders from the environmental liability attached to their collateral makes lending less costly for lenders, which thus reduces the cost of capital and increases credit supply. Firms that can borrow more are more likely to invest more, which increases production and mechanically increases toxic releases.

The second mechanism is that firms could reallocate their production to the location that becomes less regulated. The reallocation could happen either by tranferring production to another location or by buying products, that were previously produced by the treated establishment, from another supplier located outside the treated group. This would imply that some production in the control group is reallocated in the treatment group after the shock. One consequence of this reallocation is that it would create a mechanical increase in production and pollution.

The third mechanism is that production is not affected, but lenders' influence of their debtors' environmental practices drops, because they are less incentivized to do so. In the next section, I run several tests to distinguish between these three views. Overall, I find no evidence that production was either reallocated or increased after the shock, consistent with a reduction in pollution not affected by changes in production.

6.1 Impact on production

The first test replicates the specification of equation 1, where the dependent variable is Production ratio$_{cit}$, the production ratio collected by EPA data. The production ratio at year t captures how much of the component c was used in year t with respect to year $t-1$. Panel A of Table 4 reports the results. When all the fixed effects and controls are included, the relative impact of the Lender Liability Act of 1996 on the Production ratio$_{cit}$ is equal to 0.0178. This marginal effect is equivalent to 2.66% of the baseline production ratio in the sample. The magnitudes are low and non-statistically significant, even at the 10% level.

I then use the confidence intervals to bound the maximum plausible impact of the treatment. With a 95% confidence interval, one cannot reject that the coefficient is equal to .039 —at most— in the baseline specification of equation 1. This result implies an increase in the production ratio of at most 5.82%.

In Panel A of figure 6, I explore the sensitivity of this result by plotting the coefficients of 16 regressions that explore how the effects change when different sets of controls are added. The coefficients are non-statistically significant for 14 regressions. The remaining two specifications that predict a statistically significant result on production are of negative sign, which is not consistent with an increase in production. When the coefficient is positive, the point estimates range from .01 to .02, which implies an increase in the production ratio from 1.49% to 2.98%.

I then replicate the exercise with another measure of production. Specifically, the second test estimates a specification similar to equation 3, where the dependent variable is $\log(Q)_{it}$, that is, the log of the real production as found in the ASM/CMF surveys. Similar to the result using the production ratio, there is no significant impact of environmental lender liability on production for firms located in the 11th Circuit after 1996, as shown in Panel B of Table 4. Specifically, the point estimate where the firm-level controls and the industry, legal status time trends are included, is equal to -0.0183 and is not statistically significant.

I use the confidence intervals to bound the maximum plausible impact of the treatment. With a 95% confidence interval, one cannot reject that the coefficient is at most equal to .003 in the baseline specification of equation 3. This finding implies a marginal semi-elasticity of 0.3%.

In Panel B of figure 6, I evaluate the sensitivity of this result by plotting the coefficients of 16 regressions that explore how the effects change when different sets of controls are added. When one does not account for any time-trend, the impact on production is positive and statistically significant: the coefficient ranges from .09 to .1. However, the coefficients are non-statistically significant for 14 regressions and the sign is negative when a time trend is included in the regression.

Overall, these two tests reject the idea that the increase in pollution that we observe was driven by a concomitant large surge in production, coming from reduced financial constraints or production reallocation. However, the absence of evidence of an effect is not evidence of an absence of an effect. Therefore, I provide additional tests in the following subsections to better validate the idea that a change in production scale does not drive the increase in pollution.

6.2 Controlling for production, input quantity and costs

For some production functions, small increases in economic activity could cause significant positive changes in pollution.

One way to measure whether the weakened environmental practices observed after 1996 in the 11th Circuit were fully driven by changes in production is to replicate the baseline specifications of Table 3 and add controls for firms' costs of production, input quantity and real output that are not directly designed to reduce pollution, such as capital and labor choices. If changes in production drive the efect entirely, then the controls will absorb the effect and make the coefficient $\text{Post}_t \times \text{Group}_i$ non-significant.

Table A.2 in the online appendix reports the results when detailed production controls are added. I add the real production of the facility, the quantity of capital and labor input, and the input costs. The reason to do so is that they correlate heavily with total production. This addition increases the precision of the controls in case the real production is measured with noise. Capital input is proxied by two variables: (1) new and used machinery and equipment and (2) new and used buildings and other added structures. The quantity of labor is captured by the number of employees, their payrolls and the total number of hours worked. Finally, I capture the cost of input through the cost of materials or the cost of electricity, fuels or heat. The results remain statistically significant and economically meaningful when such controls are added. Specifically, treated facilities increase their total on-site CERCLA pollution by 13.7% and increase the releases of new chemicals (extensive margin) by two percentage points.

The specification curves of figure A.3 in the online appendix show how a particular set of real controls affect the point estimates. I run a total of 128 regressions each time. I also add an interaction term between the quantity of output and costs to capture potential economies of scales. Moreover, I add an interaction term of labor with capital, to account for a potential substitution or complementarity effect in total production between these two inputs. Overall, the estimates are stable across all the specifications, rejecting the view that controlling for observable output or labor-capital variables does not fully account for the baseline reduction in pollution.

6.3 Abatement activities

In this subsection I report direct evidence that lowered environmental efforts by treated firms drove the reduction in pollution. To do so, I consider the impact on abatement activities. I focus on process related activities, which consist of modifying how the product is made to reduce pollution. For instance, firms can reuse chemicals or reduce the packaging or the chemicals contained in their product. According to the EPA, as shown in the Waste Management Hierarchy (see figure A.4 in the online appendix), this approach to reducing pollution is the most preferred one as it reduces pollution at the source.

Panel A of figure 3 contains the normalized raw averages per year of both the treated and control groups with respect to 1994 for $\mathbb{1}(\text{Process-related abatement})_{cit}$. Panel B of figure 3 plots the dynamic event window of equation 1 for the same variable. Both figures show that the effect is not driven by the existence of a pre-trend and support the view that the effect took place when the law was passed.

Table 5 contains the regression results of equation 1 where the dependent variable is equal to $\mathbb{1}(\text{Process-related abatement})_{cit}$. When all the controls and fixed effects are included, treated establishments reduced investment in process-related activities on average by 2.917 percentage points. This decrease consists of a reduction of 36.64%, which is economically meaningful and statistically significant at the 1% level. Overall, the result is consistent with the view that firms reduced their environmental efforts when their secured lenders were less responsible for the environmental cleanup costs of their collateral.

6.4 Placebo regarding air pollution

If the baseline effects were driven by an increase in production scale or a strategic change in the production mix, then all types of pollution should experience an increase in pollution. In this subsection, I exploit the fact that air pollution is not regulated by CERCLA to investigate whether the treatment caused a change in this variable.

Table 6 contains the regression results of equation 1 where the dependent variable is equal to $\log(\text{on-site air pollution}+1)_{cit}$. The effects are not statistically significant, even at the 10% threshold. The sign of the point estimate is negative and the economic magnitudes are small. Specifically, the results imply a decrease in air pollution of 0.289%. This magnitude is small, compared to the 13.7% increase for on-site releases, which supports the view that only regulated pollution under CERCLA was changed, alleviating any concern that a change in production would have shifted all types of pollution.

Overall, all the different tests point to the interpretation that the weakening of environmental practices is unlikely to be driven by a change in production scale.

7 Variations in lenders' influence efforts

The results of the two previous sections do not support the idea that lending was cut after the Lender Liability Act, as we do not observe a drop in economic activity that would have automatically lessened pollution. Rather, they support the view that lenders intentionally decreased their level of influence upon passage of the Lender Liability Act. Lenders can influence debtors through two non-exclusive channels: a pricing and a contractual channel. In the pricing channel, lenders ask debtors that pollute to pay a higher interest rate, which incentivizes the debtor to reduce pollution to avoid paying this increased interest rate. Alternatively, in the contractual channel, lenders can include additional or stricter environmental covenants into their debt contracts to force their debtors to adopt cleaner practices. In this section, I exploit cross-sectional variations among firms to provide additional evidence that lenders influence their debtors. I first show in subsection 7.1 that the effects on pollution were significantly stronger for firms with less bargaining power over their lenders. I then show in subsection 7.2 that the effects were significantly higher for firms with high expected environmental lender liabilities. Finally, in subsection 7.3, I perform several tests showing that lenders focused their costly efforts on firms with signals of higher environmental liability risks.

7.1 Impact for lenders with greater bargaining power

As shown in the theoretical model of Balkenborg (2001), the marginal impact of an increase in lender liability should be higher for firms with less bargaining power over their lenders. If lenders have full bargaining power, they can reward borrowers that engage in sound environmental practices by sharing some of the surpluses, which could take the form of lower interest rates. Conversely, lenders cannot reward their borrowers when they have no bargaining power, as their participation constraints are saturated. Moreover, debtors with less bargaining power over their lenders are more likely to accept stricter environmental covenants.

In general, I dot not observe an exogenous measure of lenders' bargaining power and rely instead on one proxy. The proxy I use is the firm's leverage, as observed in Compustat. The idea is that firms with high leverage cannot completely avoid debt and thus are more exposed to their lenders' actions. As a result, they are more dependent on their lenders than firms with a low level of debt. Consistent with this idea, Gilje, Loutskina, and Murphy (2020) show that firms with greater leverage are more likely to act inefficiently during the loan renegotiation process with their banks to maximize the perceived value of their collaterals.

Column (1) of table 7 reports the results of equation 2 and confirms that the effects are significantly stronger for firms with high leverage. Specifically, this table reports the estimates of the baseline specification where the dependent variable is log(on-site CERCLA pollution+1)$_{cit}$ for different interactions. In column (1) Cross$_i$ is a dummy variable that takes the value one if the facility has a leverage above the sample state-median leverage in 1995 and zero otherwise. The results of the triple interaction are statistically significant at the 1% level and the economic magnitudes are meaningful. On average, treated firms with high leverage have an additional 15.5% increase in on-site releases than the treated firms with low leverage. Overall, the effects are consistent with the view that lenders with higher bargaining power are better able to influence their debtors.

7.2 Impact for firms with high expected environmental liabilities for lenders

Lender influence, which takes the form of pricing environmental risks or including environmental covenants, is costly. As a result, in equilibrium, lenders' influence should be stronger when lenders face a higher expected cost for their debtors' pollution, as predicted by Balkenborg (2001).

First, the expected environmental liabilities for lenders are higher when a firm is close to filing for bankruptcy. More specifically, if a firm incurs a contamination but does not file for bankruptcy, then the liability is governed by RCRA and paid by the shareholders. However, if the firm is bankrupt, the liability is governed by CERCLA and paid by potentially responsible parties, which include lenders. As CERCLA liabilities apply only to bankrupt firms, the effects should be stronger for firms close to bankruptcy. The predictions of the previous subsection also support this idea because firms with high leverage could be more financially constrained (Gilje and Taillard (2015)), and firms that face financial constraints are more likely to file for bankruptcy. However, in this subsection, I present additional and more direct tests of this idea.

Column (2) of table 7 compares firms with different financial strengths using the specification of equation 2. Specifically, in column (2), Cross_i is a dummy variable that takes the value one if the establishment has a Z-score below the state-median level in 1995 and zero otherwise. The results of the triple interaction are statistically significant at the 1% level, and the economic magnitudes are meaningful. This finding implies that the effect of less environmental lender liability on pollution outcomes for establishments in the 11th Circuit is significantly stronger for firms that have a low Z-score and are thus more likely to file for bankruptcy. On average, treated firms with a high probability of filing for bankruptcy have an additional 14.1% increase in on-site releases than the treated firms with a low probability of filing for bankruptcy. Overall, these cross-sectional variations are consistent with the idea that lenders influence more firms that have a greater likelihood of filing for bankruptcy.

Second, the expected environmental liabilities for lenders are stronger for debtors that use more toxic chemicals. The reason is that EPA responses are more robust for sites that pose higher environmental and public health threats. Sites that exploit more toxic components are thus more likely to create more critical contamination, with more severe damage to the local population and the environment. As a result, we should expect more substantial lender influence for debtors that use more toxic chemicals.

Column (4) of table 7 shows the results of the triple difference-in-differences where the group interaction cross_i is a dummy variable that takes the value one if the chemical causes cancer and zero otherwise. The point estimate of the triple interaction is statistically significant and equal to 0.169, which means that the increase in pollution is significantly stronger for chemicals that cause higher environmental liability.

Overall, the results are consistent with the view that lenders more substantially influence their debtors when the environmental lender liabilities are higher, consistent with the comparative static of Balkenborg (2001).

7.3 Impact for firms with information signals of high environmental risks

An important argument in the model by Lewis and Sappington (2001) is that some environmental accidents happen without bankrupting a firm. These minor environmental accidents are important for the lender because they provide information on the effort undertaken by the debtor to reduce environmental safety risks. Contrary to a large contamination event that bankrupts the debtor, lenders can punish debtors that incur a small contamination, which creates an ex ante incentive for the firm not to pollute. This result holds when the environmental safety tasks that aim to reduce larger environmental accidents are positively correlated with the tasks that aim to reduce the incidence of minor environmental accidents. Indeed, this assumption guarantees that these minor environmental accidents are sufficiently informative about the overall safety efforts undertaken by the company. Following such an accident, a lender is more likely to make environmental covenants stricter or increase the cost of capital if the firm does not implement a reduction in pollution.

In this paper, I proxy these minor environmental accidents by the amount of ongoing environmental liabilities. I measure contingent environmental liability in the same way as Akey and Appel (2021), that is, by using the variable "lo" in Compustat. This variable captures non-financial liability, including accrual for expected future environmental costs.

Column (3) of Table 7 shows the results of the triple difference-in-differences. In Column (3), the variable Cross_itakes the value one if the establishment has the variable "lo" above the state-median level in 1995 and zero otherwise. The point estimate of the triple interaction is statistically significant at the 1% level and equal to 20%. This result means that establishments with high contingent environmental liability have 20% more on-site pollution following the Lender Liability Act of 1996 compared to establishments in the 11th Circuit Court that have lower contingent liability and facilities that are not located in the 11th Circuit. The coefficient of the sign is robust across different specifications. Overall, this is consistent with stronger lenders' influence for firms that have more ongoing environmental liabilities.

Second, I exploit a variable that lenders often use as a signal for high environmental risks: the age of the facility. Older facilities are more likely to rely on obsolescent capital and are more prone to leakages, as they have been eroded by past production and time. They also have less embedded technology, such as up-to-date safety equipment, that would make them less prone to accidents. As stated by Barclays in its first "key considerations" to evaluate the environmental risks of a firm:[17] "How long has the site been used for this purpose? The contamination risk increases with time." This statement supports the argument that younger firms have fewer environmental risks.

Column (5) of Table 7 shows the triple difference-in-differences according to firm age. Specifically, the variable Cross_i takes the value one if the firm has an age above the median sample value of the state where the establishment is located and zero otherwise. The age comes from the LBD. The coefficient $\text{Post}_t \times \text{Group}_i$ is statistically significant at the 1% level, and the economic magni-

[17]Environmental and Social Risk Briefing (ESRB), Barclays, Version 6.0 March 2015, page 18

tudes are close to the baseline estimates. However, the sign of $\text{Post}_t \times \text{Group}_i \times \text{Cross}_i$ is negative and equals -0.0905. The net effect for young firms on pollution is still positive but is significantly lower than the effect for older firms. This finding is consistent with the view that younger firms were less subject to the influence of their lenders because they were facing fewer environmental liability risks.

Overall, these different tests support the view that lenders are more likely to influence firms with greater exposure to environmental risks and when the payoffs of reducing pollution are higher. These tests provide evidence consistent with lender influence that can occur through two non-exclusive channels: a pricing and a contractual channel.

8 Labor outcomes

In this section, I quantify the impact of this lower compliance on employment and wages to provide a more precise picture of the benefits caused by the Lender Liability Act. Understanding its impact on labor is important. There is a lingering policy debate of whether environmental regulation imposes costly job transitions for workers of regulated firms or a demand for workers to perform the additional tasks created by the regulation.[18] Moreover, investors and lenders who commit to ESG principles often highlight the "inherent" complementarities between the environmental and social aspects, including paying workers a higher wage.

Panel A of Table 8 shows that employment slightly increased in the 11th Circuit compared to the control group after 1996. Specifically, the coefficient is equal to 0.0208 when the dependent variable is $\log(\text{emp})_i$ and all the controls are included, namely the facility, NAICS year and legal status year fixed effects, as well as the time-varying controls from Compustat. Such a coefficient

[18]For examples of this debate of environmental regulation on job creation in the popular press, see for instance "Biden's Big Bet: Tackling Climate ChangeWill Create Jobs, Not Kill Them" (The New York Times, July 2021), "Joe Biden's climate-friendly energy revolution: What it will take to fight rising temperatures" (The Economist, February 2021).

implies a 2% increase in the number of employees. For a firm with 500 employees, the sample average, this increase is equivalent to 10 additional employees. Panel A of figure 7 investigates the robustness of this relationship to the inclusion of different controls. Overall, the relationship is always statistically significant at the 10% level. The 16 coefficients range from 1.74% to 3.3%, implying and increase of 8.7 to 16.5 additional employees.

Panel B of Table 8 shows the impact on wages. The point estimate is economically negligible, equivalent to a 0.508% decrease in the average annual payroll for the treated facilities. Given the sample average wage, this is equivalent to a loss of $190.55 per year. Although the point estimate remains stable, the statistical significance of the results depends on the controls added. Specifically, as shown by the specification curve from Panel B of figure 7, 12 specifications give statistically significant results at the 10% level, which it is not the case for the remaining four. Except when any time-trend fixed effect is included (two coefficients among the 16), the coefficients are always negative and stable below zero.

Overall, the results support the view that there is a trade-off between environmental compliance and employment. This trade-off is consistent with previous work that has studied environmental compliance in other empirical settings (Walker (2013, 2011)). The reduction in employment does not stem from a lower production scale and capital investment in abatement activities decreased. Taken together, the results are consistent with a different usage in the input mix used by treated firms and highlight how deeply integrated pollution-reduction projects are to corporate capital and labor decisions.

9 Sensitivity analysis

I run many robustness tests, which I describe in great detail in the section B of the online appendix. Overall, the results are robust to other definitions of pollution (subsection B.1). In particular, the results hold when I rescale the total pollution by the establishment production instead of taking the log. The results are robust when the control group is made up only of bordering states or excludes the bordering states (subsection B.2), as well as to a shorter or longer time frame (subsection B.3). The results still hold when the regressions are estimated when the panel variables are collapsed into a pre and post-average, as suggested by Bertrand, Duflo, and Mullainathan (2004) or with different clustering approaches (subsection B.4). Finally, the results are not driven by time-varying reporting requirements or the enforcements of using chemicals (subsection B.5).

10 Conclusion

The US federal regulation heavily protects secured lenders from the cleanup costs attached to their collateral since the Lender Liability Act of 1996. For instance, lenders are protected from environmental liabilities if they ask their debtors to conduct an environmental audit, include an environmental covenant in the debt contract, or require their debtors to improve their environmental practices ("safe harbors"). However, lenders are not incentivized to perform these monitoring tasks because they bear no direct consequences of ignoring the environmental aspects attached to their collateral in case of an accident. If the asset is contaminated, the federal government will clean it up, and the secured lenders will sell the repossessed asset at a higher price.[19] This practice is akin to a significant implicit subsidy. Proponents of this implicit subsidy have argued that, as modeled in Pitchford (1995), reducing lenders' liability decreases the cost of capital and incentivizes firms to invest in pollution reduction-projects.

The first set of results of this paper shows that, contrary to the narrative that led to the Lender Liability Act of 1996, protecting lenders from the environmental cleanup costs attached to their collateral can decrease their incentives to influence debtors to adopt better environmental practices. Specifically, this paper develops an identification strategy that compares establishments in the 11th Circuit—which were more exposed to environmental lender liability because of a Circuit Court of Appeals decision—to other firms, both before and after the Lender Liability Act of 1996 that

[19]Purchasers of an asset are liable for the full cleanup costs attached to their purchase, even if the environmental contamination took place before they became the owner of the asset.

overruled these court decisions. Using this empirical design, the paper shows that the level of investment in process-related abatement activities decreased by 36.64%, on-site pollution increased by 13.7%, and firms faced 21.2% more environmental violations when secured lenders were less exposed to the cleanup costs of their collateral. The reduction was not driven by a change in production but was mostly consistent with reduced influence from lenders, as this effect was driven by firms close to bankruptcy, with high initial debt and facing more environmental liability risks.

The second set of results of this paper quantifies the incidence of this environmental compliance induced by lenders' influence on firms' real outcomes, using detailed and high-quality data from the US Census Bureau. As measured by two different variables, firms' production remained the same for the treated group after the Lender Liability Act. It slightly benefited employment but not wages. This finding is consistent with a trade-off between employment and environmental sustainability, which this paper quantifies in the context of the Lender Liability Act.

Secured lenders plausibly collect information and monitor their debtors regarding the non-environmental operational aspects of their business to ensure that their collateral value is preserved and that the firm avoids bankruptcy. The marginal cost of collecting more information or monitoring the environmental practices, given that lenders already engage in these activities for non-environmental practices, could be low and the results of this paper indirectly support this statement. Indeed, it is likely that environmental screening and monitoring are costly tasks, and in equilibrium part of these costs would be transferred to the debtor through higher capital costs. Firms facing higher capital costs are more likely to cut production, fire workers, and reduced their abatement investments. The fact that the paper does not find evidence of such an effect is consistent with the view of strong complementarities between the environmental monitoring and screening tasks of lenders and their usual non-environmental tasks of monitoring and screening the collateral value and the repayment capacity of debtors.

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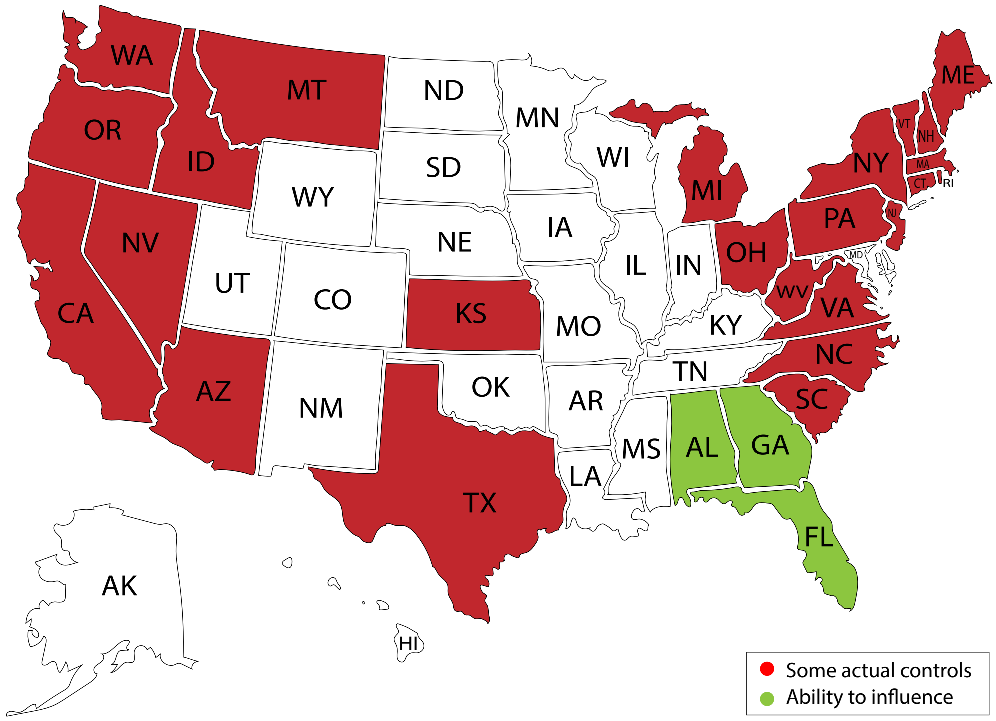
Figures

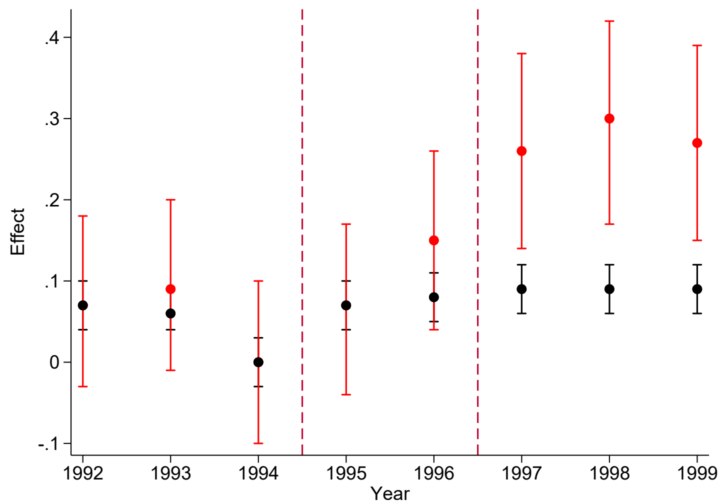
Figure 1: Treated and Control Groups



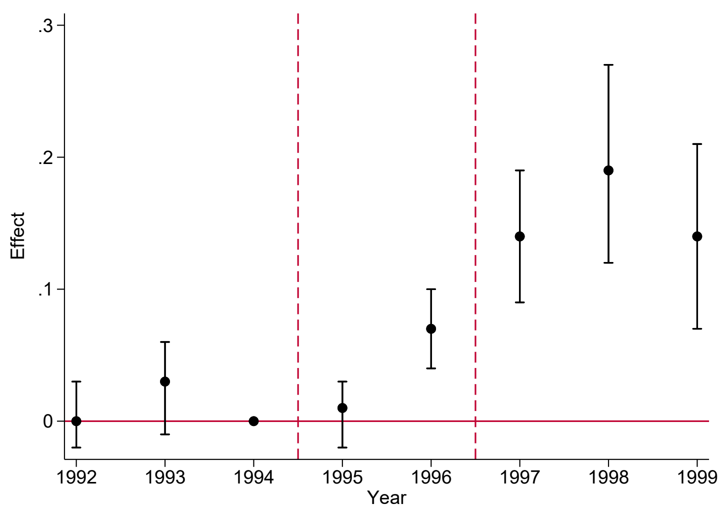
Note: This figure plots the courts that adjudicated the secured creditor exemption, either according to the capacity to control test (11th Circuit, in green) or some notions of actual controls (in red). The treated groups are plants located in the 11th Circuit, and the control group is made up of all plants that are not located in the 11th Circuit.

Figure 2: Effect on on-site Pollution

Panel A:



Panel B:



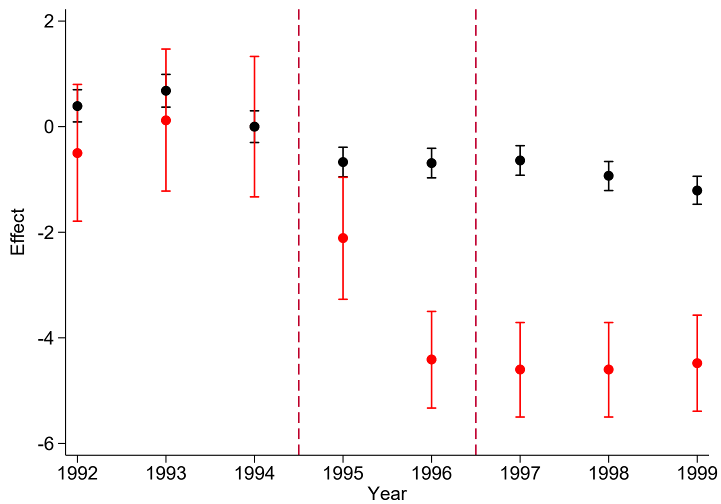
Note: Both figures represent the dynamics of outcomes around the Lender Liability Act, which was introduced to Congress in 1995 and enacted in 1996. The figure of Panel A reports the sample average of log(on-site CERCLA pollution+1)$_{cit}$ per year for both the treatment and control groups. The averages are taken with respect to their level in 1994 for each year for both the treated (in red) and control groups (in black). Confidence intervals are constructed at the 5% level. Panel B reports the coefficients of an event study difference-in-differences, where the dependent variable Y_{cit} is log(on-site CERCLA pollution+1)$_{cit}$. Specifically, the estimated coefficients (γ_k) of the following equation are reported:

$$\begin{aligned} Y_{cit} = \; & \text{CAS FE}_c \times \text{Facility FE}_i + \text{CAS FE}_c \times \text{Year FE}_t + \text{Legal status FE}_i \times \text{Year FE}_t \\ & + \text{NAICS FE}_i \times \text{Year FE}_t + \text{Firm-level controls}_{it} + \sum_{\substack{k=1992 \\ k \neq 1994}}^{1999} \gamma_k . \text{Year}_{tk} \times \text{Group}_i + \varepsilon_{cit} \end{aligned}$$

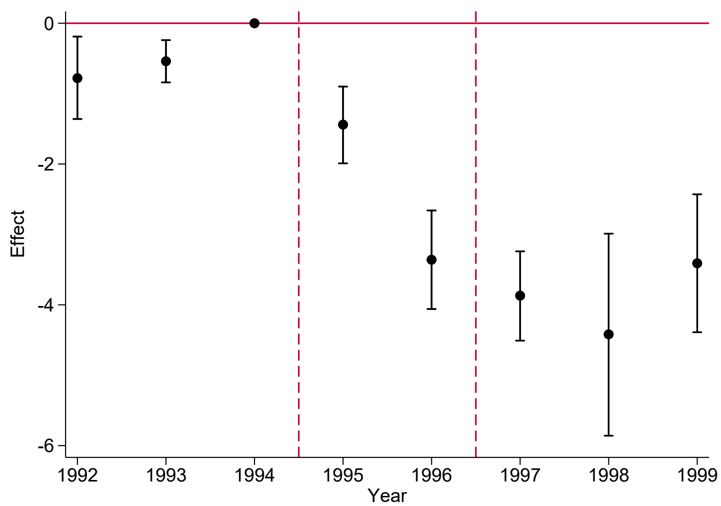
where Year$_{tk}$ is a dummy variable that takes the value one if t is equal to k and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect. The two-digit NAICS code is defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability.

Figure 3: Effect on Abatement Investment

Panel A:



Panel B:



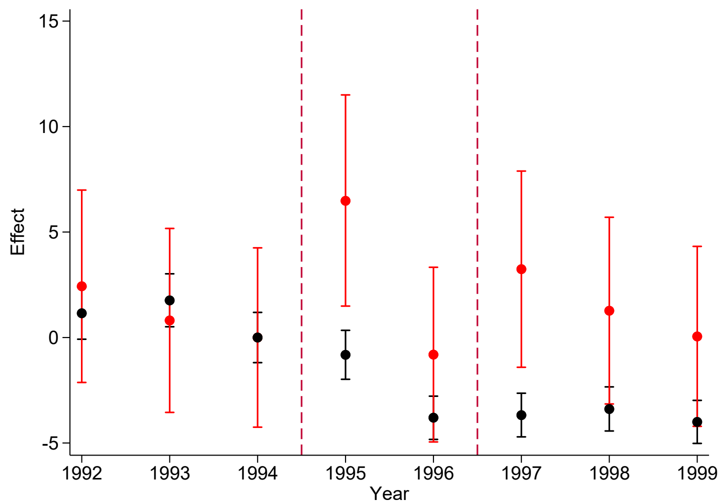
Note: Both figures represent the dynamics of outcomes around the Lender Liability Act, which was introduced to Congress in 1995 and enacted in 1996. The figure of Panel A reports the sample average of $\mathbb{1}(\text{Process-related abatement})_{cit}$ per year for both the treatment and control groups. The averages are taken with respect to their level in 1994 for each year for both the treated (in red) and control groups (in black). Confidence intervals are constructed at the 5% level. Panel B reports the coefficients of an event study difference-in-differences, where the dependent variable Y_{cit} is $\mathbb{1}(\text{Process-related abatement})_{cit}$. Specifically, the estimated coefficients (γ_k) of the following equation are reported:

$$\begin{aligned} Y_{cit} = \; & \text{CAS FE}_c \times \text{Facility FE}_i + \text{CAS FE}_c \times \text{Year FE}_t + \text{Legal status FE}_i \times \text{Year FE}_t \\ & + \text{NAICS FE}_i \times \text{Year FE}_t + \text{Firm-level controls}_{it} + \sum_{\substack{k=1992 \\ k \neq 1994}}^{1999} \gamma_k . \text{Year}_{tk} \times \text{Group}_i + \varepsilon_{cit} \end{aligned}$$

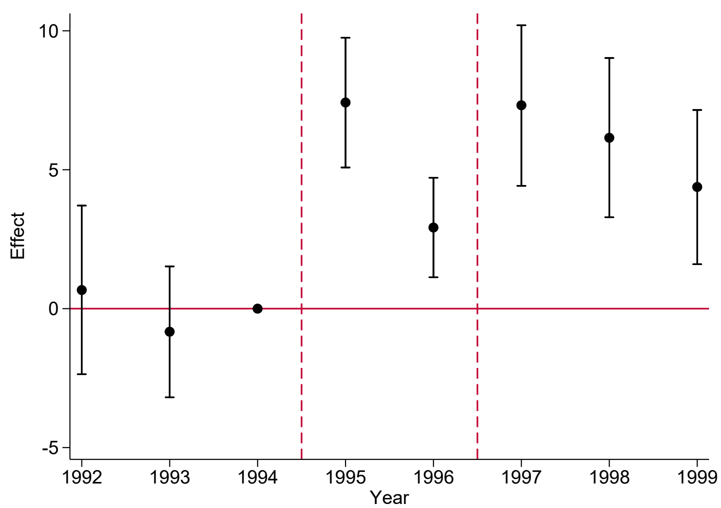
where Year_{tk} is a dummy variable that takes the value one if t is equal to k and zero otherwise. Group_i takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect. The two-digit NAICS code is defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls_{it} includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. The dataset is at the chemical-year level between 1992 and 1999.

Figure 4: Effect on Environmental Violations

Panel A:



Panel B:



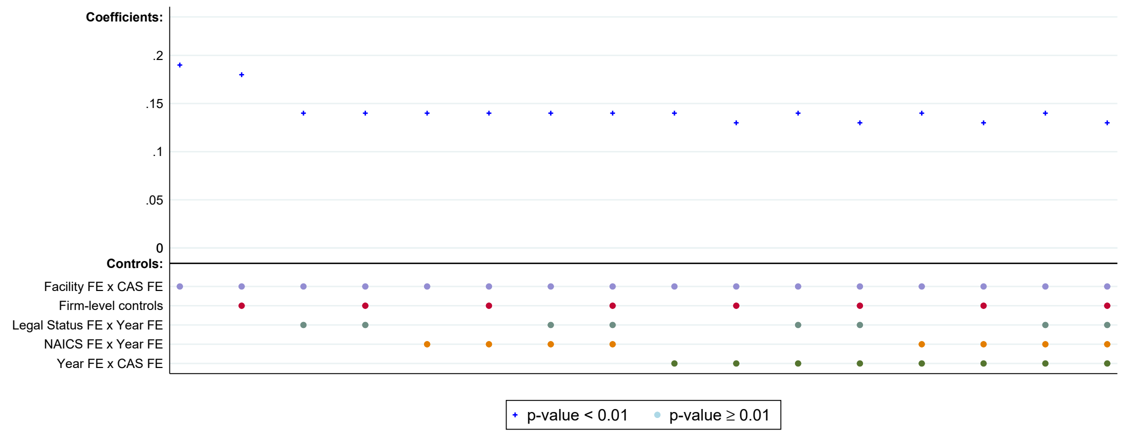
Note: Both figures represent the dynamics of outcomes around the Lender Liability Act, which was introduced to Congress in 1995 and enacted in 1996. The figure of Panel A reports the sample average of $\mathbb{1}(\text{RCRA environmental violation})_{it}$ for both the treatment and control groups. The averages are taken with respect to their level in 1994 for each year for both the treated (in red) and control groups (in black). Confidence intervals are constructed at the 5% level. Panel B reports the coefficients of an event study difference-in-differences, where the dependent variable Y_{cit} is $\mathbb{1}(\text{RCRA environmental violation})_{it}$. Specifically, the estimated coefficients (γ_k) of the following equation are reported:

$$\begin{aligned} Y_{cit} = \; & \text{Facility FE}_i + \text{Year FE}_t + \text{Legal status FE}_i \times \text{Year FE}_t \\ & + \text{NAICS FE}_i \times \text{Year FE}_t + \text{Firm-level controls}_{it} + \sum_{\substack{k=1992 \\ k \neq 1994}}^{1999} \gamma_k . \text{Year}_{tk} \times \text{Group}_i + \varepsilon_{cit} \end{aligned}$$

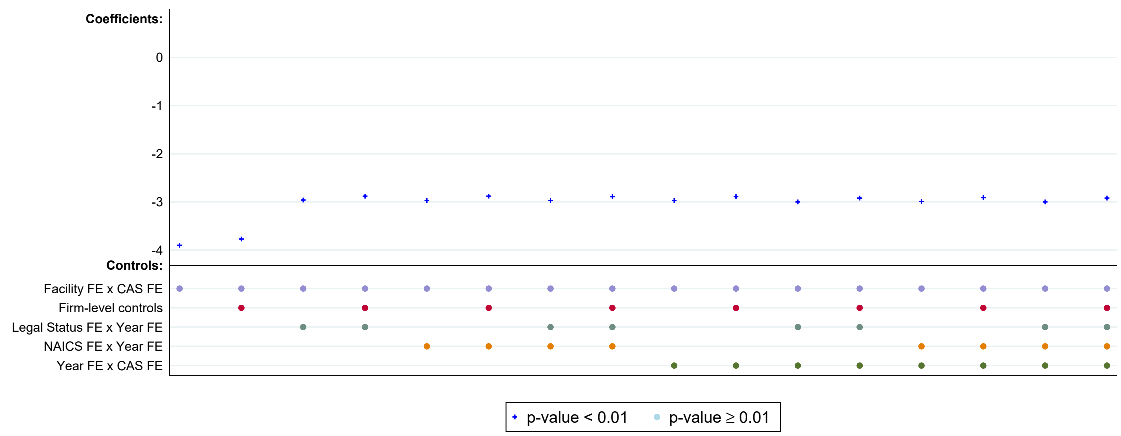
where Year_{tk} is a dummy variable that takes the value one if t is equal to k and zero otherwise. Group_i takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect. The two-digit NAICS code is defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls_{it} includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. The dataset is at the chemical-year level between 1992 and 1999.

Figure 5: Specification Curves: Pollution Outcomes

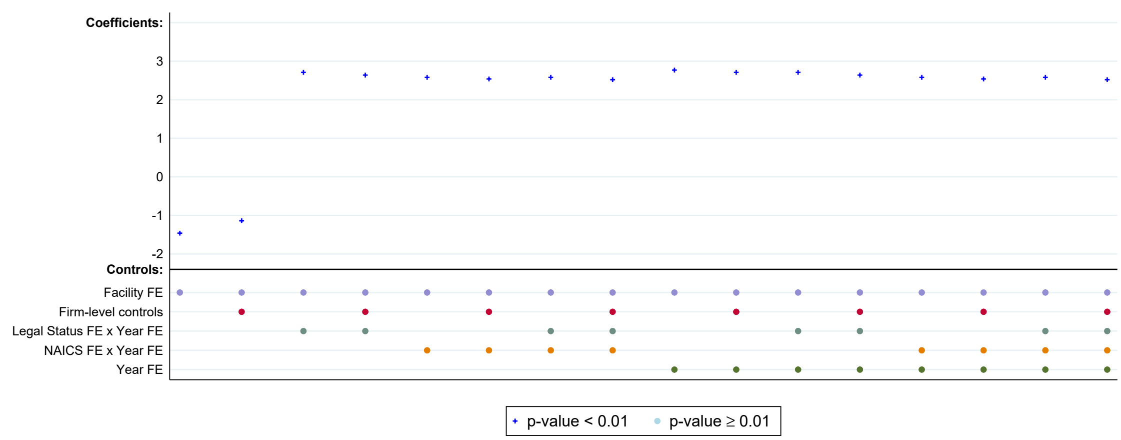
Panel A: on-site releases



Panel B: Abatement activities



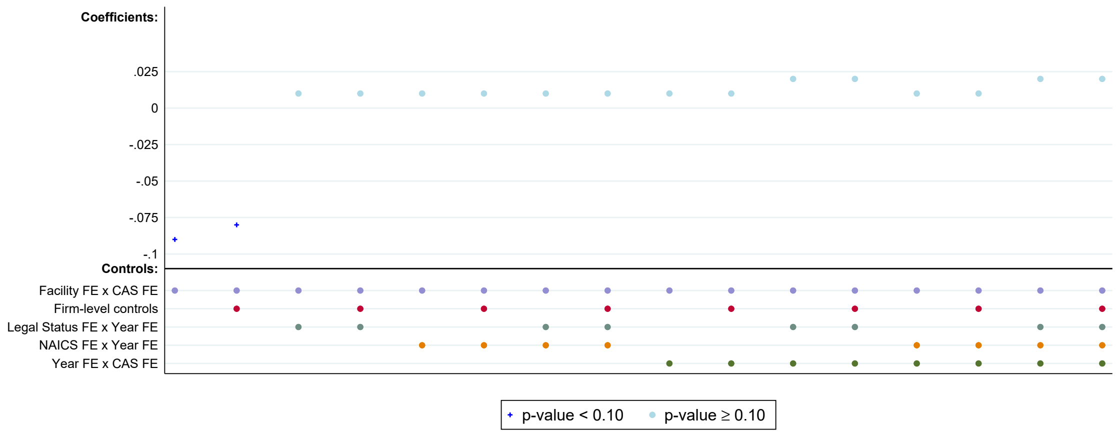
Panel C: Environmental violations



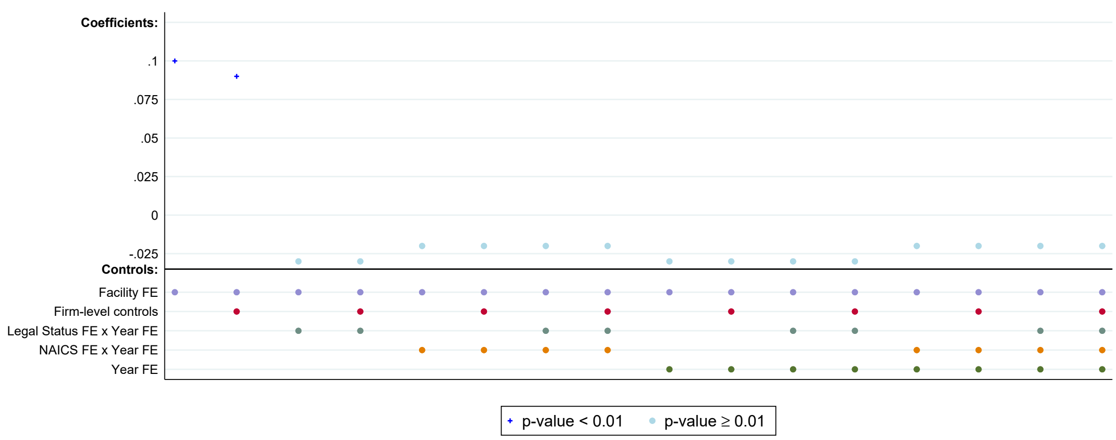
Note: The goal of these figures is to show how the coefficient of $\text{Post}_t \times \text{Group}_i$ varies for changes in the controls and fixed effects for the baseline specification of equation 1. Specifically, the figures of Panel A, B and C report the coefficient of $\text{Post}_t \times \text{Group}_i$ when the dependent variable is log(on-site CERCLA pollution+1)$_{cit}$, $\mathbb{1}$(Process-related abatement)$_{cit}$, and $\mathbb{1}$(RCRA environmental violation)$_{it}$ respectively. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls_{it} includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability.

Figure 6: Specification Curves: Production Outcomes

Panel A: Production ratios



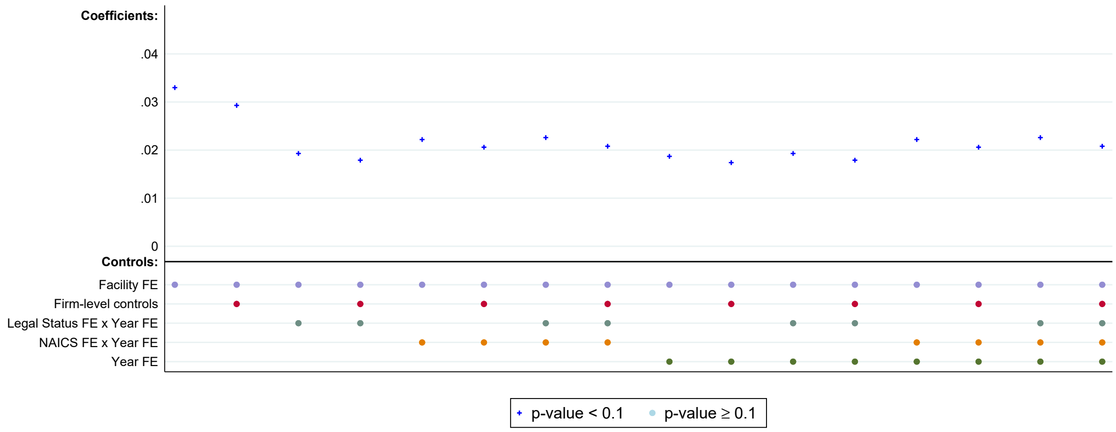
Panel B: Real output



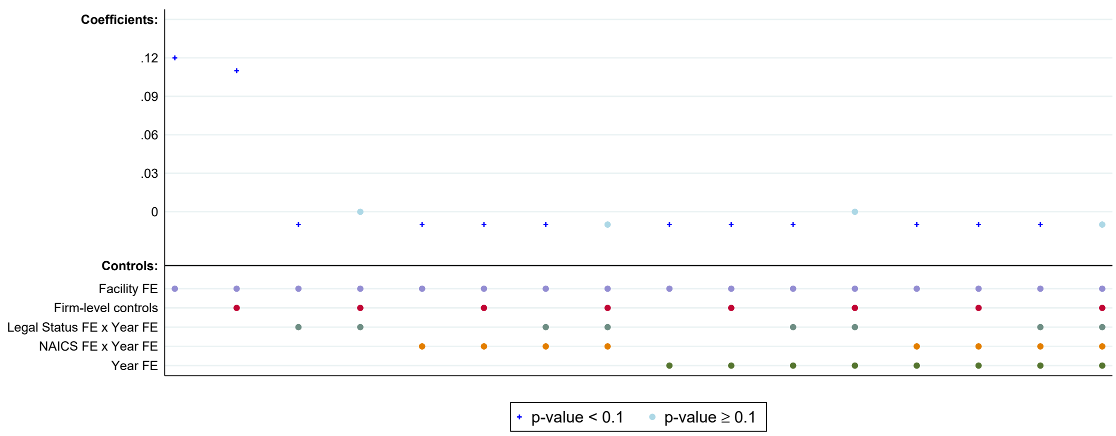
Note: The goal of these figures is to show how the coefficient of $\text{Post}_t \times \text{Group}_i$ varies for changes in the controls and fixed effects for the baseline specification of equation 1. Specifically, the figures of Panel A and B report the coefficient of $\text{Post}_t \times \text{Group}_i$ when the dependent variable is Production ratio_{cit} and $\log(Q)_{it}$ respectively. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls_{it} includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability.

Figure 7: Specification Curves: Workers' Outcomes

Panel A: Employment (log)



Panel B: Average annual payroll per employee (log)



Note: The goal of these figures is to show how the coefficient of $\text{Post}_t \times \text{Group}_i$ varies for changes in the controls and fixed effects for the baseline specification of equation 1. Specifically, the figures of Panel A and B report the coefficient of $\text{Post}_t \times \text{Group}_i$ when the dependent variable is $\log(\text{Emp})_{it}$ (the log of the total number of employees at the facility) and $\log(\text{wages})_{it}$ (the annual payroll of the facility divided by the total number of employees at the facility) respectively. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls_{it} includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability.

Table 1: Descriptive Statistics: Full Sample (1/2)

Variables	Mean	Standard Deviation
Total releases$_{cit}$	33,150	562,000
On-site releases$_{cit}$	29,000	547,000
$\mathbb{1}$(on-site CERCLA pollution)$_{cit}$	12	32.5
On-site CERCLA pollution$_{cit}$	10,500	389,100
Toxic$_{cit}$	0.467	0.498
$\mathbb{1}$(Process-related abatement)$_{cit}$	5.62	23
Air pollution$_{cit}$	18,500	381,100
IHS(on-site CERCLA pollution)$_{cit}$	0.7476	2.344
Production ratio$_{cit}$	0.669	0.793
Log(on-site CERCLA pollution+1)$_{cit}$	0.6719	2.155
Log(air pollution+1)$_{cit}$	3.497	4.228
On-site CERCLA pollution per facility capital$_{cit}$	0.6628	63.7
$\mathbb{1}$(Environmental violation)$_{it}$	11.9	32.4
Capital intensity$_{it}$	0.06388	0.03929
Cash Flow$_{it}$	0.09876	0.06952
Cash Holding$_{it}$	0.05419	0.07527
Cost of Capital$_{it}$	6.055	106.2
ROA$_{it}$	0.04629	0.09525
ROE$_{it}$	-0.5101	54.59
Tangibility$_{it}$	0.371	0.1585
Tobin's Q$_{it}$	1.719	0.8519
Leverage$_{it}$	0.7439	1.825
Employment$_{it}$	590.9	1374
Wage$_{it}$ (thousand, $)	37.51	14,15
Z Score$_{it}$	3.54	2.139
Capital (structure, thousand, $)$_{it}$	44,770	168,000
Other liabilities (LO, thousand, $)$_{it}$	606.9	1,250
Real Output$_{it}$ (thousand, $)	243,700	733,100

Note: This table reports the descriptive statistics of the main variables used in the empirical analysis. Estimates have been rounded to 4 significant digits according to the disclosure avoidance practices in place at the Census Bureau.

Table 2: Descriptive Statistics: Balance Test (2/2)

Variables	Group treated	Control group	Diff	P-value
Production ratio$_{cit}$	0.727	0.74	0.0133	0.192
Total releases$_{cit}$	35,110	36,890	1,777	0.8235
On-site CERCLA pollution$_{cit}$	6,495	12,650	6,157	0.2613
$\mathbb{1}$(on-site CERCLA pollution)$_{cit}$	11.5	11.6	0.0511	0.975
Toxic$_{cit}$	0.475	0.466	-0.0094	0.238
$\mathbb{1}$(Process-related abatement)$_{cit}$	7.96	6.37	-1.59**	0.0162
Air pollution$_{cit}$	22,290	21,020	-1,272	0.7458
Capital intensity$_{it}$	0.0455	0.0467	0.0012	0.6541
Cash Flow$_{it}$	0.0702	0.0698	-0.0004	0.8554
Cash Holding$_{it}$	0.0456	0.0435	-0.0021	0.3336
Cost of Capital$_{it}$	4.974	4.363	-0.611	0.2785
ROA$_{it}$	0.0258	0.0249	-0.0009	0.4583
ROE$_{it}$	0.0078	-0.0011	-0.0089	0.1667
Tangibility$_{it}$	0.3122	0.3035	-0.0087	0.6782
Tobin's Q$_{it}$	1.086	1.043	-0.0434	0.1357
Leverage$_{it}$	0.7477	0.7243	-0.0234	0.8959
Other liabilities (LO)$_{it}$	855.8	1,469	613.2***	0.0003

Note: This table reports the descriptive statistics of the main variables used in the empirical analysis, for both the treated group (facilities in the 11th Circuit) and control group (facilities not located in the 11th Circuit), before 1994 (included), that is when the Lender Liability Act is first introduced. Estimates have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table 3: Net Effect on Pollution Measures and Environmental Violations

	(1)	(2)	(3)
$Post_t \times Group_i$	0.132^{***}	2.105^{***}	2.521^{***}
	(0.0158)	(0.279)	(0.643)
Observations	210,000	210,000	27,000
R-squared	72.5	69.9	28.8
Facility FE_i			x
CAS $FE_c \times$ Year FE_t	x	x	
Facility $FE_i \times$ CAS FE_c	x	x	
Legal $status_i \times$ Year FE_t	x	x	x
NAICS $FE_i \times$ Year FE_t	x	x	x
Firm-level $controls_{it}$	x	x	x

Note: These tables report the difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Asset Conservation Lender Liability and Deposit Insurance Protection Act was passed. The dependent variable of column (1) is log(on-site CERCLA pollution+1)$_{cit}$, the log of the on-site releases minus air pollution plus one for chemical c, time t and facility i. The dependent variable of column (2) is $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$ a dummy variable that takes the value 100 if the on-site releases (excluding air pollution) of chemical c, for facility i at time t are strictly positive and 0 otherwise.The dependent variable of column (3) is $\mathbb{1}$(RCRA environmental violation)$_{it}$, a dummy variable that takes the value one if the establishment has an environmental RCRA violation and zero otherwise. The dataset for column (1) and (2) is at the chemical-year level between 1992 and 1999 and the dataset for column (3) is at the establishment-year level. $Post_t$ is a variable that takes one after 1996 (included) and zero otherwise. $Group_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level $controls_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, tobin's Q and the total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table 4: Effect on Production

Panel A: Production (real output)

	Dependent variable: $\log(Q)_{it}$			
	(1)	(2)	(3)	(4)
$Post_t \times Group_i$	-0.0310**	-0,0198	-0,0208	-0.0183
	(0.0130)	(0.0127)	(0.0123)	(0.0109)
Observations	22,500	22,500	22,500	22,500
R-squared	95.3	95.4	95.4	95.5
Facility FE_i	x	x	x	x
Year FE_t	x			
NAICS $FE_c \times$ Year FE_t		x	x	x
Legal $status_i \times$ Year FE_t			x	x
Firm-level $controls_{it}$				x
Sample Mean Q_{it} (thousand $)	243,700	243,700	243,700	243,700

Panel B: Production ratio

	Dependent variable: Production $ratio_{cit}$			
	(1)	(2)	(3)	(4)
$Post_t \times Group_i$	0.00756	0.0151	0.0152	0.0178
	(0.0107)	(0.0116)	(0.0115)	(0.0113)
Observations	210,000	210,000	210,000	210,000
R-squared	35.6	41.3	41.4	41.4
Facility $FE_i \times$ CAS FE_c	x	x	x	x
Year FE_t	x			
Legal $status_i \times$ Year FE_t		x	x	x
CAS $FE_c \times$ Year FE_t		x	x	x
NAICS $FE_i \times$ Year FE_t			x	x
Firm-level $controls_{it}$				x
Mean Dep. Var.	0.669	0.669	0.669	0.669

Note: These tables report the difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Asset Conservation Lender Liability and Deposit Insurance Protection Act was passed. The dataset is at the establishment-year level for panel A and at the chemical-establishment-year level for panel B. They both go from 1992 to 1999. The dependent variable of Panel A is $\log(Q)_{it}$, which is the log of the real production for facility i at time t. The dependent variable of Panel B is the Production $ratio_{cit}$ of the component c for plant i at time t . $Post_t$ is a variable that takes one after 1996 (included) and zero otherwise. $Group_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level $controls_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table 5: Effect on Abatement Technology

	Dependent variable: $\mathbb{1}$(Process-related abatement)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	-2.935***	-3.001***	-2.999***	-2.917***
	(0.231)	(0.226)	(0.222)	(0.242)
Observations	210,000	210,000	210,000	210,000
R-squared	50.4	51.4	51.4	51.5
Facility $\text{FE}_i \times$ CAS FE_c	x	x	x	x
Year FE_t	x			
Legal $\text{status}_i \times$ Year FE_t		x	x	x
CAS $\text{FE}_c \times$ Year FE_t		x	x	x
NAICS $\text{FE}_i \times$ Year FE_t			x	x
Firm-level controls_{it}				x
Mean Dep. Var.	5.62	5.62	5.62	5.62

Note: These tables report the difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Asset Conservation Lender Liability and Deposit Insurance Protection Act was passed. The dependent variable is $\mathbb{1}$(Process-related abatement)$_{cit}$, a dummy that takes the value 100 if the establishment invested in an abatement technology that changes the production process and zero otherwise. The dataset is at the chemical-year level between 1992 and 1999. Post_t is a variable that takes one after 1996 (included) and zero otherwise. Group_i takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls_{it} includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table 6: Placebo on Air Pollution

	Dependent variable: log(air pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
$Post_t \times Group_i$	-0.0306	-0.0223	-0.0291	-0.0289
	(0.0529)	(0.0433)	(0.0409)	(0.0397)
Observations	210,000	210,000	210,000	210,000
R-squared	71.5	76.6	76.6	76.6
Facility $FE_i \times$ CAS FE_c	x	x	x	x
Year FE_t	x			
Legal $status_i \times$ Year FE_t		x	x	x
CAS $FE_c \times$ Year FE_t		x	x	x
NAICS $FE_i \times$ Year FE_t			x	x
Firm-level $controls_{it}$				x

Note: These tables report the difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed. The dependent variable is log(on-site air pollution+1)$_{cit}$, the log of air pollution plus one. The dataset is at the chemical-year level between 1992 and 1999. $Post_t$ is a variable that takes one after 1996 (included) and zero otherwise. $Group_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level $controls_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table 7: Cross-Sectional Regressions

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$				
	(1)	(2)	(3)	(4)	(5)
$\text{Post}_t \times \text{Group}_i$	0.0760***	0.107***	0.0159	0.0524**	0.144***
	(0.0232)	(0.0229)	(0.0164)	(0.0171)	(0.0157)
$\text{Post}_t \times \text{Group}_i \times \text{Cross}_i$	0.155***	0.141***	0.202***	0.169***	-0.0905***
	(0.0107)	(0.0222)	(0.0121)	(0.0322)	(0.0240)
Observations	170,000	135,000	210,000	210,000	210,000
R-squared	74	74.5	72.5	72.5	72.5
Facility FE$_i \times$ CAS FE$_c$	x	x	x	x	x
Legal status$_i \times$ Year FE$_t$	x	x	x	x	x
CAS FE$_c \times$ Year FE$_t$	x	x	x	x	x
NAICS FE$_i \times$ Year FE$_t$	x	x	x	x	x
Firm-level controls$_{it}$	x	x	x	x	x

Note: These tables report triple difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed. In column (1), the variable Cross$_i$ is equal to High Leverage in 1995$_i$, which is a dummy variable that takes the value one if the firm has a leverage in 1995 that is above the median sample value of the state where the establishment is located, and zero otherwise. In column (2), the variable Cross$_i$ is equal to Distress in 1995$_i$, which is a dummy variable that takes the value one if the firm has a Z-score that is below the median sample value of the state where the establishment is located, and zero otherwise. In column (3), the variable Cross$_i$ is equal to High LO in 1995$_i$, which is a dummy variable that takes the value one if the firm has a a value of non-financial liability, including accrual for expected future environmental costs, in 1995 that is above the median sample value of the state where the establishment is located, and zero otherwise. In column (4), the variable Cross$_i$ is equal to a dummy variable, Toxic$_c$, that takes the value one if the chemical is toxic according to the IRIS database and zero otherwise. In column (5), the variable Cross$_i$ is equal to Young$_i$, which is a dummy variable that takes the value one if the firm has an age that is above the median sample value of the state where the establishment is located, and zero otherwise. The variable age comes from the LBD. The dependent variable is log(on-site CERCLA pollution+1)$_{cit}$. The dataset is at the chemical-year level between 1992 and 1999. Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table 8: Impact on Employment and Wage

Panel A: Employment

	Dependent variable: log(emp)$_{it}$			
	(1)	(2)	(3)	(4)
Post$_t$ $\times$ Group$_i$	0.0187*	0.0222**	0.0226**	0.0208**
	(0.00859)	(0.00831)	(0.00898)	(0.00873)
Observations	27,000	27,000	27,000	27,000
R-squared	96	96.1	96.1	96.1
Facility FE$_i$	x	x	x	x
Year FE$_t$	x			
NAICS FE$_c$ $\times$ Year FE$_t$		x	x	x
Legal status$_i$ $\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x
Sample mean emp	590.9	590.9	590.9	590.9

Panel A: Payroll per employee

	Dependent variable: Log(wages)$_{it}$			
	(1)	(2)	(3)	(4)
Post$_t$ $\times$ Group$_i$	-0.00699**	-0.00741**	-0.00612*	-0.00508
	(0.00263)	(0.00290)	(0.00322)	(0.00295)
Observations	27,000	27,000	27,000	27,000
R-squared	83.2	83.3	83.4	83.4
Facility FE$_i$	x	x	x	x
Year FE$_t$	x			
NAICS FE$_c$ $\times$ Year FE$_t$		x	x	x
Legal status$_i$ $\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x
Sample Mean Wages	37,510	37,510	37,510	37,510

Note: These tables report the difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed. The dependent variable of Panel A is log(emp)$_{it}$ where emp is the total number of employees in the LBD and log(wages)$_{it}$ is the annual payroll divided by emp from the LBD. Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

ONLINE APPENDIX

A Datasets, variables and descriptive statistics

A.1 Data sources and linkages

I exploit five main confidential datasets from the US Census Bureau, that I link together using the establishment or firm identifiers. First, I use the Longitudinal Business Dataset (LBD), which is a longitudinal database at the establishment level that tracks information on annual payrolls, employment, and linkages of establishments for multi-unit firms across years. It contains the population of firms with at least one employee in the United States (Chow et al. (2021)). The LBD is built from administrative survey data and information transmitted by the Internal Revenue Service (IRS). The LBD does not contain the establishments' names and addresses. I collect this information using the Business Register (BR). Second, I exploit the Census of Manufactures (CMF), which collects detailed information on establishments' quantity of inputs, costs and the real output among the population of manufacturing firms. This mandatory survey, which exposes firms to fines if they misreport, is conducted every year that ends by in the number 7 or 2 (e.g. 1992, 1997). Third, I rely on the Annual Survey of Manufactures (ASM). This data source is similar to the CMF, except that the information is collected for years that do not end in 7 or 2 and it contains a fraction of the total manufacturing establishments. Specifically, all establishments with more than 250 employees are included, while the remaining ones are sampled with a probability that increases according to the number of employees. Fourth, I use the Compustat-SSEL bridge developed by the Census Bureau to merge Compustat with the LBD.

I exploit four main datasets from the EPA, which I merge using their administrative identifiers or the chemical numbers. The first source of pollution comes from the toxic release inventory (TRI). The database is constructed using the EPA Form R or Form A Certification Statement. The data are collected following Section 313 reporting requirements of the 1986 Emergency Planning and Community Right-to-Know Act (EPCRA). It provides administrative information on the hazardous releases and disposal made by facilities that are either above 20,000 hours full-time equivalent employees, within a determined set of industries code or that employ certain chemicals above specific thresholds. The second dataset is drawn from RCRA Corrective Action Enforcement database. The data on enforcement actions allow me to establish a picture of environmental compliance at the facility level, which ultimately affects the probability and severity of hazardous releases. It includes, for instance, whether the facility failed to train employees in hazardous waste management properly, has open or leaking containers of hazardous waste or poor labeling of their hazardous waste, such as an absence of hazardous waste manifests or determinations. The third dataset is the EPA's Integrated Risk Information System (IRIS), which contains information on chemical toxicity for each CAS number reported in the TRI. The fourth and final dataset is the EPA's Pollution Prevention (P2) database, which provides information on firms' production ratios and abatement activities.

There is no existing linkage between the administrative identifiers of EPA databases and the ones from the US Census Bureau. Therefore, I perform several fuzzy-matching steps to connect the environmental datasets from the EPA to the BR from the Census Bureau, which I describe in section H in the online appendix. The algorithm exploits a notable advantage of the BR database: the ability to perform the match at the establishment level. Specifically, the matching exploits the street name and establishment's names; the physical address number; the zip, county, and state codes; and the two-digit NAICS industry code when this information is not missing. The accuracy of all final matches is manually verified.

I perform several data consistency checks of the final link table and dataset. I show that the main measure of pollution from TRI correlates well with both measures of production size from the ASM/CMF. Specifically, in Panel A of figure A.2 in this online appendix, I plot the binscatter between real production (Panel A) and log(on-site CERCLA pollution+1)$_{cit}$. Each of the dots represents the average of the two variables for each 5th percentile of real production. The binscatter exhibits a strong linear and positive relationship between the two variables. This finding demonstrates that the dataset used is able to replicate the stylized fact that a higher production scale leads to a mechanical increase in pollution. Panel B of figure A.2 in this online appendix performs the same exercise but with another proxy for production scale, namely the capital in structure and building used by the facility.

Panel C of figure A.2 shows the classical relationship between the probability of default and pollution releases. Firms close to bankruptcy are more likely to increase pollution, a classical result known as the judgment proof problem (Shavell (1986)). The reason is similar to a risk-shifting mechanism: firms only fully benefit from additional pollution at time 0, namely through reduced abatement costs, but bear part of the cost in the future, namely higher litigation costs, because these costs are truncated to 0 if the firm files for bankruptcy. Consistent with this mechanism, Panel C of figure A.2 shows a negative relationship between pollution and the Altman Z-score. Overall, these tests confirm the quality of the matched links between the EPA and US Census Bureau datasets.

I perform two additional data consistency checks of the final link table. Participating in the TRI implies that the firm met an employment threshold. I, therefore, verify whether this employment threshold is met using information from the LBD. Next, I confirm that the exit and entry patterns of facilities in the TRI are consistent with the exit and entry patterns from the LBD, supporting the quality of the link table.

I explain in the online appendix I how I constructed the database and reports how I merge the datasets step-by-step and the number of observations in each step. I clean the raw files in a way that is consistent with previous works using US Census Bureau data or the TRI. I verify that the results do not depend on the ways I clean the dataset.

A.2 Variable construction

The main measure of hazardous waste used in this paper is log(on-site CERCLA pollution+1)$_{cit}$, which is the log of the on-site pollution minus air pollution that does not expose the facility to CERCLA liabilities, for facility i, in year t and for the toxic component c. The reason I exclude air pollution is that this type of waste does not expose the owner of the facility to CERCLA liability. To run a placebo, I construct a variable log(on-site air pollution+1)$_{cit}$ that is the log of the on-site air pollution plus one. Figure A.1 exposes what on-site releases contain. According to EPA and previous academic studies (Akey and Appel (2021), Li, Xu, and Zhu (2021)), more on-site releases expose the owner to a higher probability of an environmental spill. Therefore, this type of discharging pollution is the least preferred one by EPA, as shown in the hierarchy of hazardous waste management (see figure A.4 in the online appendix).

While the practice of adding one when taking the variable is used by almost all researchers using the TRI, it could theoretically lead to biased estimates. Therefore, I construct three additional transformations of this variable. I construct the variable $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, that is a dummy variable taking the value 100 if on-site CERCLA pollution is strictly positive and zero otherwise. Next, I use the inverse hyperbolic sine transformation, which has been increasingly popular in empirical work (see for Burbidge, Magee, and Robb (1988)). It is approximately equivalent to the natural logarithm but is well defined at zero. Finally, I renormalize (on-site CERCLA pollution)$_{cit}$ by the total capital of the establishment.

I also use environmental variables that are not part of the TRI database. For example, $\mathbb{1}$(Process-related abatement)$_{cit}$, is a dummy that takes the value 100 if the establishment invested in an abatement technology that changes the production process and zero otherwise. Abatement activities that directly reduces the source of pollution during the production process are considered by the EPA as the most reliable source of pollution reduction (see figure A.4 in the online appendix). $\mathbb{1}$(RCRA environmental violation)$_{it}$ is a dummy variable taking the value 100 if the establishment has at least one RCRA environmental violation and zero otherwise. A firm with an RCRA environmental violation means that the firm has not abided by all regulations that aim at minimizing the probability of an environmental contamination. Finally, I use the EPA's Integrated Risk Information System to construct the variable toxic$_{ict}$, a dummy variable taking the value one if the chemical poses a threat to human health and zero otherwise. A component is toxic if people exposed to it have alterations in their biological system, such as the cardiovascular or dermal system, or if it causes cancer.

Two distinct measures of production are available. First, I observe the variable Production ratio$_{cit}$, which is the ratio of the output at time t over the output at time $t-1$ from which the chemical is used. Second, I observe the variable *log(Q)*$_{it}$, which is the logarithm of the real output of the facility from the CMF/ASM.

I construct other firm-level variables from the US Census Bureau. Specifically, log(emp)$_{it}$ and log(wage)$_{it}$ are respectively the logarithm of the number of employees and the total payroll amount divided by the number of employees. For some tests, I include all the inputs, some costs and the real output from the ASM/CMF defined at the establishment level as controls.

I use Compustat to construct proxies for default and environmental liability risks as well as firm-level controls. I investigate whether the effect is more substantial for a firm with higher leverage or Z-score in 1995. Similarly, I test whether the effect is stronger for young firms, as they are less likely to be exposed to environmental contamination, or for firms that report more environmental liability. Specifically, I measure contingent environmental liability in the same way as Akey and Appel (2021), that is, by using the variable lo in Compustat. This variable captures non-financial liability, including accrual for expected future environmental costs. Finally, I construct firm-level controls using Compustat.

B Sensitivity analysis

B.1 Other measures of pollution

Previous papers that also use the TRI database (for instance Akey and Appel (2021, 2019); Xu and Kim (2022)) apply the natural logarithm plus one to the measure of pollution releases. I also use this transformation in the paper. However, as on-site pollution can be equal to zero, researchers add one to the original variable to correctly apply a logarithm transformation. Adding plus one to the dependent variable before taking the natural logarithm changes the initial interpretation of a log-level regression as a semi-elasticity, and is non-robust to different data generating processes (Cohn, Liu, and Wardlaw (2022)).

To verify that this transformation does not drive the results, I first apply an inverse hyperbolic sine transformation, which has been increasingly popular in empirical work (see for instance Burbidge, Magee, and Robb (1988)). It is approximately equivalent to the natural logarithm but is well defined at zero. Panel A of Table A.3 reports the results. The coefficient capturing the causal impact of the Lender Liability Act is statistically significant and the economic magnitudes are consistent with the baseline effect, predicting an increase in pollution of 14%. Finally, Panel B of Table A.3 shows the results when the on-site releases are normalized by the capital used by the plant. The results are consistent with the baseline effect and still predict an increase in pollution.

B.2 Adjacent circuits as a control group

The choice of the control group faces a trade-off between comparability and spillover effects. If we compare two nearby plants, except that one is located in the 11th Circuit and the other one is not, then the two plants are plausibly exposed to the same local economic shocks. However, that there may be spillover effects, in the sense that the economic activity from one plant could move to the other one following the treatment, as the transportation and labor switching costs are low.

To maximize the level of comparability between plants, I first run the baseline specification of equation 1 by selecting states from the 5th, 6th and 4th Circuits, which are all adjacent to the 11th Circuit. Doing so increases the likelihood that regional economic shocks would affect the treated and control group similarly. Table A.4 displays the estimated results, which are consistent with the baseline results that use the entire sample.

To minimize possible spillover effects between plants, I run the baseline specification of equation 1 by excluding states from the 5th, 6th and 4th Circuits in the control group. This filtering translates to removing from the control group plants located in a Circuit adjacent to the 11th Circuit (the treated group). Table A.5 reports the estimated results for the main outcome variables. The effects are consistent with the baseline results that use the whole sample.

B.3 Changes in the panel time frame

The choice of the sample time frame is subject to a trade-off between statistical power and robustness. The longer the sample time frame, the higher the statistical power of the estimator, as they rely on a large time dimension. However, this comes at the cost of robustness, because it increases the likelihood of having a random and concomitant state-level shock that would affect the treated and control groups differently.

I exploit different time horizons: 1993 to 1998 (Table A.6), then 1994 to 1997 (Table A.7) and 1995 to 1996 (Table A.8). The time horizon of 1995 and 1996 is highly restrictive, as it compares pollution decisions for firms within the time the legislation was discussed (1995) in Congress and passed (1996). Despite such a restriction, the results are always statistically significant, both on the extensive and intensive margins.

B.4 Clustering and standard errors

The environmental compliance variables that are used are potentially highly serially correlated. Firms' pollution decisions depend on many factors, some of which could be fixed for several years. Even if these factors are strictly exogenous, they could create a bias in the way standard errors are computed, as shown by Bertrand, Duflo, and Mullainathan (2004). This bias would lead to inflated t-statistics, creating an over-rejection bias of the null hypothesis and more statistically significant results of our coefficient of interest, namely the interaction of $\text{Post}_t \times \text{Group}_i$.

As suggested by Bertrand, Duflo, and Mullainathan (2004), one credible way to address this problem is to aggregate the data into a pre-treatment (before 1996) period and a post-treatment (after 1996) period and then estimate the baseline model using this transformed dataset. Aggregating the data in such a way removes the time-series dimension, which limits the time-series correlation problem. Column (1) of Table A.10 reports the results when such aggregation is made. The economic magnitudes of this before and after comparison are slightlty higher than in the baseline specification. Notably, the results remain statistically significant.

I then perform different ways of clustering and computing the standard errors. I first adopt a bootstrapped approach to compute the standard errors. As the specifications include a many fixed effects, which make the bootstrapped approach time-consuming, I take the first difference of the before and after sample. These transformations of the sample allow me to compute almost instantaneously an unbiased and asymptotically consistent estimator, which makes the bootstrapped approach implementable. Column (2) of Table A.10 shows the standard errors and point estimate without the bootstrapped approach, while column (3) of Table A.10 reports the p-value of the significance of the coefficient of interests using the bootstrapped standard error. Finally, I cluster the standard errors at the firm level (column (4) of Table A.10) and at the chemical level (column (5) of table A.10). The significance of the results remains identical.

B.5 Changes in the coverage of chemicals reporting

The list of chemicals eligible establishments must report changes with time because of evolving needs of the public and EPA priorities as well as advances in innovation and information technology. Enforcement and the ability to report also change with time. For instance, the chemical component *hydrogen sulfide* was supposed to be added to the reporting list in 1995, but some issues were raised in an administrative stay, so the chemical was not added to the list that year.

Given this time-varying coverage in the number of chemicals, one concern could be that the estimated causal effects rely more on the cross-sectional variation's post-treatment rather than on double differences pre and post-treatment. While having an effect estimated using only the cross-sectional variations is still consistent with the message of the paper, it would rely on more identifying assumptions about the unobserved heterogeneity than a difference-in-differences specification does, where the comparison post and pre-treatment is an important source of credibility.

I design a test to show that this is not a concern in the sample. Specifically, I drop all the chemicals that were never reported before 1995 and re-run the baseline estimates. Table A.9 shows the results, which are consistent with the baseline effects estimated using the full sample, ruling out an explanation of the effect driven by an endogenous change in the list of chemicals to be reported.

C Theoretical predictions regarding the relationship between environmental lender liability and pollution

Both banking theories and theoretical models of vicarious liability —that is when one party is responsible for another party's liabilities— provide an ambiguous relationship between pollution and environmental lender liability. In this section, I sort the theories that motivate my empirical analysis according to their predictions regarding the sign of the relationship between pollution and environmental lender liability.

C.1 Less environmental lender liability leads to more pollution

The starting point of the literature on lenders' vicarious liability (Pitchford (1995), Balkenborg (2001)) relies on three assumptions. First, lenders cannot write perfect contracts specifying to debtors which environmentally practices to adopt. As a result, lenders incentivize debtors by writing contracts that depend on the occurence of an environmental accident. Second, environmental accidents lead to the bankruptcy of the firm. Third, the lending market is competitive. Under these assumptions, higher environmental lender liability increases the expected cost of providing funding, thus forcing lenders to ask for more surplus. As a result, debtors' net payoff is now reduced in the absence of an accident, but remains the same should an accident occur. The reason is that in the accident state, the firm files for bankruptcy and its payoffs are always equal to zero. This mechanism decreases the debtor's incentive to exert environmental compliance effort. In equilibrium, more environmental lender liability leads to more pollution.

A key component of Pitchford (1995) is that firms with a higher cost of capital have greater incentives to decrease investment in abatement technology projects. As a result, the intuition still hold in a world with unsecured debt or equity issuances, as long as secured debt is unique in reducing debtors' cost of capital. Secured debt has specific contractual properties that lead to a lower cost of capital. Under the Article 9 of the Uniform Commercial Code (henceforth, UCC), secured debtholders have a security interest in an explicitly identifiable asset, that they can seize if the borrower fails to repay their credit prior to bankruptcy. As such, secured debt is more easily enforceable than a contractual right. Lender consent is required to sell, move, transform, or reallocate an encumbered asset, protecting their security interest. These unique contractual features of secured debt allow lenders to reduce their monitoring costs[20] and make more credible threats,[21] which discipline debtors and lower their costs of capital.

C.2 Less environmental lender liability lowers pollution

If environmental liability for secured lenders makes the usage of secured debt too costly, it could paradoxically increase firms' debt capacity from unsecured debtors. Given the priority rule, the expected value of unsecured debt is reduced once a debtor obtains secured debt. Unsecured debtors often write negative pledge covenants to bar other debtholders from encumbering firms' assets (Bjerre (1998), Ivashina and Vallee (2020)). These negative pledge covenants are enforceable only against the borrower and not against third parties with a security interest that violates the covenant. Consequently, if debtholders cannot use secured debt because of the exposure it creates to firms' environmental cleanup costs, then it makes firms' commitment not to encumber their assets more credible, thus boosting their pledgeable income.

If a lender has full bargaining power, then more lender liability leads to a greater safety effort on the part of the debtor (Balkenborg (2001), Heyes (1996), Shavell (1997)). The lender will induce more safety effort by lowering the cost of debt to the owner of the facility when no environmental liability is to be paid. This action is possible because the lender's participation constraint is not binding. The result holds if the liability incurred or the probability of an accident is not too large.

Contrary to the assumption of Pitchford (1995), an environmental spill of minimal impact can happen without causing the firm to file for bankruptcy. Under this new assumption, a lender can derive a contract to incentivize the debtor to improve its environmental practices if two conditions are met (Lewis and Sappington (2001), Pitchford (2001)): first, it is not possible for the debtor to hide a small environmental spills from the lender; second, the debtor's environmental effort has one dimension, which means that it is not possible to reduce the probability of a small environmental spill without reducing the probability of a significant environmental disaster (that causes the firm to file for bankruptcy). These assumptions guarantee that small environmental spills are both *observable* and *informative* regarding the probability of firms' larger environmental accidents. As a result, the lender will punish the debtor when such a small environmental spill occurs but rewards it if no accident happens. Such a contract can reach the first-best allocation of pollution.

[20]Lenders that focus on some specific physical assets instead of the entire company or its going concern face reduced monitoring complexity (Jackson and Kronman (1978)). Moreover, secure debt solves coordination frictions in monitoring tasks when a firm borrows from multiple lenders (Rajan and Winton (1995), Park (2000)). The secured lender has an incentive to bear the full cost of monitoring because it reaps the full reward of the monitoring effort, as the lender will be first to seize any assets it secured.

[21]A rich literature in contract theory shows that lenders optimally punish debtors by seizing their collateral, if they strategically default or do not exert effort to maximize profit. Borrowers anticipate the threat of liquidation, which disciplines them, thus boosting their equilibrium pledgeable income. The mechanism does not require debt to be secured, but higher liquidation value makes collateral repossession in case of non-repayment less costly for the lenders, which decreases borrower financial constraints. Empirical works support the view that bankruptcy payoffs affect the decision of agents to file for bankruptcy (Indarte (2020), Yannelis (2016)).

In practice, while contracts are far from perfect, lenders use more than just different state-dependent surpluses to incentivize their debtors, as in Pitchford (1995). First, lenders can use the debt maturity to discipline their debtors through the threat of not rolling over their debt (Myers (1977)). Second, lenders use covenants, which allow them to monitor in a state-contingent manner and ensure that they benefit from additional information regarding any intermediary spills. For instance, Choy et al. (2021) document that banks write covenants stipulating that debtors carry out remedial actions, conduct environmental audits, and disclose environmental events.

D Contaminated areas in the United States

To put the results of this paper into perspective, this section describes some salient facts on contaminated sites in the United States. Specifically, subsection A shows that federal funding allocated to environmental cleanup in the United States has diminished in the last 20 years, despite the immense cost of environmental liabilities (subsection B) and the social benefits of environmental cleanups (subsection C). Finally, I summarize studies that show that climate change will make the brownfield problem in the United States even more acute.

D.1 Clean up cost of all currently contaminated sites in the United States

Estimates about the total cost of cleaning up all contaminated areas do not exist and the problem "is plagued by a lack of quantitative data" (Northeast Midwest Institute).

One way to provide a quantification is to collect information using public balance sheet and recent policy proposals. The US government's environmental liability amounted to $577 billion in fiscal year 2018. However, this number does not take into account the cleanup of sites contaminated by per- and polyfluoroalkyl substances (PFAS). During a House Defense Appropriations Subcommittee meeting in 2021, Richard Kidd, deputy assistant secretary of defense for environment and energy resilience, estimated that cleaning military sites to remove this substance would cost $29 billion. In Biden's proposal of March 2021, $16 billion were allocated for cleaning abandoned mines and orphaned oil and gas wells (E&E News PM, March 31). These numbers omit the cleanup of abandoned sites owned by private entities that are not in the oil and gas or mining industries but provide a conservative lower bound estimate of $622 billion.

Precise estimates about the magnitudes of the problem for other private sites are not readily available. There is an agreed estimated number of 450,000 brownfields in the United States. Moreover, there were 1,374 sites registered in the National Priorities List (NPL) and awaiting remedial action. On average, a Superfund site costs between $25 and $50 million and the average per-site cost for brownfield remediation is estimated at $602,000 according to the Northeast Midwest Institute, which is based on cleanup data from EPA (Paull (2008)). The extrapolation ignores the large variability in cleanup costs. For instance, the Kingston Fossil Plant coal fly ash slurry spill in 2008 cost the Tennessee Valley Authority more than $1 billion in cleanup costs. With these caveats in mind, simple extrapolation and back-of-the-envelope calculations give a total cost of $339.6 billion.

D.2 Social gain of environmental cleanup

While the cleaning of a contaminated area necessitates considerable upfront costs, the benefits are diffuse, scattered and even more challenging to identify and quantify precisely. The literature has identified several ways through which contaminated areas reduce welfare.

First, contaminated areas pose a public health problem to a significant fraction of the US population. One out of three Americans live within three miles of a federal Superfund sites (US EPA (2016), Persico, Figlio, and Roth (2020)), and 11 million Americans, including 3 to 4 million children, are located within one mile of a Superfund site (Steinzor and Clune (2006), Persico, Figlio, and Roth (2020)). People are exposed to the contaminants from Superfund sites by drinking or swimming in contaminated water or eating food grown on toxic land. As a result, people exposed to contaminated areas are more likely to suffer from health problems, including cancer (Environment America Research and Policy Center (2021)), which reduces life expectancy (Kiaghadi, Rifai, and Dawson (2021)). Young children and pregnant women are particularly affected by these effects. In particular, children living close to Superfund sites have higher lead levels in their blood (Klemick, Mason, and Sullivan (2020)), which causes anemia, weakness, kidney failure, and brain damage. Children living close to a contaminated site or who experienced prenatal exposure also have lower cognitive and behavioral outcomes (Persico and Venator (2021), Persico, Figlio, and Roth (2020)).

Second, the release of hazardous substance by contaminated sites endangers the survival of ecosystems (Environment America Research and Policy Center (2021)). It is difficult to evaluate how prevalent this damage is because of data scarcity. Moreover, it is challenging to quantify how the loss of ecosystems affects human welfare, as it depends on unknown parameters, such as the cash flows of ecosystems, their discount rates and the irreversibility their losses.

Third, contaminated areas are often previous industrial sites located in densely developed urban areas with high location efficiency. Cleaning up the areas allows for urban redevelopment with better energy efficiency uses at the city level. For instance, the Office of Brownfields and Land Revitalization (2015) shows that brownfield redevelopment in five areas[22] would lead to 32-57% less carbon dioxide emissions per capita and air pollutants. It would also reduce stormwater runoff more than other conventional developments by reducing the daily vehicle miles and trips per capita.

[22] Seattle (WA), Baltimore (MD), Minneapolis-Saint Paul (MN), Emeryville (CA), and Dallas-Forth Worth (TX)

E EPA response to a contamination threat

During the Preliminary Assessment phase, an EPA team performs initial and limited inspections to assess the danger of a site. The assessment is made using the *Hazard Ranking System* (HRS). This system provides a grade between 0 and 100 that evaluates the risk level a site represents to human health and the environment. The risk is multidimensional because it takes into account different pathways through which the toxic releases could affect environmental systems or human health. The EPA evaluates four main pathways: groundwater migration, soil exposure, surface water migration, and air migration. For instance, groundwater migration relates to the likelihood of toxic components traveling to aquifers and drinking water wells. Sites ranked highly are registered in the National Priorities List (NPL). In April 2021, there were 1,374 sites on this list, with an average score of 43.5. Figure A.5 shows their locations.

The EPA team then decides the type of *response actions* it requires. A release may necessitate an *emergency response* to eliminate immediate risks to human health, such as in the case of a road accident where toxic chemicals may directly enter into contact with the population. A site could necessitate an *early action* to block a near-future threat of contamination or a *long-term action* if the risk of contamination may take several years or decades to materialize. For instance, if drums storing chemical components leak from an industrial site, an *early action* would consist of removing the leaking drums, and a *long-term action* would be a cleanup of the contaminated soil and underground water formation from the chemical component.

The EPA's plans for long-term responses are subject to public comments at least 30 days before the remedial action begins. The plan describes the options possible to perform the cleanup as well as the remediation preferred by EPA. Public concerns are taken into account, and then the EPA issues a *Record of Decision* (ROD) that describes how the cleanup will be performed. Once the cleanup is completed, the site is removed from the NPL.

F Case study 1: *United States v. Mirabile (E.D. Pa. Sept 4, 1985)*

I describe the case in three steps : first, I present the facts, then the procedural history. Finally, I expose the court's rationale for its decision.

F.1 Case facts

In 1976, Turco Coatings, Inc. (henceforth, Turco) purchased a facility in Phonixville, Pennsylvania (henceforth, Turco site) and opened a manufacture paint factory on the site. The purchase was made from Arthur C. Mangels Industries Inc. (henceforth, Mangels). The previous owner of the facility has taken a loan from the American Bank and Trust Company (ABT), which was partially secured by a mortgage on the Turco site. Turco filed for bankruptcy under Chapter 11 in January 1980, but the petition was rejected in 1981 by a bankruptcy court. Turco ceased operating in December 1980.

In 1976, the predecessor of Mellon Bank provided a credit line to advance working capital at Turco, secured by the inventory and assets of the company. One board member in charge of supervising Turco's operations was the loan officer initially responsible for the loan. The monitoring effort increased after Turco filed the petition.

Finally, Turco took out a loan from the Small Business Administration (henceforth, SBA) in July 1979, secured by a second lien on equipment, inventory, account receivables and real estate. An SBA representative monitored the site three times to inspect how the assets were sold in 1981. SBA contracts contained several limitations of Turco's actions. Specifically, Turco was not allowed to enter into management consulting services withtout SBA approval, and the bank set a cap on the total remuneration of operating officers. Moreover, the purchase of any life insurance or dividend required SBA approval.

The bank ABT repossessed the facility and sold it to Thomas A. Mirabile and Anna Mirabile on December 15, 1981. Between the foreclosure and the sale to the Mirabiles, the bank performed several tasks on the property, including « boarding up windows and changing locks, made inquiries as to the approximate cost of disposal of various drums located on the property, and, through its loan officer Donald Hans, visited the property on various occasions ». The predecessor of Mellon Bank took possession of the inventory from the Turco site with the approval of the bankruptcy court.

In December 1981, the Pennsylvania Resources of Environmental Resources (D.E.R.) informed Mr. Mirabile that toxic leaking drums were on the Turco site, contaminating the surroundings. Mirabile undertook some actions to clean up the site, regrouping the drums into a warehouse, but no further action was undertaken. However, there is an absence of evidence that the Mirabiles increased the overall pollution when they purchased the site at auction.

In February of 1983, a representative from the EPA visited the site and noticed that many drums were in poor condition and the access to the site was not sufficiently protected from trespassers. Evidence that some trespassers could access the site was noted. Immediate removal was ordered, and the EPA started the cleanup on February 11 of that year using Superfund money.

F.2 Procedural history and Final disposition

The court entered a summary judgment in favor of the SBA and ABT. However, the court rejected the motion for a summary judgment from Mellon Bank.

F.3 Court rationale

The court's reasoning was based on both statutory arguments and the legislative history of CERCLA. First, the statutory argument derived from CERCLA implied that a secured lender must participate in the management of a facility to be held liable. The court enunciated a narrow standard of what it means to "participate in the management", stating that "before a secured creditor such as ABT may be held liable, it must, at a minimum, participate in the day-to-day operational aspects of the site." The court accepted participation in management affairs as equating to participation at the site, that is, "the participation in operational, production or waste disposal activities" to incur environmental liabilities for secured lenders.

Second, the court justified this standard as being closer to the principle of CERCLA, which is to make polluters pay for their pollution, as they bore the fruit of negligent environmental practices. The court referred to a decision from the District Court of Missouri (*United States v. Northeastern Pharmaceutical & Chemical Co. (NEPACCO), 579 F. Supp. 823, 849 (W.D. Mos. 1984)*), where this principle was first stated.

Given this standard, the court rejected the motion for a preliminary judgment from the Mellon Bank, as one of its loan officers was part of the board attached to the management of Turco's site. However, SBA and ABT did not participate in the day-to-day operational aspects of the business and were therefore exempt according to this test.

G Case study 2: United States v. Fleet Factors Corp. (11th Cir. 1990)

This case is presented similarly to the discussion above, outlining the details of the matter and reviewing the court's final judgment.

G.1 Case details

In 1976, Fleet Factors Corporation (Fleet), a factoring company, made a collateralized factoring agreement with Swainsboro Print Works (SPW), a cloth printing facility. In the agreement, Fleet advanced funds against the assignment of SPW's accounts receivable. Fleet took a security interest in SPW's equipment, inventory, and fixtures. In August 1979, SPW filed for chapter 11 bankruptcy, but the loan contract between SPW and Fleet continued. At the beginning of 1981, Fleet stopped providing funds to SPW because the company estimated that the ongoing debt of SPW exceeded the value of its accounts receivable. On February 27, 1981, SPW ceased operations, and in December 1981, the company filed for chapter 7 bankruptcy.

As soon as SPW stopped operating, Fleet started to participate directly in the management of the facility in a number of dimensions to maximize the amount collected on the accounts receivable.

(1) Fleet tried to sell "the twenty to twenty-five million yards of grey goods and finished cloth remaining" and collected from the accounts receivable from those goods. Specifically, Fleet took care of the resolving disputes, ensured the reliability of consumers and that they did not have delinquent accounts.

(2) Fleet wired money to SPW's account to pay the remaining workers to maintain the production of the facility. No workers directly employed by Fleet were on-site. Fleet also directly paid some suppliers that were not accepting SPW checks.

(3) Finally, Fleet participated in the tax management of SPW. Fleet provided advice to the company and used the EIN of SPW. It was involved with the "tax deposit reports" of the company.

One disputed fact concerns whether Fleet blocked the sale of SPW chemicals and, by doing so, maintained the leaking drums on-site. The Government used the argument as evidence that Fleet participated in the management of the company. However, the evidence at trial suggested otherwise. Managers instead testified at trial that they were constrained by the Fleet lien in relation to SPW's chemicals. A communication problem ocurred among SPW's managers that did not transmit correctly their intentions to sell the drums. Subsequently, the non-response by Fleet was interpreted by SPW's managers as a refusal to sell the drums.

However, Fleet never foreclosed on its whole collateral but did so for the equipment and machines.

After 1981, Fleet hired two contractors. The first contractor, Baldwin Industrial Liquidators (Baldwin) was responsible for auctioning off the remaining equipment. The task of the second contractor, Nix Riggers (Nix) was to clean the facility and make it "Broom clean". Nix testified that he was allowed to do anything possible so that no equipment or machinery remained.

The Environmental Protection Agency inspected the facility on January 20, 1984, and found evidence of environmental contamination. The EPA proceed to clean up and then sued the two principal owners of the facility as well as Fleet to cover the cleanup costs.

G.2 Procedural history and final judgment

Fleet filed for a summary judgment, which was rejected in *United States v. Fleet Factors Corp., 724 F.Supp. 955, 960 (S.D.Ga. 1988)*, on the basis that its participation in the management of the facility made the applicability of the secured creditor exemption questionable. Fleet filed an interlocutory appeal following the denial of its summary judgment. The 11th Circuit Court of Appeals stated in *United States v. Fleet Factors Corp., 901 F.2d 1550 (11th Cir. 1990) (Fleet II)* that, as a matter of law, the secured creditor exemption was not applicable. As a result, the court concluded that rejecting Fleet's motion for summary judgment was correct and remanded the case.

G.3 Court rationale

The court explicitly rejected the interpretation given during *Mirabile*. The 11th Circuit put forward two main arguments in *United States v. Fleet Factors Corp., 901 F.2d 1550 (11th Cir. 1990) (Fleet II)* to justify the final disposition.

The first argument is that the legislative history of CERCLA supports a broader interpretation of lender liability. Indeed, Senators made a clear distinction between an operator and a secured lender that participates in managing a facility. The interpretation of environmental lender liability that *Mirabile* gives is similar to the one related to operators. However, when the Senators wrote the initial CERCLA law, they made a clear distinction between a secured lender that "participates in the management" with the one of an "operator". The definition of the secured lender exemption is similar to the definition of an owner or operator under *Mirabile*, thus making it redundant. The 11th Circuit Court interpreted the statement made by Representative Harsha when the amendment was introduced as consistent with the narrow interpretation of CERCLA liability. Indeed, the word "affiliated" was used to describe which lenders would be exposed to CERCLA liabilities under the new statement. Affiliation implies less involvement in day-to-day activities made by lenders than an owner.

The second argument is that more robust environmental lender liability helps lenders influence their debtors to adopt better environmental practices, consistent with one of CERCLA's goals. "Our ruling today should encourage potential creditors to investigate thoroughly the waste treatment systems and policies of potential debtors." Lenders that are more exposed to the cleanup costs of their secured assets have astronger incentive to require better environmental compliance when negotiating their loan terms with debtors.

H Fuzzy matching

To match the business register to the EPA database and obtain a cross-link between the two administrative sources, I perform a fuzzy matching algorithm that contains multiple steps.

Step 1: Normalization of fields

Names are normalized so that each word has the exact spelling and is capitalized. For instance, INC. and Incorporated are transformed to INCORPORATED, as their meanings are the same. I exploit the four different names available in the Business Register (BR) from the Census Bureau and the two names available in the TRI data from the EPA.

The street number from the address field in both databases is extracted. Next, the street name is normalized. For instance, rd is the abbreviation for road, so I replace road with rd. For the BR, I use the physical address when available. If this field is missing, the mailing address is used instead.

Step 2: Drop duplicate observations

From the BR and TRI, I use a time span from 1992 to 1999. I drop the duplicates according to the field that will be used for the matching, namely the establishment names, addresses, zip, state and county codes, NAICS, and other identifiers.

Step 3: Run matching without pre-processing the data

I run a *perfect* matching of variables using names and addresses within establishments that share the same state number, street number and two-digit NAICS code. As we have two names for the TRI and four for the BR, the score for the name field is the highest score of all name pairs. The reason I first keep all perfect matching sets before pre-processing is to avoid dropping relevant information. For instance, if someone drops the common name "GROUP," "INTERNATIONAL," and "AMERICAN," then the firm AIG would be dropped, which would result in a loss of relevant information.

Step 4: Pre-processing of variables

I then pre-process the variables to keep the most relevant information in a firm's name. Intuitively, if one term is used by many firms, then its usefulness in terms of matching is more limited than a unique term. I compute the frequency of each term for each database separately. I create a list of terms to be dropped from the database if the term is among the 1% most frequent terms for each database. This step results in dropping common terms, such as "America," "group," or "LLC."

Step 5: Coarse fuzzy matching

I then perform a first fuzzy matching on the address and company names, using a bigram approach with no weight where the similarity scoring is based on the Jaccard index. The final score is the unweighted average of the best score for the name matching, between the combination of the four names from the BR and the two names from TRI, with the score for the street name. The matching is done at the establishment level with the same zip code and industry code. If the physical address is used, I review that the street number matches perfectly. All matches that have a score above 90% accurary are kept. I manually check the accuracy of matches when the score is between 70% and 90%.

Finally, all establishments for which I am able to find a linkage are dropped from the BR and TRI files before moving to the next step.

Step 6: Broader fuzzy matching

I then perform a second fuzzy matching on the address and company names. Similar to the previous approach, I use a bigram approach with no weight where the similarity scoring is based on the Jaccard index. The final score is the unweighted average of the best score for the name matching, between the combination of the four names from the BR and the two names from TRI, with the score for the street name.

If the physical address is used, I review whether the street number matches perfectly. I then verify that the two establishments are in the same county. All matches that have a score above 90% accurary are retained. I manually check the accuracy of matches when the scores is between 70% and 90%. In particular, I use the industry code when this information can be located.

Finally, all establishments for which I am able to find a linkage are dropped from the BR and TRI files before moving to the next step.

Step 7: Visual inspection of perfect matches for addresses

I then perform matching within counties but using only the address name. I keep all matches that have a score above 90%. I manually check the names for these observations. Sometimes, a database will report a name through abbreviations or only the initials, resulting in a low matching rate for the name score. Alternatively, one name will be a lengthy description of the business, with the name inside the description. In these cases, the matching score for the name field will be below 70%, although a visual inspection makes it evident that the company is the same.

Step 8: Visual inspection of perfect matches for addresses

I manually check all the matched links. As I keep all links with a score above 90%, I end up having multiple links for the same establishment in some rare cases. In this case, I visually inspect the name and detailed industry code to keep the most relevant linkage.

I Data cleaning steps

I create a balanced panel at the establishment level between 1992 and 1999, which retains 374,158 observations representing 71.53% of the unbalanced sample. Several reasons motivate such an action. The first is to make my results comparable with other papers (such as Ohlrogge (2020)) using TRI, which also adopts this assumption.

Second, unbalanced panels introduce noise into the regressions. If this noise is exogenous, then it attenuates the coefficients. However, if the selection is due to the reporting framework of the TRI, then the unbalanced panel will put more weight on some specific industries or establishments with more employees.

The third advantage is that focusing on firms that report consistently every year allows us to focus on the highest quality part of the dataset. Previous works, such as Brehm and Hamilton (1996), have shown that misreporting in the TRI[23] results from ignorance rather than strategic misconduct, as the errors are concentrated among firms that report small amounts of chemicals. However, firms that consistently report a higher quantity of chemicals and are more likely to have a specific team dedicated to TRI reporting. Also, it means that they are not "new firms" that had to learn how to report to the survey, e.g., the utilities included in 1998. Note that creating a balanced panel does not mean that bankrupt firms are automatically dropped from the sample. If an establishment is liquidated and sold to another firm, then the establishment will still report to the TRI and will be observed.

I impute the missing chemicals by a zero. This imputation is motivated by the fact that when facilities report to the TRI, they can either mention a chemical that they do not report as using zero pounds of the component, or simply omit to mention it. Replacing zero to the missing components solved this problem.

Finally, I focus on publicly listed firms. This brings the sample to 210,000 observations[24]. The first reason for this choice is that the cross-sectional tests and the firm-level controls are based on Compustat, which is available only for publicly listed firms. Another advantage of focusing on publicly listed firms is that it allows us to concentrate on the highest quality segment of the TRI. As Brehm and Hamilton (1996) have shown, there are fewer inconsistencies in reporting among firms that report higher pollution measures. Publicly listed firms have a higher scale of production, and as a result, report more pollution.

[23] Bui and Mayer (2003) found that there is little systematic over or under reporting in the TRI.

[24] All sample sizes are rounded to four significant digits following Census Bureau disclosure guidelines

J Additional tables and figures

Table A.1: Prediction of The Shock with State Level Variables

	Dependent variable: Treated group × Post 1996 (included)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Corporate income tax	-0.001			-0.001	-0.003		-0.001
	(0.003)			(0.003)	(0.004)		(0.003)
Sales tax	-0.000			-0.002	-0.002		-0.003
	(0.003)			(0.004)	(0.003)		(0.005)
Personal income tax	-0.006			-0.007	-0.006		-0.006
	(0.006)			(0.006)	(0.006)		(0.005)
Property taxes (state)	0.000			-0.000	-0.000		0.000
	(0.000)			(0.000)	(0.000)		(0.000)
Unemployment insurance		0.000		0.000		0.000	0.000
		(0.000)		(0.000)		(0.000)	(0.000)
Unemployment insurance rate		-0.024		-0.033		-0.026	-0.032
		(0.024)		(0.029)		(0.024)	(0.029)
Unemployment insurance base wage		-0.000		-0.000		-0.000	-0.000
		(0.000)		(0.000)		(0.000)	(0.000)
Unemployment rate		-0.012		-0.010		-0.009	-0.010
		(0.013)		(0.012)		(0.011)	(0.012)
Gross domestic product		0.000		0.000		0.000	0.000
		(0.000)		(0.000)		(0.000)	(0.000)
Total revenues (state)			-0.000		-0.000	-0.000	0.000
			(0.000)		(0.000)	(0.000)	(0.000)
General revenues (state)			0.000		0.000	-0.000	-0.000
			(0.000)		(0.000)	(0.000)	(0.000)
State budget balance			0.043		-0.025	0.058	-0.009
			(0.055)		(0.043)	(0.061)	(0.054)
Observations	459	459	459	459	459	459	459
R-squared	0.020	0.055	0.0070	0.074	0.026	0.065	0.079

Note: This table reports state-year level regressions to investigate whether our treated group experienced potential state-level shock post 1996. It reports regressions where the dependent variable takes one if the state is in the 11th Circuit after the year of 1996 (included) and zero otherwise.

Table A.2: Baseline Effects with Real Controls

Panel A: on-site pollution (continuous variable)

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
Post$_t$ × Group$_i$	0.152***	0.142***	0.140***	0.137***
	(0.00909)	(0.0129)	(0.0130)	(0.0132)
Observations	183,000	183,000	183,000	183,000
R-squared	70.5	72.7	72.8	72.8
Input $_{it}$, Input costs $_{it}$ and Output $_{it}$	x	x	x	x
Facility FE$_i$× CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i$× Year FE$_t$		x	x	x
CAS FE$_c$× Year FE$_t$		x	x	x
NAICS FE$_i$× Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Panel B: on-site pollution (discrete variable)

	Dependent variable: $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
Post$_t$ × Group$_i$	1.965***	2.065***	2.044***	2.016***
	(0.218)	(0.267)	(0.270)	(0.261)
Observations	183,000	183,000	183,000	183,000
R-squared	69	70.5	70.5	70.5
Input $_{it}$, Input costs $_{it}$ and Output $_{it}$	x	x	x	x
Facility FE$_i$× CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i$× Year FE$_t$		x	x	x
CAS FE$_c$× Year FE$_t$		x	x	x
NAICS FE$_i$× Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Note: These tables report the difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Asset Conservation Lender Liability and Deposit Insurance Protection Act was passed. The dataset is at the chemical-year level between 1992 and 1999. Input$_{it}$includes the following variables as controls: (1) new and used machinery and equipment, (2) New and used buildings and other structures as well as (3) the number of employees and (4) total hours worked. Input cost$_{it}$ includes the annual employee payrolls, the cost of materials, cost of resales, cost of contract work and the cost of electricity, fuels or heat. Output$_{it}$ is the real output of the facility. Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table A.3: Other measures of pollution

Panel A: Inverse Hyperbolic Sine

	Dependent variable: IHS(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.160***	0.150***	0.148***	0.144***
	(0.0135)	(0.0170)	(0.0181)	(0.0173)
Observations	210,000	210,000	210,000	210,000
R-squared	70.3	72.4	72.4	72.4
Facility FE$_i$× CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i$× Year FE$_t$		x	x	x
CAS FE$_c$× Year FE$_t$		x	x	x
NAICS FE$_i$× Year FE$_t$			x	x
Firm-level controls$_{it}$				x
Mean Dep. Var.	0.7476	0.7476	0.7476	0.7476

Panel B: Pollution per capital

	Dependent variable: on-site CERCLA pollution per facility capital$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.654**	0.734**	0.747**	0.704**
	(0.213)	(0.297)	(0.275)	(0.241)
Observations	183,000	183,000	183,000	183,000
R-squared	67.6	67.6	67.6	67.6
Facility FE$_i$× CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i$× Year FE$_t$		x	x	x
CAS FE$_c$× Year FE$_t$		x	x	x
NAICS FE$_i$× Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Note: These tables report the difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed, for alternative measures of pollution. The dependent variable of Panel A is the inverse hyperbolic sine ($f(x) = log(x+\sqrt{1+x^2})$) of the on-site CERCLA release of chemical c at time t. The inverse hyperbolic sine is approximately equal to the natural logarithm of x, but is well defined in 0. The dependent variable for Panel B is the on-site CERCLA release of chemical c at time t divided by the capital of the facility's structure (as defined the ASM/CMF). The dataset is at the establishment-chemical-year level. Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table A.4: Include adjacent Circuits as control group

Panel A: CERCLA on-site pollution (continuous)

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.147**	0.131**	0.131**	0.123**
	(0.02)	(0.028)	(0.026)	(0.025)
Observations	99,000	99,000	99,000	99,000
R-squared	69.8	72.4	72.4	72.5
Facility FE$_i\times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i\times$ Year FE$_t$		x	x	x
CAS FE$_c\times$ Year FE$_t$		x	x	x
NAICS FE$_i\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Panel B: CERCLA on-site pollution (discrete)

	Dependent variable: $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	2.079**	2.146**	2.134**	2.072**
	(0.310)	(0.399)	(0.396)	(0.355)
Observations	99,000	99,000	99,000	99,000
R-squared	67.6	69.4	69.4	69.5
Facility FE$_i\times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i\times$ Year FE$_t$		x	x	x
CAS FE$_c\times$ Year FE$_t$		x	x	x
NAICS FE$_i\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

This table reports the difference-in-differences between the 11th Circuit and the states from adjacent Circuits, namely the 5th Circuit (Texas Louisiana Mississippi) the 6th Circuit (Kentucky, Michigan, Ohio and Tennessee) and the 4th Circuit (Maryland, North Carolina, South Carolina, Virginia and West Virginia). The treatment year is 1996, the year that the Lender Liability Act was passed. The dependent variable of Panel A is log(on-site CERCLA pollution+1)$_{cit}$ the log of the total amount in pound of on-site pollution +1. The dependent variable of Panel B is $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, a dummy variable that takes one if the total amount in pound of on-site pollution is strictly positive and zero otherwise. The dataset is at the establishment-chemical-year level. Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table A.5: Exclude Adjacent Circuits

Panel A: CERCLA on-site pollution (continuous)

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.150***	0.144***	0.140***	0.140***
	(0.0180)	(0.0200)	(0.0217)	(0.0212)
Observations	123,000	123,000	123,000	123,000
R-squared	69.7	72.1	72.2	72.2
Facility FE$_i$× CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i$× Year FE$_t$		x	x	x
CAS FE$_c$× Year FE$_t$		x	x	x
NAICS FE$_i$× Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Panel B: CERCLA on-site pollution (discrete)

	Dependent variable: $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	2.061***	2.254***	2.185***	2.196***
	(0.399)	(0.408)	(0.416)	(0.390)
Observations	123,000	123,000	123,000	123,000
R-squared	68.5	70.2	70.2	70.2
Facility FE$_i$× CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i$× Year FE$_t$		x	x	x
CAS FE$_c$× Year FE$_t$		x	x	x
NAICS FE$_i$× Year FE$_t$			x	x
Firm-level controls$_{it}$				x

This table reports the difference-in-differences between the 11th Circuit and the states that are not from adjacent Circuits. This means that I exclude states from the 5th Circuit (Texas Louisiana Mississippi) the 6th Circuit (Kentucky, Michigan, Ohio and Tennessee) and the 4th Circuit (Maryland, North Carolina, South Carolina, Virginia and West Virginia). The treatment year is 1996, the year that the Lender Liability Act was passed. The dependent variable of Panel A is log(on-site CERCLA pollution+1)$_{cit}$ the log of the total amount in pound of on-site pollution +1. The dependent variable of Panel B is $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, a dummy variable that takes 100 if the total amount in pound of on-site pollution is strictly positive and zero otherwise. The dataset is at the establishment-chemical-year level. Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table A.6: Different time ranges for the sample: 1993 to 1998

Panel A: CERCLA on-site pollution (continuous)

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.140***	0.128***	0.128***	0.121***
(0.00976)	(0.0136)	(0.0146)	(0.0132)	
Observations	157,000	157,000	157,000	157,000
R-squared	74.4	76.3	76.3	76.3
Facility FE$_i\times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i\times$ Year FE$_t$		x	x	x
CAS FE$_c\times$ Year FE$_t$		x	x	x
NAICS FE$_i\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Panel B: CERCLA on-site pollution (discrete)

	Dependent variable: $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	2.022***	2.158***	2.152***	2.090***
	(0.240)	(0.298)	(0.306)	(0.287)
Observations	157,000	157,000	157,000	157,000
R-squared	73	74.2	74.2	74.2
Facility FE$_i\times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i\times$ Year FE$_t$		x	x	x
CAS FE$_c\times$ Year FE$_t$		x	x	x
NAICS FE$_i\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

These tables report triple difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed. The dependent variable of Panel A is log(on-site CERCLA pollution+1)$_{cit}$ the log of the total amount in pound of on-site pollution +1. The dependent variable of Panel B is $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, a dummy variable that takes 100 if the total amount in pound of on-site pollution is strictly positive and zero otherwise. The dataset is at the chemical-year level between 1993 and 1998 (instead of 1992 to 1999). Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table A.7: Different time ranges for the sample: 1994 to 1997

Panel A: CERCLA on-site pollution (continuous)

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.120***	0.109***	0.108***	0.103***
	(0.00981)	(0.0124)	(0.0135)	(0.0138)
Observations	105,000	105,000	105,000	105,000
R-squared	80.6	81.9	82	82
Facility $\text{FE}_i \times$ CAS FE_c	x	x	x	x
Year FE_t	x			
Legal $\text{status}_i \times$ Year FE_t		x	x	x
CAS $\text{FE}_c \times$ Year FE_t		x	x	x
NAICS $\text{FE}_i \times$ Year FE_t			x	x
Firm-level controls_{it}				x

Panel B: CERCLA on-site pollution (discrete)

	Dependent variable: $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	1.986***	1.960***	1.953***	1.884***
	(0.207)	(0.251)	(0.253)	(0.251)
Observations	105,000	105,000	105,000	105,000
R-squared	79.7	80.5	80.5	80.5
Facility $\text{FE}_i \times$ CAS FE_c	x	x	x	x
Year FE_t	x			
Legal status $\text{FE}_i \times$ Year FE_t		x	x	x
CAS $\text{FE}_c \times$ Year FE_t		x	x	x
NAICS $\text{FE}_i \times$ Year FE_t			x	x
Firm-level controls_{it}				x

These tables report triple difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed. The dependent variable of Panel A is log(on-site CERCLA pollution+1)$_{cit}$ the log of the total amount in pound of on-site pollution +1. The dependent variable of Panel B is $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, a dummy variable that takes 100 if the total amount in pound of on-site pollution is strictly positive and zero otherwise. The dataset is at the chemical-year level between 1994 and 1997 (instead of 1992 to 1999). Post_t is a variable that takes one after 1996 (included) and zero otherwise. Group_i takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE_c is a chemical fixed effect that is defined at the CAS registry number level. Year FE_t is a year fixed effect, Facility FE_i is a facility fixed effect and NAICS FE_i is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE_i is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls_{it} includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table A.8: Different time ranges for the sample: 1995 to 1996

Panel A: CERCLA on-site pollution (continuous)

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.0713***	0.0587***	0.0587***	0.0608***
	(0.0150)	(0.0173)	(0.0169)	(0.0155)
Observations	52,500	52,500	52,500	52,500
R-squared	92.8	92.9	93	93
Facility FE$_i\times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i\times$ Year FE$_t$		x	x	x
CAS FE$_c\times$ Year FE$_t$		x	x	x
NAICS FE$_i\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Panel B: CERCLA on-site pollution (discrete)

	Dependent variable: $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	1.318***	1.102***	1.083***	1.148***
	(0.230)	(0.284)	(0.267)	(0.277)
Observations	52,500	52,500	52,500	52,500
R-squared	90.7	90.8	90.8	90.9
Facility FE$_i\times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i\times$ Year FE$_t$		x	x	x
CAS FE$_c\times$ Year FE$_t$		x	x	x
NAICS FE$_i\times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

These tables report triple difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed. The dependent variable of Panel A is log(on-site CERCLA pollution+1)$_{cit}$ the log of the total amount in pound of on-site pollution +1. The dependent variable of Panel B is $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, a dummy variable that takes 100 if the total amount in pound of on-site pollution is strictly positive and zero otherwise. The dataset is at the chemical-year level between 1995 and 1996 (instead of 1992 to 1999). Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, Tobin's Q, and total firms' liability. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

Table A.9: Reporting Robustness Tests

Panel A: CERCLA on-site pollution (continuous)

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	0.135***	0.129***	0.130***	0.125***
	(0.0162)	(0.0162)	(0.0170)	(0.0158)
Observations	197,000	197,000	197,000	197,000
R-squared	72.4	73.4	73.4	73.4
Facility FE$_i \times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i \times$ Year FE$_t$		x	x	x
CAS FE$_c \times$ Year FE$_t$		x	x	x
NAICS FE$_i \times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

Panel B: CERCLA on-site pollution (discrete)

	Dependent variable: $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Group}_i$	1.933***	2.019***	2.025***	1.983***
	(0.316)	(0.323)	(0.322)	(0.300)
Observations	197,000	197,000	197,000	197,000
R-squared	69.4	70.3	70.3	70.3
Facility FE$_i \times$ CAS FE$_c$	x	x	x	x
Year FE$_t$	x			
Legal status$_i \times$ Year FE$_t$		x	x	x
CAS FE$_c \times$ Year FE$_t$		x	x	x
NAICS FE$_i \times$ Year FE$_t$			x	x
Firm-level controls$_{it}$				x

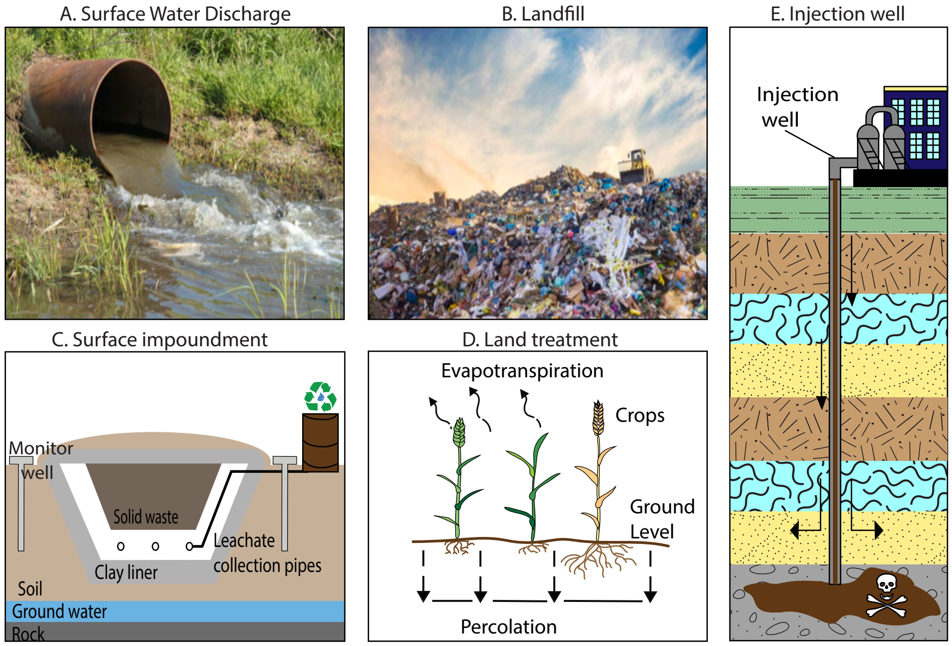
These tables report triple difference-in-differences between the 11th Circuit (treated group) and the others (control group) after 1996, the year that the Lender Liability Act was passed. All the chemicals that were never reported before 1995 are dropped. The dataset is at the chemical-year level, between 1992 and 1999. The dependent variable of Panel A is log(on-site CERCLA pollution+1)$_{cit}$ the log of the total amount in pound of on-site pollution +1. The dependent variable of Panel B is $\mathbb{1}$(on-site CERCLA pollution)$_{cit}$, a dummy variable that takes 100 if the total amount in pound of on-site pollution is strictly positive and zero otherwise. Post$_t$ is a variable that takes one after 1996 (included) and zero otherwise. Group$_i$ takes the value one for plants located within the 11th Circuit and zero otherwise. CAS FE$_c$ is a chemical fixed effect that is defined at the CAS registry number level. Year FE$_t$ is a year fixed effect, Facility FE$_i$ is a facility fixed effect and NAICS FE$_i$ is an industry fixed effect based upon the two-digit NAICS code as defined in the LBD dataset. Legal status FE$_i$ is a fixed effect that groups together firms with the same legal status as defined by the LBD. Firm-level controls$_{it}$ includes 12 time-varying controls defined at the firm level that are commonly used in empirical corporate finance. These controls are the firm sales, capx, capital intensity, cash flow, cash holding, cost of capital, total asset, the log of firm size, the net income, R&D intensity, the return on asset (ROA), the return on equity ROE, tangibility ratio, tobin's Q and the total firms' liability.

Table A.10: Clustering Robustness Tests

	Dependent variable: log(on-site CERCLA pollution+1)$_{cit}$				
	(1)	(2)	(3)	(4)	(5)
$\text{Post}_t \times \text{Group}_i$	0.180***	0.196**	0.196**	0.138***	0.138***
	(0.0231)	(0.0841)	(p-value: 0.0203)	(0.0302)	(0.0495)

This table reports different robustness tests to compute the standard errors for the baseline regression. Column (1) reports the coefficients estimated on a sample that takes the average of all variables before and after 1996. Column (2) takes the first difference of the previous before / after comparison, and reports the coefficient of this cross-section. The coefficient estimated of this sample by ordinary least square is an asymptotically consistent estimator. Column (3) reports the standard errors estimated on the previous sample using the bootstrapped approach. Running the bootstrapped approach on this sample significantly reduces the simulation time. Column (4) clusters at the firm level, while column (5) reports the standard errors clustered at the chemical level. Estimates and sample size have been rounded to four significant digits according to the Census Bureau disclosure guidelines.

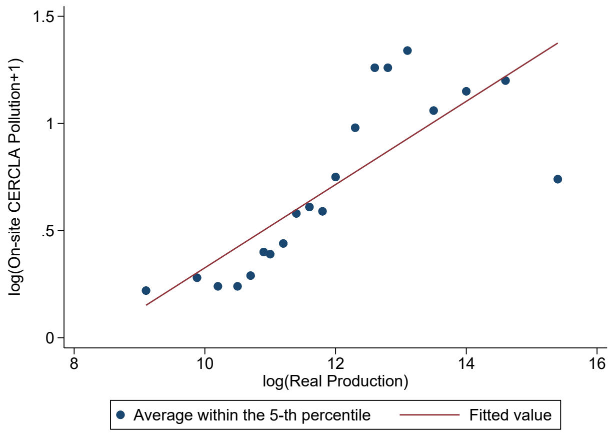
Figure A.1: Types of on-site Pollution



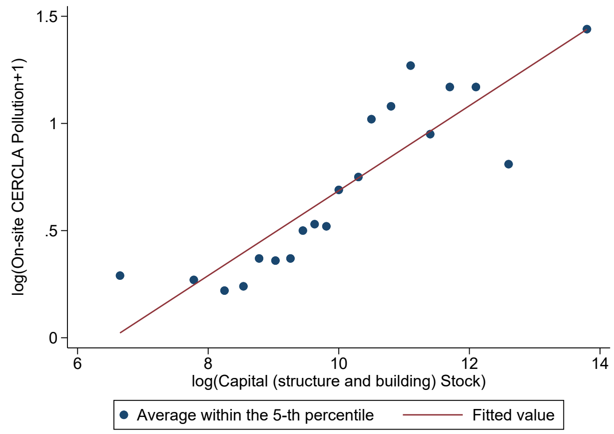
Note: This figure depicts the different ways of releasing on-site toxic pollutants that are included in the measure log(on-site CERCLA pollution+1)$_{cit}$, the log of the on-site releases minus air pollution plus one for chemical c, time t and facility i.

Figure A.2: Validation of the Dataset

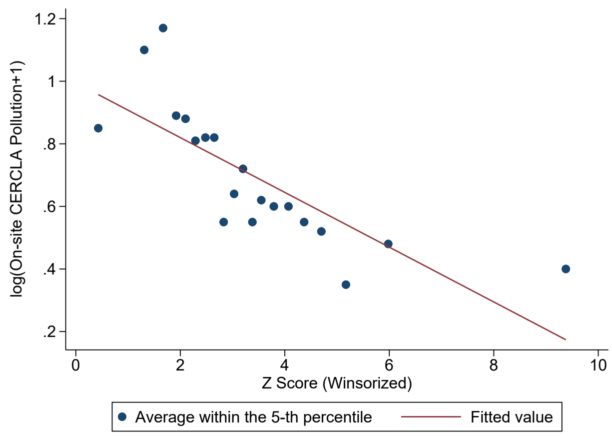
Panel A: Real Production and Pollution



Panel B: Capital Stock and Pollution



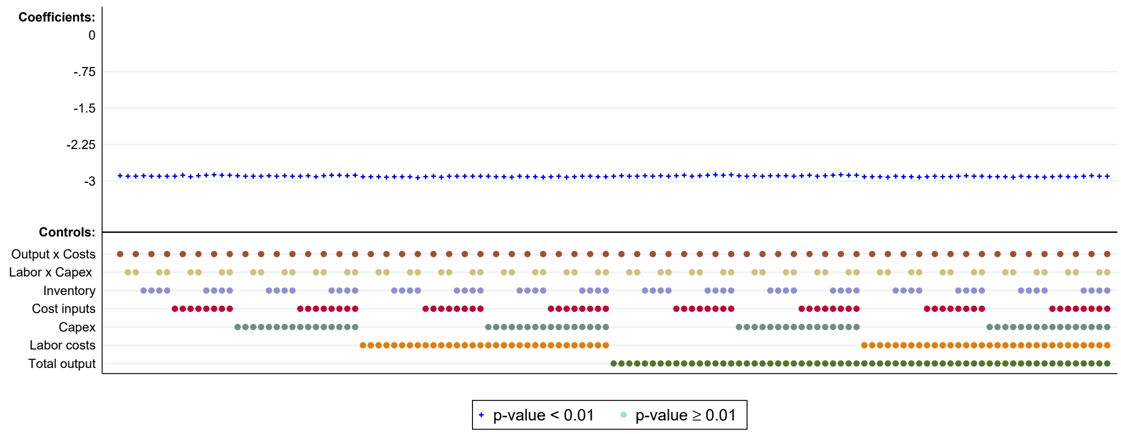
Panel C: Altman Z-score and Pollution



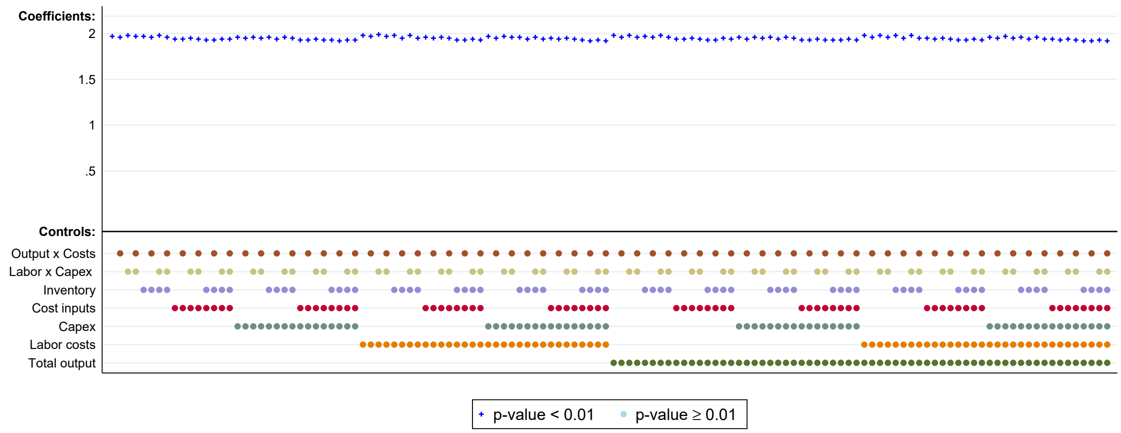
Note: The goal of these figures is to investigate the quality of the matching, by replicating the well-known relationships between firms' production size and pollution as well as the probability of bankruptcy and pollution. Specifically, Panel A plots the average level of on-site CERCLA pollution (in log) for each 5th percentile of $\log(Q)_{it}$, the log of the real production at the facility level. There is a monotonic relationship between production and pollution, consistent with the idea that larger plants generate more waste. Panel B uses another measure of facility's scale, namely the capital invested in building and structure of the facility. For each 5th percentile of this variable, it plots the average of on-site CERCLA pollution (in log). Similarly, there is a positive relationship between pollution and facility size. Finally, Panel C reports the relationship between the probability a firm will file for bankruptcy, as proxied by the Altman Z-score, and the variable on-site CERCLA pollution (in log). For each 5th percentile of the Z-score, the graph plots the average of on-site CERCLA pollution (in log). Consistent with economic theory, firms that are more likely to file for bankruptcy and thus have a lower Z-score are more likely to pollute. Estimates have been rounded to four significant digits according to the disclosure avoidance practices in place at the Census Bureau.

Figure A.3: Specification Curves: Pollution Outcomes with Real Controls

Panel A: Abatement activities

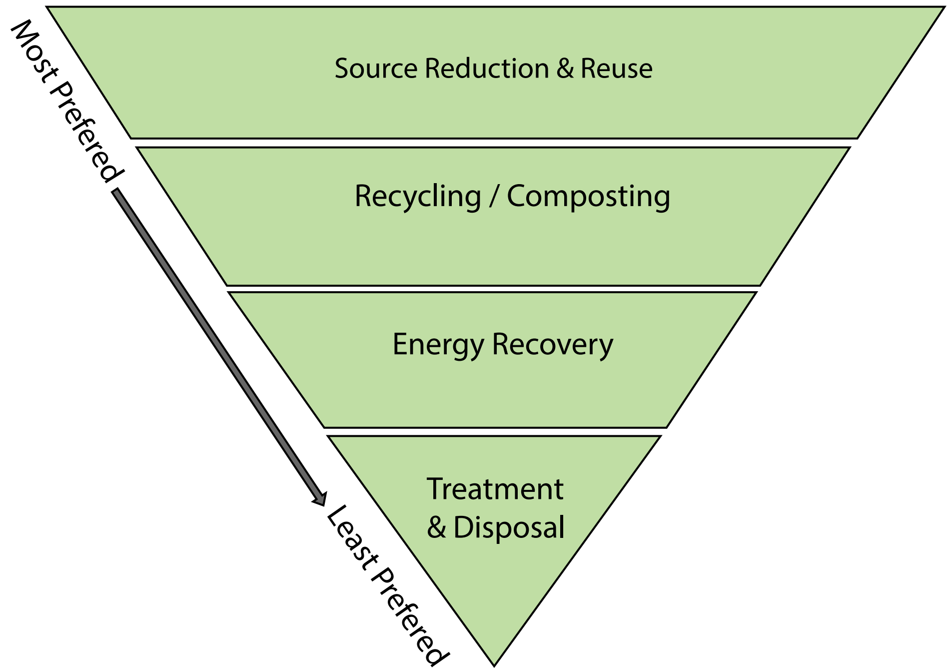


Panel B: On-site releases



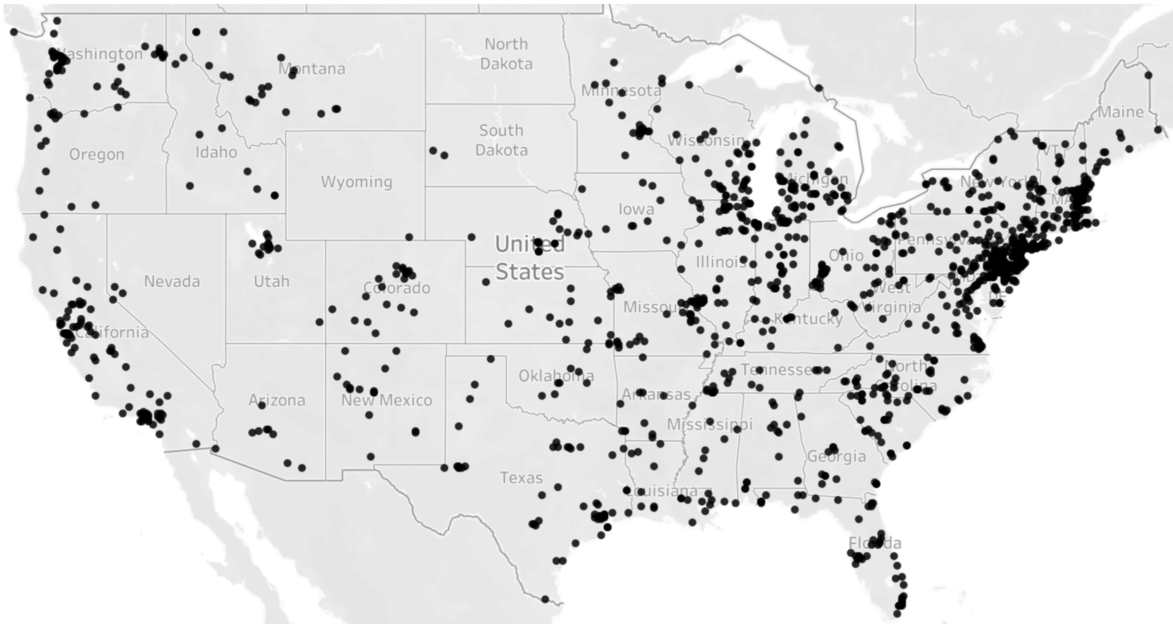
Note: The goal of these figures is to show how the coefficient of $\text{Post}_t \times \text{Group}_i$ varies for changes in the controls and fixed effects for the baseline specification of equation 1 where additional controls are included. Specifically, the figures of Panel A and B report the coefficient of $\text{Post}_t \times \text{Group}_i$ when the dependent variable is $\mathbb{1}(\text{Process-related abatement})_{cit}$, and $\mathbb{1}(\text{on-site CERCLA pollution})_{cit}$, respectively. *Output* represents the real output of the facility. *Cost inputs* includes as controls the following variables: cost of fuels, cost of materials and parts, cost of resales, cost of contract work, and cost of purchased electricity. *Inventory* includes the total value of shipments and work-in-process inventory end. *Labor costs* regroups the total employment, the total worker hours and earnings. *Capex* represents the capital expenditure on new and used buildings and other structures. *Labor* is the total employment and is interacted with *Capex*.

Figure A.4: Waste Management Hierarchy (EPA)



Note: This figure represents the Waste Management hierarchy, as defined by EPA.

Figure A.5: Brownfield in the USA



Note: This figure depicts the distribution of brownfield in the Superfund National Priorities List (NPL), when the sites have status information, in April 2021.