# The Limits of Limited Liability: Evidence from Industrial Pollution *

Pat Akey†
University of Toronto

Ian Appel‡
Boston College

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**Abstract**

We study how parent liability for subsidiary environmental cleanup costs affects industrial pollution and production. Our empirical setting exploits a Supreme Court decision that strengthened parent limited liability protection for some subsidiaries. Using a difference-in-differences framework, we find that increased liability protection for parents leads to a 5–9% increase in toxic emissions by subsidiaries. Evidence suggests the increase in pollution is driven by lower investment in abatement technologies rather than reallocation across plants or increased production. Cross-sectional tests suggest a harm-shifting motivation for these effects. Overall, our results highlight moral hazard problems associated with limited liability.

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†University of Toronto. Phone: +1 (647) 545-7800, Email: pat.akey@rotman.utoronto.ca

‡Boston College. Phone: (617) 552-1459, Email: ian.appel@bc.edu

For more than 150 years, limited liability has been a defining characteristic of many business entities. This legal concept is often credited with spurring economic growth and the development of capital markets (Manne, 1967); some call it “one of man’s greatest inventions” (The Economist, 2016). Economists have long recognized, however, that limited liability engenders a moral hazard problem because the assets of a firm may be insufficient to pay creditors’ claims. This, in turn, may incentivize behavior that is privately profitable but socially costly (Admati, 2017). In an effort to limit such effects, courts can impose liability on firm owners in some circumstances. Easterbrook and Fischel (1985) note that such circumstances are primarily confined to closely-held corporations and parent-subsidiary relationships.

In this paper, we study the tradeoffs of limited liability in the parent-subsidiary context. While reducing exposure to environmental liabilities may encourage investment and economic growth, it also weakens incentives to limit toxic emissions. Such emissions potentially impose significant costs on other stakeholders, including adverse health outcomes (Chay and Greenstone, 2003), decreased worker productivity (Graff Zivin and Neidell, 2012), and lower home prices (Greenstone and Gallagher, 2008). Policymakers in many countries have adopted a “polluter pays” approach to environmental regulation to encourage the internalization of such costs; Esty (2008) states the principle has “taken on a quasi-constitutional aura in international environmental law.” However, the effectiveness of this regulatory framework is, to an extent, undercut by limited liability. If liability truly is limited, a parent will not bear the costs of environmental remediation that exceed the value of its subsidiary’s assets.

Our empirical setting uses a Supreme Court case that clarified parent company liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund. CERCLA authorizes the Environmental Protection Agency (EPA) to impose ex post liability on parties responsible for toxic sites. In *United States v. Bestfoods* (hereafter *Bestfoods*), the Supreme Court narrowed the circumstances under which parents are responsible for subsidiaries’ environmental cleanup costs. Prior to *Bestfoods*, some circuit courts held parent firms liable for such costs under a relatively broad range of circumstances, namely if they had "actual control" of or the "ability to control" subsidiaries.[1] In *Bestfoods*, the Supreme Court invalidated these tests. We use this decision as a natural experiment in a difference-in-differences setting. The treatment group for our analysis consists of plants located in areas that had weaker liability protection prior to *Bestfoods*; the control group consists of those located in areas where a relatively narrow standard for parent liability was already in place.

We use plant-chemical-level data on toxic emissions from the EPA to study changes in environmental behaviors in response to *Bestfoods*. Our main outcome of interest is the amount (in pounds) of toxic ground pollution (e.g., disposals in landfills), as this is the focus of CERCLA enforcement efforts. In total, our sample consists of 6,953 parent corporations that on average have 2.8 subsidiary plants emitting 3.91 chemicals. Our baseline regression specification controls for time-invariant heterogeneity at the plant level, and time-varying heterogeneity at the chemical and parent level. Thus, our within-plant estimates are relative to plants with the same parent and plants that use the same chemicals but are located in districts that employed the narrow standard for parent liability.

We first examine the extent to which limited liability for future cleanups affects the amount of pollution generated by subsidiaries. We find that treated plants increase ground emissions by approximately 5–9% relative to the control group in the five years following *Bestfoods*. This increase is driven by both the intensive and extensive margins of pollution. In addition, the effect is particularly strong for plants with publicly traded parents, consistent with evidence that such firms have a higher propensity to pollute (Shive and Forster, 2018). We document similar magnitudes for chemicals that are known to cause harm to humans (including cancer and other chronic diseases) and for other chemicals. Increased liability protection also has a positive effect on firm value; CARs around oral arguments for *Bestfoods* are approximately 1% for parents with relatively high exposure to the decision.

We consider three (non-mutually exclusive) channels that potentially explain this change in environmental behavior. First, the increase in emissions may stem from reduced invest-

[1] In the US, circuit courts (also called courts of appeals) are intermediate-level courts. Each circuit court covers a geographic area containing multiple states.

ment in abatement. This may occur because parents do not fully internalize the costs of environmental cleanups, thus weakening incentives to limit pollution. Second, the harmonization of legal standards across jurisdictions may have relaxed constraints on firms' optimal allocation of economic activity across different plants. The increase in emissions for treated plants may therefore reflect a reallocation from sibling plants in the control group. Finally, our findings may be a consequence of increased production resulting from lower costs of using pollutive technologies. To the extent that these costs are variable (rather than fixed) in nature, standard economic theory predicts an increase in output. We explore each of these possible channels in turn.

First, we test whether stronger parent liability protection is associated with changes in pollution abatement activities. We measure abatement at the plant-chemical level using the EPA's Pollution Prevention (P2) database. Our analysis focuses on the two most common forms of abatement: changes to operating practices (e.g., improved record-keeping) and the production process (e.g., modifying equipment or improving chemical reaction conditions). We find evidence that *Bestfoods* decreases incentives to invest in abatement. Specifically, plants decrease production-related abatement by 15–17% following the decision. We do not find evidence of a change in abatement related to operating practices.

Next, we conduct two tests to examine the reallocation channel. In our first test, we exploit the fact that some parents have plants in both the treatment and control groups, while others only have plants in the control group. We test whether there is a differential effect of *Bestfoods* for plants in the control group that have siblings in the treatment group versus those that do not. We do not find robust evidence of a difference between the groups, suggesting that reallocation between sibling plants does not drive the main findings. Our second test examines differential effects for plants that belong to diversified or non-diversified parents. If the reallocation channel drives our main findings, the effects of *Bestfoods* are likely stronger for non-diversified firms because there are fewer frictions associated with reallocating economic activity across plants in the same industry. We do not, however, find evidence that this is the case; the magnitudes of the effects are similar for plants of diversified and non-diversified parents.

Finally, we consider whether the change in emissions stems from increased economic activity. Specifically, we examine whether *Bestfoods* is associated with changes in output using plant-chemical level production data from the EPA. We also examine whether the decision lead to changes in plant-level employment using data from the National Establishment Time-Series (NETS) database. For both measures, the estimated effect of *Bestfoods* is economically small and statistically indistinguishable from zero. This lack of a change in economic activity in response to stronger liability protection is consistent with the notion that costs associated with cleanups and abatement for ground pollution are often fixed in nature and therefore do not affect marginal costs of production (EPA, 2011).

We perform a series of cross-sectional tests to explore heterogeneity in responses to *Bestfoods*. First, we consider the role of subsidiary solvency. The likelihood of parent liability is, in part, a function of the likelihood that the cost of an environmental cleanup would bankrupt a subsidiary. Consistent with this idea, the increase in pollution and reduction in abatement concentrate in less solvent subsidiaries. The effects are also driven by facilities of parents with a higher proportion of tangible assets—those for which pollution abatement activities are likely more costly. Finally, we document a moral hazard motivation for the increase in pollution and decrease in abatement activities. Specifically, the effects of *Bestfoods* are concentrated in the plants of parents that are close to financial distress and likely prioritize short-term financing needs over the avoidance of long-term liabilities.

Our paper contributes to the broad literature on the economics of industrial pollution. One strand of this literature studies corporate liability for environmental disasters. Previous papers find that *strict* liability, a legal standard that imposes liability on polluters regardless of intent or negligence, is associated with fewer environmental accidents (Alberini and Austin, 2002) and compliance with regulations (Stafford, 2002). Shapira and Zingales (2017) argue that firms are cognizant of legal liability stemming from industrial pollution, but this does not necessarily deter socially harmful behavior. Other papers study a variety of factors that affect corporate environmental behavior, including third-party auditors (Duflo et al., 2013)), reputational penalties (Karpoff et al., 2005), financial characteristics (Chang et al., 2016; Kim and Xu, 2018), and ownership structure (Shive and Forster, 2018). Our paper contributes to this literature by showing that limited liability also plays an important role in incentivizing the use of pollutive technologies.

More generally, we provide some of the first evidence on how limited liability impacts managerial decision making. Coase (1960) argues that when transaction costs are negligible and property rights are well-defined, the initial allocation of these rights is irrelevant. Subsequent work has noted that market imperfections (e.g., information asymmetry and moral hazard) can render regulation or the demarcation of liability important (Shavell, 1984; Laffont, 1995). More recent papers including Biais et al. (2010) and Chaigneau et al. (2014) have focused on the optimal compensation contract in the presence of externalities, the limited liability of agents, and moral hazard. A tradition in legal scholarship has also debated the costs, benefits and legal practicalities of limited liability (Easterbrook and Fischel, 1985; Clark Jr. and Hickok, 2016). Previous empirical work has also studied limited liability outside of the parent-subsidiary context (e.g., Grossman, 2001; Koudijs and Salisbury, 2016; Weinstein, 2008).

Finally, our cross-sectional tests highlight the effect of firms' financial strength on the response to the increase in limited liability protection, a finding that is similar to the risk-shifting incentives described by Jensen and Meckling (1976). Evidence consistent with the risk-shifting hypothesis has been documented in a variety of settings including banking (Esty, 1997; Landier et al., 2015), venture capital (Denes, 2016), and investments by distressed firms (Eisdorfer, 2008). However, evidence inconsistent with the hypothesis has also been reported by Andrade and Kaplan (1998), Gilje (2016), and Gormley and Matsa (2011), among others. A related strand of literature examines how firms' financial conditions impact non-financial stakeholders. For example, previous papers show that distress affects worker safety (Cohn and Wardlaw, 2016) as well as product quality and pricing (Dionne et al., 1997; Phillips and Sertsios, 2013). Similar to these strands of literature, we find that the increase in pollution and decrease in abatement activities are concentrated in the subsidiaries of parents that are close to financial distress. One interpretation of this finding is that such firms forgo investment in costly pollution abatement in order to free up funds for more immediate financing needs, thus shifting risk, and potentially harm, to other stakeholders.

# 1 Background

## 1.1 CERCLA

Congress passed CERCLA in 1980 in response to the Love Canal disaster in Niagara Falls, NY (Greenstone and Gallagher, 2008).[2] Rather than implement ex ante restrictions on polluters, the legislation was designed to address the ex post remediation of toxic sites. In many cases, sites targeted by CERCLA enforcement are non-operating or abandoned. The goal of CERCLA is twofold: cleanup existing toxic sites and deter the creation of new ones. Deterrence is achieved under CERCLA by broadly imposing liability on parties responsible for pollution, even after a site has shut down. Policymakers argue that the liability provisions in CERCLA "serve as powerful incentives to deter risky industrial and commercial practices that can result in releases" (EPA, 2011) and "induce the highest standard of care" (Senator Stafford, quoted in Healy (1992)).[3]

Under CERCLA, the EPA maintains a National Priorities List (NPL) of toxic facilities that are eligible for cleanup based on threats to human health or the environment. The list currently consists of over 1,300 facilities. Once assigned to the NPL, facilities are further scrutinized by the Agency to determine their levels of environmental and health risks as well as appropriate remedial actions. CERCLA grants the federal government "extraordinary" unilateral power in this regard—the EPA can either undertake a cleanup itself or compel the polluter to do so (Gaba, 2015).

The costs associated with the remediation of NPL sites are substantial, averaging $43

[2]Love Canal was used as an industrial waste landfill used by Hooker Chemical Corporation. In 1978, the site gained national prominence after chemicals seeped out, and President Carter ordered the evacuation of 900 local residents.

[3]See Healy (1992), Oswald (1993), and Westerfield (1993) for further discussion on the deterrence function of CERCLA.

million per cleanup (Greenstone and Gallagher, 2008). However, cleanups of larger and more complex sites can entail significantly higher costs and take decades to complete. For example, Love Canal was removed from the NPL following a cleanup effort that lasted 21 years and cost $400 million (DePalma, 2004). More recently, the EPA has initiated CERCLA claims in excess of a billion dollars against a number of companies including Lyondell Chemical Corp. ($4.8 billion), Assarco LLC ($3.6 billion), and Chemtura Corp. ($2.1 billion) (Blair, 2011). However, in each of these cases the firms filed for bankruptcy, and the EPA's recovery was a fraction of the initial claim.

Congress intended the "polluter pays" principle to play a key role in CERCLA. To this end, the legislation imposes two statutory mechanisms to pay for cleanups: Superfund and liability rules. Superfund is a trust fund used by the EPA to pay for site cleanups in instances when the polluter either cannot pay (e.g., due to bankruptcy) or be identified (e.g., "midnight dumping") (Plater et al., 2016). Revenue for the fund initially came from taxes on firms that use hazardous substances; the US Treasury currently funds the program.

CERCLA also funds cleanups by imposing liability on the "owners or operators" of toxic sites. Owner liability (i.e., indirect liability) under CERCLA is relatively uncontroversial; parents are liable for cleanup costs as owners under the standard veil piercing doctrine in corporate law. Generally speaking, the owners of a corporation have limited liability for the acts of the corporation. However, courts can impose liability on firm owners (i.e., pierce the veil separating the parent and subsidiary) in limited circumstances involving abuse of the corporate form (e.g., failing to maintain corporate formalities, fraud, etc.) (Plater et al., 2016). Normal behaviors in a parent-subsidiary relationship (e.g., appointing directors and officers, approving capital expenditures, setting performance targets) are not generally grounds for parent liability.

Parents can also be held directly liable as operators of toxic sites under CERCLA. The legislation does not, however, specify a specific legal standard for operator liability. The lack of clarity perhaps stems from CERCLA being "a last minute compromise" that was "hastily and inadequately drafted" (Bartley (2005), quoting *United States v. A. & F. Materials*

*Co.*). Lacking such a directive, federal judges had discretion to impose legal standards for operator liability of parents under CERCLA. The nature of these standards varied across federal circuit courts.[4] Specifically, each of the circuit courts originally adopted one of the following tests for parent liability (Silecchia, 1998; Stovall, 1998):

- **Ability-to-Control (ATC)** (also called Authority-to-Control) is the broadest standard that defines an "operator" as any person who has the power to control the activities of the polluter. This standard was adopted by the Fourth, Eight, and Ninth Circuits.

- **Actual-Control (AC)** imposes liability on the parent if the subsidiary does not act independently. This may be the case, for example, if the parent corporation is involved in the day-to-day operations of its subsidiary. This standard for parent corporation liability was adopted by the First, Second, Third, and Eleventh Circuits

- **Veil Piercing** is the narrowest standard. This test effectively "read out the 'operator' part of the statute" and imposed liability only if the corporate veil can be pierced (Cook, 1998). Courts that used this standard argued that the legislative intent of CERCLA was not to "alter so substantially a basic tenant of corporate law" (*Joslyn Manufacturing Co. v. T.L. James & Co., Inc.*). The veil piercing standard was adopted by the remaining circuits.

Figure 1 shows the geographic areas that employed each of the three standards. Because CERCLA claims are usually brought in jurisdictions where a plant is located, the liability standard is based on plant location, not the location of the parent or state of incorporation.[5]

[4]When there is a lack of Supreme Court jurisprudence, individual circuit courts can arrive at different conclusions when presented with an ambiguous legal statute (i.e., a "circuit split").

[5]There are not significant forum shopping concerns in this setting. CERCLA claims name, on average, nearly a dozen parties as defendants (e.g., parents, subsidiaries, other firms polluting the site, previous owners, arrangers and transporters, etc.) (GAO, 2009). Connors (1987) notes that "in a dispute with multiple defendants, the only forum practically available to the EPA may be the site of the toxic waste spill, especially if the multiple defendants have diverse home jurisdictions."

## 1.2 *Bestfoods* and Its Effects

In 1998, the Supreme Court resolved the ambiguity surrounding parent liability under CERCLA in *United States v. Bestfoods.* We provide background on the case in in Internet Appendix Section A.I. This unanimous decision rejected the Ability-to-Control and Actual Control standards that broadened parent liability relative to traditional corporate law standards. The Court ruled that parents are liable for environmental remediation costs under two circumstances. First, parents can be held liable under the traditional veil piercing standard. Second, parents are potentially liable for cleanup costs if they operated the *facility* responsible for the pollution. Satisfying this condition requires showing involvement that is "eccentric under the accepted norms of parental oversight of a subsidiary's facility" (*U.S. v. Bestfoods*). Such actions may include the parent leasing the site from a subsidiary, a joint-venture with a subsidiary, or direct control of facility operations by an employee of the parent (Plater et al., 2016). Normal oversight of a subsidiary and its operations that would not give rise to CERCLA parent liability include "appointing a subsidiary's officers and directors, monitoring its performance, supervising the subsidiary's finances, approving budgets and capital expenditures, and even articulating general policies and procedures for the subsidiary" (Plater et al., 2016).

Thus, relative to the weaker ATC and AC standards, *Bestfoods* significantly increased the difficulty of holding parents liable for environmental cleanup costs (Plater et al., 2016). In courts that had adopted the weaker standards, plaintiffs often argued that shared officers/directors or parent oversight of a subsidiary gave rise to parent liability; under Bestfoods, such actions are "viewed as indicative of normal parent-subsidiary relationships" and not grounds to impose liability (Plater et al., 2016). By reducing the liability of parents for cleanup costs that exceed the value of the subsidiary, the *Bestfoods* decision disincentivizes behaviors that make such liabilities less likely. White (1999), for example, notes that the decision creates "perverse incentives" to forego investments in environmental controls.

Alternative regulatory mechanisms may, at least in part, undercut such incentives. Along with CERCLA, the Resource Conservation and Recovery Act (RCRA) plays an important role in regulating ground pollution. Unlike CERCLA, RCRA regulates the disposal of toxic waste for currently operating sites. It contains two key regulatory mechanisms to this end. First, RCRA provides an ex ante regulatory framework to control the production, management, and disposal of solid waste (from "cradle to grave"). Second, it grants the EPA the ability to initiate "corrective actions" (i.e., cleanups) of toxic sites that are currently in operation.

However, RCRA provisions are likely an imperfect substitute for the ex ante deterrence function of CERCLA.[6] For one, previous work argues that there are important complementarities between ex ante and ex post regulatory mechanisms that mitigate their individual shortcomings (e.g., Kolstad et al., 1990; Shavell, 1984). Specifically, regulators have imperfect information about market participants, leading to sub-optimal oversight, while bankruptcy undercuts the effectiveness of ex post lawsuits. In addition, RCRA and CERCLA remedial actions generally aim to address different types of situations. RCRA actions target firms that are currently operating, financially solvent, and willing to participate in the cleanup effort (OIG, 2002). In contrast, CERCLA targets non-operating or abandoned sites, and *Bestfoods* specifically involves situations where the polluter is unable to cover the cost of a cleanup. Furthermore, RCRA cleanups are usually smaller in scale (both in terms of complexity and expense) than those under CERCLA (Stoll, 1990); their goal is to prevent "RCRA facilities that pose the greatest risk from becoming Superfund sites." (OIG, 2002).

The effects of *Bestfoods* may have also extended beyond firms and influenced the enforcement behavior of the EPA. Enforcement actions and litigation are costly events for both the defendant and plaintiff. While *Bestfoods* likely had little effect on the EPA's incentive to initiate claims against solvent subsidiaries, the agency may have been reluctant to initiate claims against those close to insolvency due to a higher probability of a limited recovery. Thus, it is unclear whether changes in firms' environmental behaviors in response to the decision are necessarily be accompanied by changes in enforcement.

[6]Legal scholars have pointed out that there are important complementarities between the CERCLA and RCRA. Rallison (1987) argues "[CERCLA's] liability provisions, in conjunction with those of RCRA, provide significant incentives to current and future waste producers."

# 2 Data and Methodology

## 2.1 Data

Our sample consists of plants in the EPA's Toxic Release Inventory (TRI) database from 1994–2003. This database has been extensively used by economists as well as public policy, environmental, and public health researchers.[7] Since 1987, the EPA has reported chemical-level emissions data in TRI for plants that exceed a minimum number of employees, operate in certain industries, and emit specific hazardous pollutants. The current standard requires reporting if a facility has at least 10 full-time employees, operates in one of roughly 400 industries defined at the six-digit NAICS level, and uses one of nearly 600 chemicals.[8] Appendix Table A.1 lists the three-digit NAICS industries that are currently included in TRI; the most common are chemical manufacturing (25.1% of sample), fabricated metal product manufacturing (11.0%), primary metal manufacturing (9.1%), and transportation equipment manufacturing (6.9%). For most chemicals, disclosure is triggered if more than 25 thousand pounds of a chemical are manufactured or processed or 10 thousand pounds are otherwise used during a year, though some substances have more stringent requirements.

While TRI data are self-reported, the EPA conducts audits to investigate anomalies. Misreporting can lead to either criminal and civil penalties (Kim and Xu, 2018). Indeed, the only penalties associated with TRI are for false reports, not high emissions (Greenstone, 2003). For example, P4 Production LLC, a wholly owned subsidiary of Monsanto, was fined $600 thousand for violating chemical reporting laws in 2015. Nevertheless, previous studies have documented evidence of some inaccuracies in the TRI database (e.g., Brehm and Hamilton, 1996; De Marchi and Hamilton, 2006). Brehm and Hamilton (1996) argue violations are concentrated in facilities that release a small amount of toxins, suggesting misreporting

[7] For example, see Banzhaf and Walsh (2008), Bui and Mayer (2003), Currie and Schmieder (2009), Currie (2011), Greenstone (2003), Hamilton (1995), and Konar and Cohen (1997).

[8] Some requirements (e.g., the industries subject to reporting) have changed over the course of our sample. Because of this, raw total emissions in the TRI database are not directly comparable over time. As a robustness test, we limit the analysis to industries that were reported in the database for the entire sample.

is a result of ignorance rather than evasion.[9] Evidence also indicates the aggregate effects of misreporting are marginal; EPA (1998) reports the results of an audit of TRI facilities and finds that facility and surveyor estimates were within 3% of each other for most industries. In addition, Bui and Mayer (2003) note that there is little evidence of systematic over- or underestimation in TRI data.

For each chemical subject to TRI reporting, plants are required to provide the number of pounds released into the ground, air, and water. Ground emissions consist of waste disposed in underground injection wells, landfills, surface impoundments, or spills and leaks released to land. Air emissions consist of stack or point releases (e.g., through a vent or duct) and fugitive emissions (e.g., evaporative losses). Water emissions consist of releases to streams and other surface bodies of water. Because CERCLA cleanups focus on contamination of the ground or ground water, our analysis focuses on ground emissions.[10] We drop observations with zero air, water, and ground emissions in a chemical-facility-year. Figure 2 plots the time series of aggregate emissions for the three categories over our sample period. Consistent with previous findings (Shapiro and Walker, 2015), emissions fell through the 1990s, primarily driven by a decrease in air pollution.

We obtain information on the toxicity of emissions from the EPA's Integrated Risk Information System (IRIS). IRIS provides information on potential human health effects from exposure to over 400 chemicals. The database includes both carcinogenic and non-carcinogenic chemicals, which are chosen for inclusion in the database according to potential effects on public health, regulatory implementation needs, and availability of scientific assessment of chemicals. IRIS also includes information on the primary system affected or tumor site for the chemicals (e.g., nervous, respiratory, developmental). We match the IRIS database to TRI using chemical identifiers (i.e., Chemical Abstract Services (CAS) numbers) and use the database to construct an indicator for whether a chemical in TRI poses potential harm to

[9] As a robustness test, we show our results are similar when we drop small facilities from the sample.

[10] Courts have ruled the CERCLA does not apply to air emissions, even if chemicals pollute land or water after being released into the air (see *Pakootas v. Teck Cominco Metals*). In addition, while CERCLA technically does cover disposals into waterways, the EPA only recently began cleanups of such sites on a large scale (DePalma, 2012).

humans as well as indicators for whether particular bodily systems are affected.

We use the EPA's Pollution Prevention (P2) database to analyze abatement activities. Plants reporting to the TRI database are required to document source reduction activities at the chemical level that reduce the amount of hazardous substances entering the waste stream. The most common abatement activity is "good operating practices," which comprises actions such as improved maintenance scheduling, record keeping, or procedures. The second most common abatement activity is "process modifications," which include actions such as modifying equipment, layout, or piping. The list of activities included in both types of abatement are provided in Table A.2. We use these classifications to construct indicators for process-related abatement and operating-related abatement activities.

The P2 database also includes a production or activity ratio that measures changes in the output or outcome of processes in which a chemical is involved. For example, if a chemical is used in the manufacturing of refrigerators, the production ratio for year $t$ is given by $\frac{\#\, Refrigerators\, Produced_t}{\#\, Refrigerators\, Produced_{t-1}}$. If a chemical is used in a capacity not directly related to production (e.g., cleaning), the EPA alternatively requires facilities to report the ratio reflecting changes in this activity. For example, if a chemical is used to clean molds, the activity ratio for year $t$ is given by $\frac{\#\, Molds\, Cleaned_t}{\#\, Molds\, Cleaned_{t-1}}$. If a particular chemical is used in multiple production processes/activities, firms are required to report a weighted average. Due to errors in the data, we exclude production ratios that are not between zero and three (inclusive), though our findings are qualitatively similar using narrower or wider bounds (e.g., [0, 2] or [0, 5]).

Plant-level data are from the National Establishment Time-Series (NETS) database, which is constructed by Walls & Associates using archival data from Dun & Bradstreet. We use plant Paydex score and number of employees from NETS. Paydex score, which ranges from 0 to 100, is a business credit score based on trade credit performance provided to Dun & Bradstreet by a large number of vendors and suppliers. The score is value-weighted according to size of obligations, and a score of 80 indicates that, typically, payments are made according to the loan terms. Our analysis focuses on the minimum score reported over the course of a year. Dun & Bradstreet determines plant employment by directly contacting entities and using statistical models to impute missing values.[11] Financial information for public parent corporations is from Compustat.

For each plant, TRI provides the parent company, defined as highest-level corporation that owns at least 50 percent of voting shares. To account for possible errors or other discrepancies in names, we identify parent using the first 25 alphanumeric characters and remove common suffixes (e.g., "Corp.", "Incorporated", "LLC", etc.). We match plants to court districts to form treatment and control groups. Plants located in "Ability-to-Control" and "Actual Control" districts form the treatment group, and those located in districts with the veil piercing standard comprise the control group.

Figure 3 depicts the fraction of observations in each of the 11 court circuits and shows the breakdown between treatment and control groups during our study (1994-2003). Approximately 22% of plants are located in districts that adopted the "Actual Control" standard (the first of our treatment groups), 28.5% are in districts with the "Ability-to-Control" standard (the second of our treatment groups), and 49.5% fall into circuits that used the veil piercing standard for parent liability (our control group). Despite there being large differences in the size of some circuits (e.g., the Ninth Circuit contains nine states including California), the number of observations are fairly balanced between treatment and control groups.

In total, our sample consists of 6,953 parent corporations which have an average 2.80 subsidiary plants. Each of these plants report emissions for an average of 3.91 toxic chemicals. Table 1 reports summary statistics for our main outcomes of interest. The first four columns of the table report statistics for all plants, and the second four limit the sample to plants with public parent corporations. Unless otherwise noted, all summary statistics are at the chemical-plant-year level. For the full sample, plants average 43 thousand pounds of ground pollution for each chemical reported in TRI, though nearly 85% do not report ground

[11] Neumark et al. (2011) find that the correlations between NETS and Current Employment Statistics (CES) and Quarterly Census of Employment and Wages (QCEW) are 0.99 and 0.95 at the county-by-industry level, respectively. However, NETS has some shortcomings relative to establishment employment determined by government statistical agencies. We take steps where possible to mitigate these shortcomings. First, we obtain similar results if we exclude estimated values. Second, Barnatchez et al. (2017) note that NETS over-samples small establishments (<10 employees). Such establishments are rare in the TRI database (<5% of observations) and excluding them does not have a material effect on our findings.

emissions. Air and water emissions average about 30 thousand and 4 thousand pounds, respectively. Abatement activities are fairly common: operating and process related actions are taken for 8% and 5% of the sample, respectively. The production ratio averages 0.96 and has a median of 1.0, and the average plant employs 334 workers.

## 2.2 Regression Specification

We use the *Bestfoods* decision as a natural experiment in a difference-in-differences framework. We define an indicator*Bestfoods* that takes a value of one starting in 1999, the first full calendar year following the decision, for plants located in a district that previously adopted relatively weaker standards for parent liability (i.e., the AC or ATC legal tests).

Our initial analysis focuses on ground pollution, as this is the focus of CERCLA enforcement efforts. The main outcome variable is the natural logarithm of 1 plus the pounds of emissions (chemical-level) for each plant.[12] Our main specification takes the following form:

$$log(1 + Lbs\,Ground\,Pollution_{c,p,f,i,t}) = \beta\,Bestfoods_{f,t} + \alpha_p + \alpha_{i,t} + \alpha_{c,t} + \epsilon_{c,p,f,i,t},$$

where $c$ indexes a chemical emitted by a plant $p$ located in federal circuit $f$ and belonging to parent firm $i$ at time $t$. We include plant fixed effects ($\alpha_p$) to control for time-invariant heterogeneity at the facility level (e.g., industry). In addition, we include parent-year fixed effects ($\alpha_{i,t}$) to control for time-varying heterogeneity at the parent level. The coefficient estimates for the main specification are therefore relative to plants with the same parent located in areas with a stronger liability standard already in place. We also include chemical-year fixed effects ($\alpha_{c,t}$) to control for time-varying heterogeneity at the chemical-year. As Chatterji et al. (2009) and DiGiuli (2013) note, there is not a clear way of aggregating pollutants or easily comparing their environmental impact; chemical-year fixed effects allow us to exploit within-chemical-time variation. In some specifications, we also include industry-year fixed effects, defined using the primary 4-digit SIC code for each plant to control for

[12] In unreported analysis, we rescale pollution levels by adding 1000 instead of 1 as in Chatterji et al. (2009). This does not have a material effect on the results.

time-varying heterogeneity at the industry level. We cluster robust standard errors at the circuit level.

We also conduct analysis on outcomes related to abatement and production (both at the facility-chemical level) using the above specification. We analyze employment at the plant level using a similar specification but excluding chemical-year fixed effects. Finally, we use 1997 values (prior to *Bestfoods*) to analyze subsets of the main sample based on plant characteristics (e.g., Paydex) or parent characteristics (e.g., Z-score). The specifications used for these tests is the same as above.

# 3 Results

## 3.1 Effect of Parent Liability on Emissions

We first analyze the effect of *Bestfoods* on toxic emissions by subsidiaries. The main outcome of interest is ground pollution, as this is the focus of CERCLA enforcement efforts. In this section, we ask whether the change in liability standards affected the quantity and toxicity of ground emissions.

### 3.1.1 Facility Ground Emissions

Table 2 examines the effect of the *Bestfoods* on facility ground emissions. The dependent variable is the natural logarithm of one plus pounds of ground pollution. Columns (1)–(4) indicate *Bestfoods* is associated with an increase in ground emissions for treated plants that experienced a relative increase in parent liability protection. In addition to the baseline specifications (columns (3) and (4)), we also report coefficients for relatively parsimonious specifications with plant and year (column (1)) or plant and chemical-year fixed effects (column (2)). The point estimates range from 0.047 to 0.086 and are statistically significant at the 1% level in each of the specifications. The increase in emissions is economically large: the average value of the dependent variable is 0.90, indicating an increase of between 5% and 9% relative to the sample average.

The remainder of Table 2 analyzes the effect of *Bestfoods* on different subsets of plants. Columns (5) and (6) separately estimate the treatment effect for plants located in districts that employed Ability-to-Control and Actual Control tests. The indicators $ATC$ and $AC$ are defined analogously to *Bestfoods* in the baseline specification, but only take a value of one for plants located districts that used the respective standards. The results indicate similar effects across both types of jurisdictions. Specifically, the coefficients for both $ATC$ and $AC$ are statistically significant at the 5% level or lower, and the points estimates for both are of similar magnitude to the baseline specification.

Next, we restrict the sample to subsidiaries with publicly traded parents. Shive and Forster (2018) argue public status is positively associated with pollution, potentially as a consequence of pressure from short-term investors. Consistent with their finding, the median output for chemicals with positive ground emissions for all plants in our sample is approximately one quarter (2,050 pounds) that of plants with public parents (8,472 pounds). The effects of *Bestfoods* may be particularly strong for this set of facilities because larger emissions potentially lead to larger future liabilities. Our findings are consistent with this intuition. Specifically, the point estimates in columns (7) and (8) are nearly triple those of the main sample, corresponding to an increase of approximately 17% relative to the subsample mean.

Finally, columns (9) and (10) restrict analysis to plants that do not have a parent listed in the TRI database. Consistent with the idea that a change in parent liability should only affect plants with a parent corporation, we find no evidence of an increase in emissions for this set of plants. The point estimates are both economically small (ranging from -0.006 to -0.018) and statistically indistinguishable from zero. This analysis serves as a useful falsification test as it suggests there was not a confounding shock (e.g., local economic conditions or public attitudes towards pollution) that broadly affected emissions by all plants (both with and without parent corporations) in districts that previously adopted weaker liability standards.

Figure 4 plots the coefficient dynamics around the *Bestfoods* decision. We construct this figure by replacing the pooled treatment variable in the baseline specification with indicators for each year before and after the decision. The coefficient trend is relatively flat prior to the decision, but begins to increase once liability standard changed for the treated group. While the "parallel trends" assumption necessary for empirical identification in our setting is untestable, this figure provides evidence that is consistent with the assumption.

We verify that the main result on ground emissions is not driven by any individual court circuit by iteratively removing one circuit and rerunning our main analysis. This analysis further mitigates concerns that contemporaneous geographical shocks that are unrelated to the *Bestfoods* decision may confound the analysis. We plot the point estimates and confidence intervals in Figure A.1. The estimate for each iteration remains positive and statistically significant at the 5% level or lower.

Overall, the results indicate *Bestfoods* is associated with an increase in toxic emissions. This change in environmental behavior may not be optimal from the perspective of a subsidiary that maximizes its own value if it leads to a higher probability of future EPA enforcement. While an employee of the parent cannot direct the subsidiary to conduct environmental behavior in a manner that is not in the interest of the subsidiary without risking parent liability (see Internet Appendix Section A.I), *Bestfoods* still affords parents considerable leeway to influence the behavior of subsidiaries as majority shareholders. For example, parents can, among other things, appoint directors/officers and approve capital expenditures (Plater et al., 2016). The ability of the parent to influence the subsidiary in this manner may lead to changes in environmental behavior to the parent's benefit that would not be optimal for the subsidiary as a standalone firm.

### 3.1.2 Intensive and Extensive Margins

Table 3 examines whether the increase in emissions is driven by the intensive or extensive margins of pollution. To analyze the intensive margin, columns (1)–(4) restrict the sample to plants that reported positive ground pollution in 1997, the year before the *Bestfoods* decision. Because we exclude plants with zero (or missing) ground pollution in 1997, the sample size is considerably smaller than the main test reported in Table 2. Thus, this test also mitigates concerns that the primary effect is driven by the presence of firms with zero ground emissions. We find the change in parent liability protection is associated with an increase in ground emissions along this margin for both the full sample of subsidiaries (columns (1) and (2)) as well as the sample with public parents (columns (3) and (4)). As in Table 2, the point estimates for the sample with public parents are approximately three times larger than those for the full sample of subsidiaries. The economic magnitude of this effect is sizable, corresponding to an increase of 7.5% to 9.6% relative to the sample mean of the dependent variable for the full sample.

We next examine the extensisve margin of pollution. The dependent variable in columns (5)–(8) is an indicator for ground emissions at the chemical level. For the sample of all subsidiaries (columns (5)–(6)), the likelihood of ground pollution increases by approximately 0.8 percentage points, though this effect is statistically noisy and not significant at conventional levels when we include industry-year fixed effects. The effect is stronger both in terms of economic magnitude (approximately 3 percentage points) and statistical significance ($p < .01$) for the sample of subsidiaries with public parents.

Taken together, the findings in Table 3 indicate that the increase in emissions following the change in liability standards occurs along both the intensive and extensive margins.

#### 3.1.3 Chemical Toxicity

We next turn attention to the types of chemicals emitted by subsidiaries. By definition, the chemicals included in the TRI database are toxic, though not all have adverse effects on humans. In this section, we analyze whether there is a differential effect for chemicals that are known to be toxic to humans versus those that are not. It is possible, for example, that stronger liability protection afforded firms leeway to increase emissions of less-hazardous chemicals, but the presence of ex-ante regulations (e.g., RCRA) made it costly to increase emissions of chemicals that are hazardous to humans. To this end, we match the chemicals from the TRI database with the EPA's Integrated Risk Information System (IRIS), which classifies chemicals based on evidence of harm to humans. We define chemicals as either harmful or non-classified based off of the IRIS definitions. Approximately 62% of the chemical observations in the full sample have known adverse effects on humans.

Table 4 reports the results. Panel A shows the impact of *Bestfoods* on ground pollution split by chemical type. The sample consists of chemicals that have known adverse health outcomes in columns (1)–(4) and unclassified chemicals in columns (5)–(8). For both samples we report results for both all subsidiaries as well as subsidiaries with public parents. Overall, estimates for both samples are similar and comparable to the baseline results in Table 2. Panel B further categorizes harmful chemicals based on biological impact to humans. We document an increase in ground emissions of chemicals that harm a variety of biological systems, especially the nervous, respiratory, urinary, and developmental. Overall, our analysis indicates the increase in ground emissions is not driven by inert substances. Rather, we find little evidence of differences in the estimates for harmful and non-classified chemicals.

## 3.2 Effect of Parent Liability on Firm Value

We next test the effect of *Bestfoods* on the value of parent corporations. Stronger limited liability protection makes it less likely that a parent incurs costs associated with subsidiary environmental cleanups. This may, in turn, have a positive effect on firm value. Moreover, a reduced threat of environmental liability may lead to cost savings (e.g., via lower investment in abatement technologies) or increased production for subsidiaries, both of which may also increase the value of the parent corporation.

For this analysis, we focus on cumulative abnormal returns (CARs) around two important events for the *Bestfoods* case: oral arguments (March 24, 1998) and the Supreme Courts decision (June 8, 1998). These dates represent important milestones in the resolution of uncertainty for a case before the Supreme Court. During oral arguments, justices often ask attorneys questions that indicate their level of skepticism towards a given side of the case. It is plausible that market participants update their beliefs regarding the outcome of a case during such arguments before any residual uncertainty is resolved by the final ruling. This is particularly likely for unanimous decisions, such as *Bestfoods*, where the final outcome did not hinge on the decision of one or two justices.

In order to estimate the effect on shareholder value, we compute daily CARs adjusted for the Fama-French three-factor model around both the date of oral arguments and the decision. Results are qualitatively similar using a four-factor model. We estimate each model in the 100 days prior to each event for the publicly traded firms in our sample. Because such firms often have plants located in both the treatment and control districts, we define an indicator, *High Exposure*, that takes the value of one if a parent has relatively more plants (i.e., above median) in the treatment districts. This allows us to compare the CARs of firms in our sample for which the event was relatively more important.

Table 5 reports the results of this analysis. Panel A analyzes CARs for the entire sample of firms in our sample, while Panel B restricts the sample to multi-plant firms for which the effects of *Bestfoods* may be more salient. Columns (1)–(3) report results the oral arguments date, and columns (4)–(6) report results for the decision date. Overall, we find evidence of higher abnormal returns for high exposure firms around the date of oral arguments but no effect around the actual decision date. Specifically, for the (-1, 5) and (-1, 10) windows, firms with relatively high exposure experienced higher abnormal returns ranging from 82 to 148 basis points. The effect is economically smaller and indistinguishable from zero for the (-1, 1) window. However, CARs are somewhat stronger in terms of magnitude and statistical significance for the multi-plant firms in Panel B, with effects of 109 and 160 basis points for the (-1, 5) and (-1, 10) windows, respectively. In unreported results, we find similar results for the (-1, 30) window, suggesting this effect is not short-lived. We do not, however find evidence of differences in abnormal returns around the decisions date; the coefficients in columns (4)–(6) are both economically small and statistically indistinguishable from zero for both samples. This finding is consistent with the idea that investors updated their beliefs about the unanimous decision outcome during or shortly after oral arguments.

# 4 The Channel

In this section, we investigate why parent liability protection is associated with increased emissions. We consider three non-mutually exclusive channels. First, *Bestfoods* may have reduced the incentives for firms to invest in pollution abatement. While such investments may reduce emissions, the lower likelihood of parent liability for environmental cleanups reduces their expected financial benefits. Second, the increase in emissions may reflect a reallocation of emissions across facilities within the same parent. This may be the case if the harmonization of legal standards relaxed constraints on the optimal economic organization of firms. Third, higher emissions may be a result of an increase in production resulting from a reduction in the expected costs of using pollutive technologies.

## 4.1 Pollution Abatement

We first examine subsidiary pollution abatement activities. Investment in abatement is a considerable expense for industrial firms, ranging from 5–7% of new capital expenditures (EPA, 2005). Such investments are undertaken, at least in part, to reduce the costs associated with emissions (e.g., fines for violating regulations, remediation costs, etc.). By reducing parent liability for future cleanups, *Bestfoods* may have effectively reduced the cost of polluting. Because parents control subsidiaries (as majority owners), this reduction in costs may have reduced the incentives to undertake abatement activities.

We measure abatement activities using EPA's Pollution Prevention (P2) database. Our specific focus is on the two most common abatement categories: changes in operating practices and process improvements. According to P2 guidelines, good operating practices include activities like improving maintenance or quality control. For example, a soap manufacturer changing "production schedules to allow for longer run times for similar products to reduce the need for diethanolamine feedstock changeovers" is an abatement activity related to operating practices. Process improvement include activities such as improving chemical reaction conditions or implementing better process controls. For example, the EPA highlights a battery manufacturer that "upgraded its conveyor system to prevent blockage and loss of cobalt material due to contamination" as an abatement activity related to production. Table A.2 provides a detailed list of activities classified under these types of abatement.

We test whether *Bestfoods* is associated with changes in abatement activities in Table 6. The dependent variable in columns (1)–(4) is an indicator for abatement related to operating practices, and the dependent variable for columns (5)–(8) is an indicator for abatement related to process improvements. Overall, we find evidence that plants decrease abatement related to the production process but not operations. Specifically, the coefficients for abatement related to operating practices are both economically small and statistically indistinguishable from zero. However, for process-related abatement, estimates are both larger in magnitude (ranging from -0.008 to -0.018) and statistically significant at conventional levels. The economic magnitude of this effect is sizable, implying a reduction of 16–35% relative to the sample mean. As with the emissions results, our findings are particularly strong for facilities that have a publicly traded parent. In unreported analysis we examine less common types of abatement. We find evidence of a decrease in efforts to improve inventory management, but estimates for other types of abatement are statistically indistinguishable from zero, though such actions are relatively uncommon to begin with.

## 4.2 Reallocation of Emissions

We next consider whether *Bestfoods* is associated with a reallocation of emissions within a firm's boundaries. This may occur, for example, if the strengthening of parent liability protection for plants located in ATC/AC circuits (i.e., the treatment group) led to a shift in production (and the emissions associated with it) from plants located in areas that used the veil piercing standard (i.e., the control group). Examining this channel poses an empirical challenge because our baseline estimates are within parent-year. Thus, we introduce two different approaches to test the reallocation channel.

Our first test exploits the fact that some parents have plants in *both* the treatment and control groups, while others *only* have plants in the control group. We examine whether there is evidence of reallocation among sibling plants for parents with both treatment and control plants, using parents with only control plants (approximately one quarter of the observations from our original control group) as a counterfactual. We define a new variable *Sibling Treated* that takes a value of one after 1998 if a plant belongs to a parent company that has any treated plants and run the following regression:

$$
\begin{aligned}
log(1 + Lbs\, Ground\, Pollution_{c,p,f,i,t}) &= \beta_1 Sibling\, Treated_{i,t} \\
&+ \beta_2 Bestfoods_{f,t} + \alpha_p + \alpha_{c,t} + \epsilon_{c,p,f,i,t}.
\end{aligned}
$$

*Sibling Treated* captures the differential effect of *Bestfoods* for untreated plants with a treated sibling (i.e., a plant with the same parent). A negative coefficient on this variable indicates a reallocation of emissions from control to treated plants. The other variables in the regression are the same as in the baseline specification. Unlike our main specification, we do not include parent-year fixed effects because they are collinear with *Sibling Treated*, but we include plant, chemical-year and, in some specifications, industry-year fixed effects. In addition, we exclude observations from parents with only treated plants to facilitate the interpretation of the coefficients. In untabulated results we find this does not have a material effect on our findings.

Panel A of Table 7 reports the results of this analysis. Columns (1)–(2) examine the full sample, while columns (3)–(4) restrict the sample to public parents. The coefficients for *Bestfoods* are positive and of similar magnitude to the estimates reported in in Table 2. In contrast, the coefficients for *Sibling Treated* are negative across the different specifications, but they are not generally significant at conventional levels. The sole exception is for the sample of public parents in column (4) ($p < 10\%$). Thus, while we cannot rule out reallocation among some plants in the sample, this test suggests the increase in emissions is not driven by this channel.

Our second test for the reallocation channel examines differential effects to *Bestfoods* based on the operational diversification of firms. We posit this channel is relatively stronger for undiversified parents because their subsidiaries are more likely to have similar operations. To test this idea, we split the sample based on the operational diversification of parents and re-run our main specification in each subsample. The undiversified sample consists of parents with plants operating in a single industry (based on two-digit SIC codes), while the diversified sample consists of parents with plants in multiple industries. In unreported analysis, we find qualitatively similar results using alternative definitions of diversification (e.g., if a parent has plants operating in more or less than five industries). This test is suggestive in nature as operational diversification may be correlated with unobservable characteristics, though our use of parent-year fixed effects mitigates some of these concerns.

Panel B of Table 7 presents the results of this analysis. Columns (1)–(4) and (5)–(8) report results for the sample of undiversified and diversified parents, respectively. Contrary to the reallocation hypothesis, we do not find evidence that the effects of *Bestfoods* are concentrated in undiversified firms. Specifically, the coefficients for undiversified firms range from 0.033–0.044 for the full sample and 0.17–0.26 for public firms, though most of the estimates are statistically noisy. For diversified firms, coefficients range from 0.089–0.098 for the full sample and are approximately 0.23 for public firms ($p < 0.01$ for all specifications). However, the difference between the coefficients for undiversified vs. diversified firms is not statistically significant at conventional levels for any of the specifications. Thus, this test provides further suggestive evidence that the increase in emissions is not primarily driven by reallocation across plants.

## 4.3 Plant Production and Employment

Finally, we examine whether the increase in emissions results from changes in economic activity. The change in liability standards decreases the likelihood that parents are responsible for future cleanups, therefore lowering the expected cost of current emissions. Depending on the nature of these costs, this may affect the output of firms. For example, if *Bestfoods* primarily affected fixed costs associated with emissions (e.g., those pertaining to abatement), the change in liability standards would not lead to changes in production. However, if the decision instead impacted variable costs borne by firms, standard economic theory predicts increased production.

We examine this question using two measures of economic activity—the production ratio (i.e., the ratio of current year to previous year output at the chemical-level) from the TRI database and facility employment data from NETS. Table 8 reports the results of this analysis. Columns (1)–(4) indicate little evidence of changes to output as measured by the production ratio. Specifically, coefficients for the full sample of subsidiaries (columns (1) and (2)) are positive but economically small (less than 1 percentage point) and not statistically significant at conventional levels. Point estimates for subsidiaries with public parents (columns (3) and (4)), which have relatively large changes in emissions, are of similar magnitude and also indistinguishable from zero.

Columns (5)–(8) report the results for employment, a proxy for plant size. The dependent variable in these columns is the natural logarithm of facility employment. We omit chemical-year fixed effects from the regression specifications because employment is defined at the plant, rather than chemical, level. Overall, we find little evidence of changes to employment. If anything, the estimates for this analysis are *negative*, though only statistically significant at the 10% level for one specification (column (7)).

Taken together, we find little evidence that *Bestfoods* is associated with changes in production or employment. This finding is consistent with the idea that costs associated with abatement and remediation of ground pollution are often fixed in nature and therefore do not affect marginal production decisions. Indeed, EPA (2011) notes that environmental remediation costs for ground pollution "often involves upfront expenditures on costly equipment. Such sunk costs are unrelated to current production decisions, unlike variable costs that firms often incur when complying with air and water regulations." In addition, abatement efforts related to process modifications often include actions such as investing in new production technologies, which likely have a sizable fixed-cost component.

# 5 Cross-Sectional Heterogeneity in Responses

In this section we test for heterogeneity in responses to the *Bestfoods* decision based on subsidiary and parent characteristics. Specifically, we consider the effect of subsidiary solvency, parent tangibility, and parent risk of distress. We find the results are driven by less solvent subsidiaries that have the largest impact (all else equal) on their parents' expected liabilities. Moreover, the results are stronger for plants of parents with a higher fraction of tangible assets that may disproportionately benefit from reduced investment in production-related abatement technologies. Finally, the results are driven by parents that are closer to distress. Such firms are more likely to benefit from reducing investment in abatement, thus potentially shifting harm to other stakeholders.

## 5.1 Subsidiary Solvency

All else equal, less solvent subsidiaries are more likely to go bankrupt as a result of environmental liabilities. Thus, the likelihood of parent liability for cleanups depends, in part, on the solvency of subsidiaries. We conjecture the effects of strengthening parent limited liability protection are therefore concentrated in the sample of subsidiaries that are less solvent. In this section, we test this conjecture. Our analysis focuses on subsidiary solvency rather than actual bankruptcy events for two reasons. First, major environmental penalties leading to bankruptcy are relatively rare events. Rather than rely on this limited variation, we instead make use of a proxy for the relative distance from bankruptcy. Second, *Bestfoods* may have altered to behavior of the EPA in equilibrium by reducing the incentive to try to recover costs from subsidiaries that are close to bankruptcy. Thus, it is theoretically unclear whether the change in liability protection should lead to an increase in bankruptcy events.

We measure solvency at the plant level using Dun & Bradstreet's Paydex score, which measures the creditworthiness of an establishment in a given year. For this analysis, we compare the effects on ground pollution and process-related abatement for plants with above/below median Paydex scores in 1997, the year before *Bestfoods*. The minimum 1997

Paydex score for the median firm in the sample is 69, indicating payments to suppliers of trade credit typically arrive two weeks beyond terms.

Table 9 presents the results of this analysis. The dependent variable for columns (1) and (2) is the natural logarithm of one plus pounds of ground pollution, and the dependent variable for columns (3) and (4) is an indicator for process-related abatement. Columns (1) and (3) use the baseline specification, and columns (2) and (4) add industry-year fixed effects. We find that our previous results for both emissions and abatement are concentrated in plants with below-median Paydex scores. For example, column (1) indicates that the point estimate for the less solvent subsidiaries is 0.0859 (significant at the 5% level) whereas the point estimate for more solvent subsidiaries is -0.0503 (barely significant at the 10% level). There are similar patterns in column (3), where the point estimate for less solvent subsidiaries is -0.017 (significant at the 5% level) and 0.0083 (insignificant at conventional levels) for the subsidiaries that were more solvent. The differences between the coefficients for the high and low solvency samples are statistically significant at the 10% level or lower across the different specifications.

## 5.2 Parent Tangibility

We next examine how the main results vary across parents with different levels of tangible assets. The previous analysis indicates *Bestfoods* led to a decrease in pollution abatement activities related to the production process. Such activities potentially entail significant fixed costs, especially for firms with a large amount of fixed assets. Thus, we conjecture the disincentive to invest in abatement is particularly strong for plants with a higher proportion of tangible assets (net plant, property and equipment/total assets). To the extent that a drop in abatement impacts emissions, we also expect the increase in ground emissions to be driven by this set of firms. Because we do not observe tangibility at the plant level, we use parent-level data from Compustat in 1997 (i.e., the year before *Bestfoods*) to classify plants as having above or below median tangibility.

Table 10 reports the results of this analysis. Columns (1) and (2) report results for ground pollution, and columns (3) and (4) report results for process-related abatement. Columns (1) and (3) use the baseline specification, and columns (2) and (4) add industry-year fixed effects. Consistent with our conjecture, we find stronger results for the sample of plants with parent companies that have a higher fraction of tangible assets. For ground emissions, the coefficient for the baseline specification (column (1)) is 0.270 (significant at the 1% level) in the sample with high tangibility; the corresponding point estimate for the low-tangibility sample (.124) is less than half this magnitude and significant at the 10% level. We find a similar difference for abatement: the estimate for the baseline specification in column (3) is -0.0179 (significant at the 1% level) for the high-tangibility sample, whereas the corresponding coefficient for the low-tangibility sample is -0.0144 (significant at the 10% level). For the most part, these differences are suggestive in nature and not statistically significant at conventional levels.

### 5.3 Parent Risk of Distress

We finally examine how parent financial health impacts the response to the change in liability standards. While previous research argues highly-levered firms in poor financial health have incentives to shift risk from equity holders to credit holders (e.g. Jensen and Meckling (1976)), such firms may similarly have incentives to shift economic harm to other stakeholders (e.g., to plant workers or the local community). For example, parents that are close to default may disproportionately respond to *Bestfoods* because they view investments in pollution abatement as having a higher short-term value if directed towards immediate financing needs. This would particularly be true for the low probability, high cost liabilities potentially incurred under CERCLA. The incentive to shift harm suggests parents with relatively high risk of distress may disproportionately respond to *Bestfoods*.

In Table 11 we examine whether parent risk of distress is associated with differential effects to the *Bestfoods* decision. We repeat the analysis from Table 10 but define firms as having above or below median parent unlevered Z-score in 1997. The dependent variables in columns (1)–(2) and (3)–(4) are ground pollution and process abatement, respectively. We find the increase in pollution and decrease in abatement concentrate in firms with low

Z-scores (i.e., those firms that are the least financially solvent). For ground pollution, the coefficients for the sample of facilities with low parent Z-score are more than three times larger than the sample with high Z-scores (e.g., 0.378 vs. 0.125 for column (1)). We find a similar difference for investment in process abatement. The difference between the coefficients for the samples with high/low distress risk is statistically noisy for column (4), but otherwise significant at conventional levels.

# 6 Robustness Tests

We report additional robustness tests in the supplementary appendix. First, we show our findings are robust to using an alternative measure of ground pollution. The dependent variable in Table A.3 is the proportion of ground emissions to total emissions. The regression specifications in this table are otherwise identical to Table 2. We find *Bestfoods* is associated with an increase in this alternative measure for both the full sample (Columns (1)–(6)) and the sample of plants with a public parent (columns (7)–(8)). As before, we find no evidence of a change in behavior for standalone plants that do not have a parent (columns (9)–(10)).

Next, we analyze the effect of *Bestfoods* on air and water emissions. Because the focus of CERCLA enforcement is ground pollution, it is unlikely that changes to liability standards under this legislation directly affect other types of emissions. However, there could be an indirect effect on non-regulated emissions if they serve as complements or substitutes for regulated emissions. Table A.4 reports the results of this analysis. We find little evidence that the decision affected water (columns (1)–(4)) or air (columns (5)–(8)) emissions. While the point estimates are positive across different specifications for both outcomes, they are not statistically different from zero. This finding is consistent with Greenstone (2003), who finds no change in non-regulated emissions in response to the adoption of the Clean Air Act.

Several pieces of evidence suggest that our findings are not driven by unobserved, time-varying geographic heterogeneity (e.g., local economic conditions). Perhaps most importantly, in Table 2 we use standalone plants as a falsification test and show their emissions do not change in response to the change in parent liability standards. As an additional test, we confine our sample to those plants that are located in a control state that shares a border with a treatment state or vice versa. Table A.5 reports the results of this analysis. Although the sample size for this test decreases by a third relative to the baseline, we obtain similar results in terms of both economic magnitude and statistical significance.

We also show our findings are not affected by changes in industries included in the TRI database over time. In Table A.6, we omit industries added to the TRI database after the *Bestfoods* decision. The estimated coefficients for ground pollution and process-related abatement are similar, both in terms of magnitude and statistical significance, to the main analysis.

In addition, we show our findings are not driven by the smallest plants in the sample, which are most likely to misreport TRI data (Brehm and Hamilton (1996)). In Table A.7, we limit the sample to plants with above-median total emissions. The estimated coefficients remain statistically significant and are of similar magnitude to the main analysis.

Finally, we conduct tests to address potential correlation in the standard errors of our estimates. First, in Table A.8 we collapse the data to contain only one pre-treatment and one post-treatment time period, as suggested by Bertrand et al. (2004). The point estimates for both ground emissions and process abatement are similar to the main analysis and remain statistically significant at conventional levels. We further verify that our results are robust to our method of computing standard errors. Panel A of Table A.9 reports our main results with state-level clustering, which preserves much of the panel structure of our treatment unit (e.g., Circuit Courts), but has a larger number of clustering units. Panel B clusters by parent-firm in addition to by state, to account for correlation in the standard errors of subsidiaries that share a parent. Coefficients remain statistically significant at conventional levels across the different tests.

# 7 Conclusion

Limited liability is a ubiquitous feature of modern economic organization. However, because their potential losses are limited, corporate owners do not bear all costs associated with risky activities. Such risks are therefore borne by other stakeholders, including creditors, employees, the surrounding community, and society at large. Admati (2017) argues that lack of accountability for managers further exacerbates these misaligned incentives.

In this paper, we use industrial emissions as a setting to analyze the tradeoffs of limited liability in the parent-subsidiary context. Our identification strategy uses a Supreme Court case (*United States v. Bestfoods*) that clarified parent liability for subsidiary environmental cleanup costs. We find stronger liability protection for parents is associated with an increase in ground emissions of 5–9% for plants of subsidiaries. The effect operates on both the intensive and extensive margins and is partially driven by chemicals with known toxicity to humans. In addition, we document an increase in firm value for parents affected by the decision.

We undertake a number of tests to shed light on the potential channels driving the results. We find evidence that the increase in emissions stems from lower investment in pollution abatement rather than a reallocation between plants or increased economic activity. In addition, the findings are driven by less solvent subsidiaries that are more likely to impose liability on parents and by firms with relatively high tangible assets that would likely most benefit from reducing expenditures on pollution abatement. Consistent with a harm-shifting motivation, the effects concentrate in firms that are relatively close to financial distress.

Overall, our findings highlight the moral hazard problem associated with limited liability. While our setting precludes a rigorous welfare analysis, the results suggest the strengthening limited liability for parents leads to an increase in costs borne by other stakeholders. Thus, efforts by policymakers to strengthen liability protections should carefully weigh the interests of the owners of corporations with those of other constituencies.

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Figure 1: **Treatment and Control Groups**

The map below shows the states that fall into treatment and control groups.

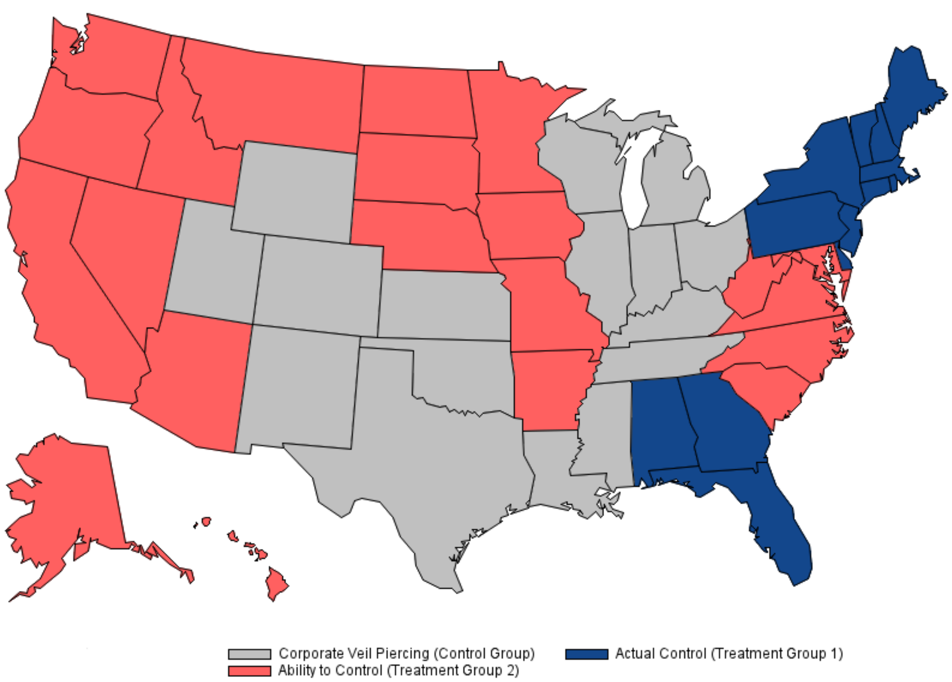

Figure 2: **Total Emissions by Type, 1994 – 2003**

The figure below shows the total amount of pollution reported by plants in the TRI database from 1994 – 2003 for industries that were required to report over the entire sample.

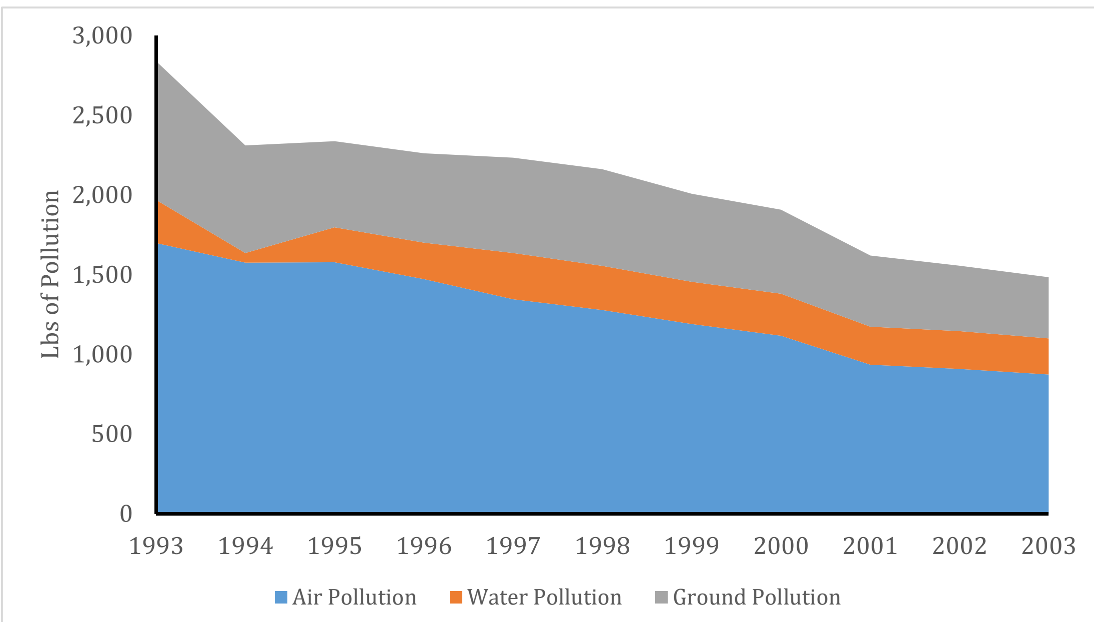

Figure 3: **Distribution of Plants to Court Circuits and Treatment Groups**

The figure below shows the percentage of observations in different court circuits and the distribution of observation into treatment and control groups.

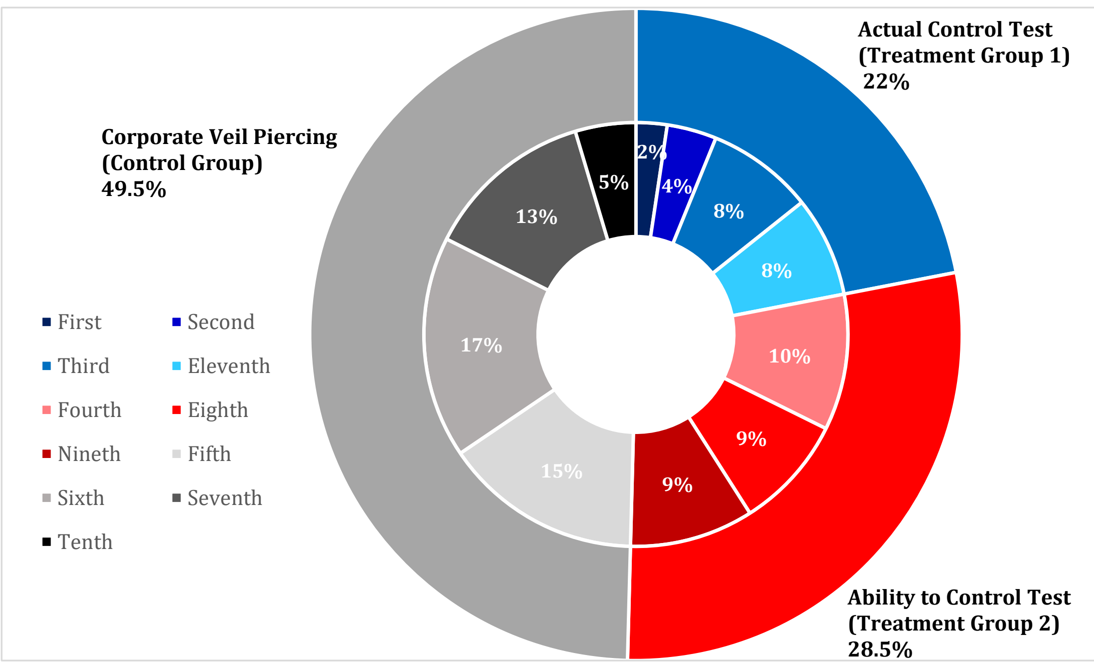

Figure 4: **Treatment Effect Dynamics – Ground Emissions**

This figure plots the coefficient dynamics for ground pollution around the *Bestfoods* decision. The dependent variable is one plus the log of pounds of ground pollution. The regression model is estimated with plant, parent-year, and chemical-year fixed effects. Standard errors are clustered by court circuit.

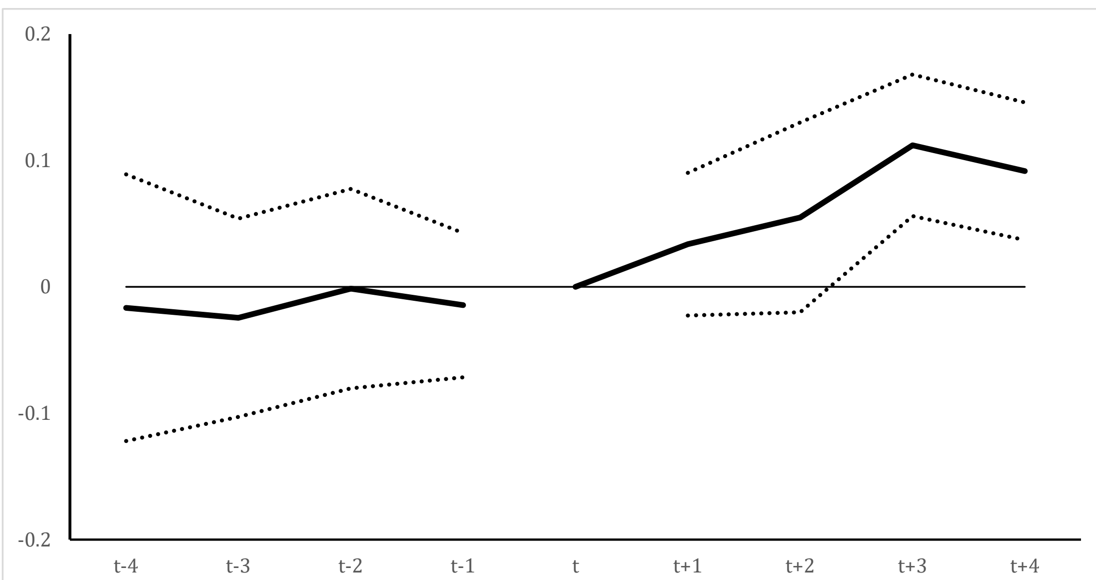

Table 1: **Summary Statistics**

The table reports summary statistics for the full sample of subsidiaries and for the subsample with public parent companies. Emissions data are from the EPA Toxic Release Inventory, abatement and productivity data are from the EPA P2 database, and employment data are from the National Establishment Time-Series database. Unless otherwise noted, observations are at the plant-chemical-year level.

| | **All Subs** | | | | **Subs w/ Public Parent** | | | |
|---|---|---|---|---|---|---|---|---|
| | Obs | Mean | Median | SD | Obs | Mean | Median | SD |
| Lbs Ground Pollution (1000s) | 503,275 | 43.60 | 0 | 1,846.80 | 156,947 | 47.78 | 0 | 1,663.69 |
| Lbs Air Pollution (1000s) | 503,279 | 29.99 | 520 | 318.41 | 156,949 | 37.98 | 566 | 321.87 |
| Lbs Water Pollution (1000s) | 503,276 | 4.35 | 0 | 160.08 | 156,947 | 5.34 | 0 | 205.01 |
| Lbs Total Pollution (1000s) | 503,275 | 77.93 | 1,000 | 1,880.72 | 156,947 | 91.11 | 1,419 | 1,706.03 |
| $\mathbb{1}$(Ground Polluter) | 503,279 | 0.12 | 0 | 0.33 | 156,949 | 0.16 | 0 | 0.36 |
| $\frac{Ground\,Pollution}{Total\,Pollution}$ | 503,275 | 0.08 | 0 | 0.25 | 156,947 | 0.11 | 0 | 0.30 |
| $\mathbb{1}$(Abatement - Operating) | 503,279 | 0.08 | 0 | 0.27 | 156,949 | 0.09 | 0 | 0.28 |
| $\mathbb{1}$(Abatement - Process) | 503,279 | 0.05 | 0 | 0.23 | 156,949 | 0.05 | 0 | 0.23 |
| Productivity Ratio | 477,903 | 0.96 | 1 | 0.38 | 149,081 | 0.96 | 1 | 0.39 |
| Employment (Plant) | 93,378 | 334.23 | 140 | 717.85 | 26,842 | 446.36 | 190 | 971.27 |

Table 2: **Effect of *Bestfoods* on Ground Emissions**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on ground pollution. The dependent variable is the log of one plus pounds of ground pollution. $Bestfoods$ is an indicator that takes the value of 1 after 1998, (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. $AC$ and $ATC$ are indicators defined similarly to $Bestfoods$, but take the value of one after 1998 for plants located in Actual Control or Ability-to-Control circuits, respectively. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ln(1+ Lbs Ground Pollution) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | All Subs | | | | | | Subs w/ Public Parent | | Non-Subs | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| *Bestfoods* | 0.0469*** | 0.0534*** | 0.0861*** | 0.0812*** | | | 0.220*** | 0.224*** | -0.0063 | -0.0184 |
| | (0.0145) | (0.0162) | (0.0193) | (0.0188) | | | (0.0309) | (0.0415) | (0.0259) | (0.0324) |
| *ATC* | | | | | 0.0925*** | 0.0873*** | | | | |
| | | | | | (0.0281) | (0.0239) | | | | |
| *AC* | | | | | 0.0773*** | 0.0727*** | | | | |
| | | | | | (0.0177) | (0.0220) | | | | |
| Plant FE | x | x | x | x | x | x | x | x | x | x |
| Year FE | x | | | | | | | | | |
| Chem-Year FE | | x | x | x | x | x | x | x | x | x |
| Parent-Year FE | | | x | x | x | x | x | x | x | x |
| Industry-Year FE | | | | x | | x | | x | | x |
| Observations | 501,259 | 500,553 | 488,739 | 488,009 | 488,739 | 488,009 | 154,404 | 153,951 | 107,695 | 106,839 |
| R-squared | 0.559 | 0.661 | 0.683 | 0.688 | 0.683 | 0.688 | 0.741 | 0.748 | 0.630 | 0.654 |

Table 3: **Margin of Response to *Bestfoods***

This table uses OLS regressions to test the effects of the *Bestfoods* court decision on the intensive and extensive margins of ground pollution. The dependent variable in columns (1) – (4) is the log of one plus pounds of ground pollution for firms with positive emissions in 1997. The dependent variable in columns (5) – (8) is an indicator variable that takes the value of one if a facility pollutes with a given chemical and zero otherwise. *Bestfoods* is an indicator that takes the value of 1 after 1998, (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ln(1+ Lbs Ground Pollution), 1997 Pollution > 0 | | | | 𝟙(Ground Pollution) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.242** | 0.187 | 0.729*** | 0.960*** | 0.0084* | 0.0070 | 0.0289*** | 0.0305*** |
| | (0.101) | (0.119) | (0.175) | (0.219) | (0.0038) | (0.0044) | (0.0041) | (0.0056) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 83,755 | 83,536 | 24,103 | 23,942 | 488,744 | 488,014 | 154,407 | 153,954 |
| R-squared | 0.568 | 0.579 | 0.538 | 0.555 | 0.641 | 0.648 | 0.690 | 0.702 |

Table 4: **Differential Effects of *Bestfoods* for Harmful Chemicals**

This table uses OLS regressions to test the differential effects of the *Bestfoods* court decision on ground pollution based on the potential harm to humans. The dependent variable is the log of one plus pounds of ground pollution. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. Specifications (1) – (4) in Panel A are run on the subsample of chemicals that are classified by the EPA as harmful to human health. Specifications (5) – (8) are run on the subsample of chemicals that are not classified. Panel B further breaks down known harmful chemicals by biological system. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

**Panel A — Ground Pollution by Human Harm**

| | Ln(1 + Lbs Ground Pollution) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Harmful Chemicals | | | | Non-Classified Chemicals | | | |
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0721*** | 0.0685** | 0.188*** | 0.174*** | 0.0989*** | 0.0919*** | 0.269*** | 0.312*** |
| | (0.0210) | (0.0219) | (0.0413) | (0.0453) | (0.0270) | (0.0273) | (0.0536) | (0.0701) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 294,201 | 293,527 | 89,544 | 89,010 | 181,320 | 180,739 | 62,970 | 62,398 |
| R-squared | 0.699 | 0.706 | 0.759 | 0.767 | 0.721 | 0.726 | 0.764 | 0.771 |

**Panel B — Biological Impact of Chemicals**

| | Ln(1 + Lbs Ground Pollution), All Subs | | | | | |
|---|---|---|---|---|---|---|
| *System Affected =* | Nervous | Respiratory | Urinary | Developmental | Hematologic | Heptatic |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Bestfoods* | 0.0701*** | 0.0847** | 0.116*** | 0.0557*** | 0.0781 | -0.0024 |
| | (0.0126) | (0.0315) | (0.0195) | (0.0123) | (0.0455) | (0.0293) |
| Plant FE | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x |
| Observations | 122,062 | 77,521 | 60,826 | 60,280 | 47,518 | 38,056 |
| R-squared | 0.683 | 0.694 | 0.829 | 0.696 | 0.822 | 0.741 |

Table 5: **Cumulative Abnormal Returns**

This table uses OLS regressions to test the effect of *Bestfoods* on cumulative abnormal returns (CARs). CARs are calculated using the Fama-French three factor model. *High Exposure* is a binary variable that takes the value of one if the parent has an above median proportion of plants in Ability-to-Control or Actual-Control (treatment) districts. Specifications (1) – (3) use CARs around the date of oral arguments for *Bestfoods*, and specifications (4) – (6) use the date of the unanimous decision. Robust standard errors are reported in parentheses. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Oral Argument CARs | | | Decision (Unanimous) CARs | | |
|---|---|---|---|---|---|---|
| | (-1,+1) | (-1,+5) | (-1,+10) | (-1,+1) | (-1,+5) | (-1,+10) |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | **Panel A: All Firms** | | | | | |
| *High Exposure* | 0.00344 | 0.00826* | 0.0148** | -0.00274 | -0.00220 | -0.00368 |
| | (0.00268) | (0.00428) | (0.00619) | (0.00274) | (0.00436) | (0.00580) |
| Observations | 771 | 771 | 771 | 771 | 771 | 771 |
| R-squared | 0.002 | 0.005 | 0.007 | 0.001 | 0.000 | 0.001 |
| | **Panel B: Multi-Plant Firms** | | | | | |
| *High Exposure* | 0.00586* | 0.0109** | 0.0160** | -0.000830 | -0.00347 | -0.00236 |
| | (0.00304) | (0.00488) | (0.00660) | (0.00313) | (0.00511) | (0.00721) |
| Observations | 501 | 501 | 501 | 500 | 500 | 500 |
| R-squared | 0.007 | 0.010 | 0.012 | 0.000 | 0.001 | 0.000 |

Table 6: **Effect of *Bestfoods* on Pollution Abatement Activities**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on abatement activities. The dependent variable is an indicator variable that takes the value of one if the plant invested in pollution abatement for operations or for process. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | $\mathbb{1}$(Abatement - Operations) | | | | $\mathbb{1}$(Abatement - Process) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0000<br>(0.0058) | 0.0006<br>(0.0077) | 0.0000<br>(0.0098) | -0.0013<br>(0.0127) | -0.0083**<br>(0.0033) | -0.0076**<br>(0.0028) | -0.0163***<br>(0.0039) | -0.0176***<br>(0.0041) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 488,744 | 488,014 | 154,407 | 153,954 | 488,744 | 488,014 | 154,407 | 153,954 |
| R-squared | 0.615 | 0.626 | 0.600 | 0.622 | 0.470 | 0.482 | 0.418 | 0.446 |

Table 7: ***Bestfoods* and Reallocation Between Plants**

This table uses OLS regressions to test whether the *Bestfoods* court decision led to a reallocation of pollution. The dependent variable is the log of one plus pounds of ground pollution. Panel A contains observations that belong to subsidiaries located in the control states (those circuits that had previously adopted the Veil Piercing test) or subsidiaries in treatment states that belonged to parent companies with operations in both treatment and control states. *Bestfoods* is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. *Sibling Treated* is an indicator variable that takes the value of 1 after 1998 for plants located in control states, but belong to a parent company that had operations in a treatment state. Panel B splits firms by diversification. Specifications (1) – (4) are run on the subsample of parent companies that had subsidiary operations in only one two-digit SIC codes in the year before *Bestfoods*, while specifications (5) – (8) are run on the subsample of parent companies that had subsidiary operations in more than one two-digit SIC codes. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

**Panel A — Response of Control Subsidiaries with Treated Siblings**

| | Ln(1 + Lbs Ground Pollution) | | | |
|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) |
| *Bestfoods* | 0.0732*** | 0.0526** | 0.192*** | 0.181*** |
| | (0.0180) | (0.0175) | (0.0395) | (0.0515) |
| *Sibling Treated* | 0.00957 | -0.0172 | -0.0765 | -0.179* |
| | (0.0104) | (0.0186) | (0.0987) | (0.0857) |
| Plant FE | x | x | x | x |
| Chem-Year FE | x | x | x | x |
| Ind.-Year FE | | x | | x |
| Observations | 415,306 | 414,594 | 144,197 | 143,712 |
| R-squared | 0.650 | 0.657 | 0.725 | 0.735 |

**Panel B — Response of More and Less Diversified Firms**

| | Ln(1 + Lbs Ground Pollution) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Parents with Undiversified Operations | | | | Parents with Diversified Operations | | | |
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0329 | 0.0435 | 0.171 | 0.256* | 0.0982*** | 0.0888*** | 0.227*** | 0.225*** |
| | (0.0356) | (0.0448) | (0.103) | (0.124) | (0.0217) | (0.0205) | (0.0340) | (0.0452) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Ind.-Year FE | | x | | x | | x | | x |
| Observations | 163,240 | 162,800 | 29,140 | 28,820 | 306,747 | 306,192 | 122,895 | 122,395 |
| R-squared | 0.732 | 0.740 | 0.814 | 0.820 | 0.646 | 0.652 | 0.708 | 0.716 |

Table 8: **Effect of *Bestfoods* on Plant Production and Employment**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on plant production. The dependent variable is the Production Ratio reported in the TRI database in specifications (1) – (4) and the natural logarithm of plant-level employment from the NETS database in specifications (5) – (8). $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Productivity Ratio | | | | Employment (Plant Level) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | 0.0097 | 0.0028 | 0.0078 | 0.0103 | -0.0146 | -0.0174 | -0.0535* | -0.0449 |
| *Bestfoods* | (0.0073) | (0.0062) | (0.0097) | (0.0100) | (0.0178) | (0.0203) | (0.0267) | (0.0270) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 463,955 | 463,336 | 146,572 | 146,141 | 60,190 | 59,303 | 21,605 | 20,654 |
| R-squared | 0.482 | 0.502 | 0.450 | 0.491 | 0.922 | 0.930 | 0.909 | 0.923 |

Table 9: **Differential Effects by Subsidiary Solvency**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. The sample is split according whether the plant had a Paydex score in 1997 that was above or below the sample median. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ground Pollution | | 𝟙(Abatement - Process) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | **Low Plant Paydex** | | |
| *Bestfoods* | 0.0859** | 0.0893* | -0.0170** | -0.0168** |
| | (0.0365) | (0.0491) | (0.0062) | (0.0069) |
| Observations | 154,256 | 153,809 | 154,256 | 153,809 |
| R-squared | 0.666 | 0.677 | 0.524 | 0.547 |
| | | **High Plant Paydex** | | |
| *Bestfoods* | -0.0503* | -0.0563 | 0.00829 | 0.0194 |
| | (0.0270) | (0.0325) | (0.0143) | (0.0132) |
| Observations | 140,396 | 140,032 | 140,398 | 140,034 |
| R-squared | 0.708 | 0.714 | 0.519 | 0.544 |
| Plant FE | x | x | x | x |
| Chem-Year FE | x | x | x | x |
| Parent-Year FE | x | x | x | x |
| Industry-Year FE | | x | | x |

Table 10: **Differential Effects by Parent Tangibility**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. The sample is split according whether the plant belongs to a parent company that had above or below median asset tangibility in 1997. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ground Pollution | | $\mathbb{1}$(Abatement - Process) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | **High Parent Tangibility** | | | |
| *Bestfoods* | 0.270*** | 0.291*** | -0.0179*** | -0.0220** |
| | (0.0566) | (0.0539) | (0.0053) | (0.0070) |
| Observations | 97,577 | 97,177 | 97,580 | 97,180 |
| R-squared | 0.750 | 0.756 | 0.410 | 0.442 |
| | **Low Parent Tangibility** | | | |
| *Bestfoods* | 0.124* | 0.152*** | -0.0144* | -0.0091 |
| | (0.0601) | (0.0347) | (0.0067) | (0.0108) |
| Observations | 56,018 | 55,655 | 56,018 | 55,655 |
| R-squared | 0.716 | 0.730 | 0.446 | 0.497 |
| Plant FE | x | x | x | x |
| Chem-Year FE | x | x | x | x |
| Parent-Year FE | x | x | x | x |
| Industry-Year FE | | x | | x |

Table 11: **Differential Effects by Parent Solvency**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. The sample is split according whether the plant belongs to a parent company that had above or below median Altman's unlevered Z-score in 1997. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ground Pollution | | 𝟙(Abatement - Process) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | **Low Parent Z-Score** | | | |
| *Bestfoods* | 0.378*** | 0.389*** | -0.0300*** | -0.0300*** |
| | (0.0756) | (0.111) | (0.0078) | (0.0059) |
| Observations | 69,690 | 69,225 | 69,690 | 69,225 |
| R-squared | 0.782 | 0.787 | 0.454 | 0.497 |
| | **High Parent Z-Score** | | | |
| *Bestfoods* | 0.125** | 0.111* | -0.0090 | -0.0116 |
| | (0.0489) | (0.0554) | (0.0083) | (0.0143) |
| Observations | 65,753 | 65,345 | 65,754 | 65,346 |
| R-squared | 0.584 | 0.605 | 0.413 | 0.454 |
| Plant FE | x | x | x | x |
| Chem-Year FE | x | x | x | x |
| Parent-Year FE | x | x | x | x |
| Industry-Year FE | | x | | x |

# Supplementary Appendix

## A.I *Bestfoods* Case Summary

The US Supreme Court clarified parent liability for subsidiary emissions under CERCLA in *U.S. v. Bestfoods*. The case involved a chemical manufacturing facility, Ott Chemical Co., located in Muskegon, MI. In 1965, Bestfoods Inc. (known as CPC International Inc. at the time) formed a wholly-owned subsidiary to purchase the assets of the facility. In 1972, the facility was sold to Story Chemical Corp., which went bankrupt in 1977. Cordova Chemical Company, a wholly-owned subsidiary of Aerojet-General Corp., purchased the facility from the bankruptcy trustee.

Shortly before it was sold to Cordova, the facility was inspected by the Michigan Department of Natural Resources, which found "thousands of leaking and even exploding drums of waste, and the soil and water saturated with noxious chemicals." In 1981, the EPA finalized a long-term remediation plan that "called for expenditures well into the tens of millions of dollars." To recover these costs, the United States sued Bestfoods and Aerojet, among other parties, in 1989.[1] The case centered on the question of whether the parent companies were liable for cleanup costs as "owners and operators" under CERCLA.

In 1991, the District Court for the Western District of Michigan, applying the Actual Control standard for liability, imposed liability on the parent corporations as operators. In regards to Bestfoods, the court noted that the presence of overlapping officers/directors and the role of a Bestfoods employee in shaping environmental policies indicated parent control of the subsidiary. This decision, however, was overruled on appeal by the Sixth Circuit Court, which ruled that parent corporations could only be held liable as owners, not operators, under CERCLA (i.e., the veil piercing standard). Because there was no evidence of fraud or injustice to justify piercing the corporate veil, the court ruled the parent corporations were not liable.

The Supreme Court resolved this dispute between the lower courts in 1998. In a unanimous opinion penned by Justice Souter, the Court largely affirmed the Sixth Circuit's ruling. The decision notes that limited liability for parent corporations is "ingrained in our economic and legal systems" and "nothing in CERCLA purports to reject this bedrock principle." Thus, the court determined that parents cannot be held derivatively liable under

[1] Other defendants included Cordova and the plant's founder (Arnold Ott). The case is referred to as Bestfoods because this was the first-named defendant.

CERCLA unless the corporate veil can be pierced. In contrast to the Sixth Circuit, however, the Supreme Court did not entirely abrogate liability for parents as operators. Specifically, the Court distinguished between operation of a subsidiary and operation of the subsidiarys facility. It ruled that parents are liable for cleanup costs if they directly operated the facility (rather than the subsidiary) responsible for the emissions. Plater et al. (2016) summarizes four types of behaviors identified by the court as potentially giving rise to this form of direct liability:

1. where the parent company actually directed operations at a site owned by one of its subsidiaries, such as when a parent had leased property from its subsidiary to conduct its own operations;

2. where a parent corporation participated in a joint venture with its subsidiary;

3. where an officer or director who holds positions in both the parent and the subsidiary abuses his or her position in the subsidiary by making decisions concerning hazardous waste or environmental compliance that, under the norms of corporate behavior, are not in the interest of the subsidiary and are to the advantage of the parent; and

4. where an employee of the parent, who holds no position in the subsidiary, directly controls those operations at the site that involve hazardous substances or environmental compliance.

The Supreme Court remanded the case to the District Court to determine whether any of these criteria were satisfied. However, it noted that because an agent of Bestfoods "actively participated in and exerted control over" the facility's environmental operations, this potentially met the standard for direct liability as an operator. In subsequent litigation, the parent company was ultimately held liable for its subsidiary through the direct liability test outlined by the Supreme Court.

Figure A.1: **Robustness to Removing Court Circuits**

The figure below plots point estimates along with 95% confidence intervals for the coefficient $Bestfoods$ in the regression described in Table 2 after iteratively removing one court circuit for each estimation of the regression. The dependent variable is the natural logarithm of one plus the amount of ground pollution. The model includes plant, parent-year, and chemical-year fixed effects. Standard errors are clustered by court circuit.

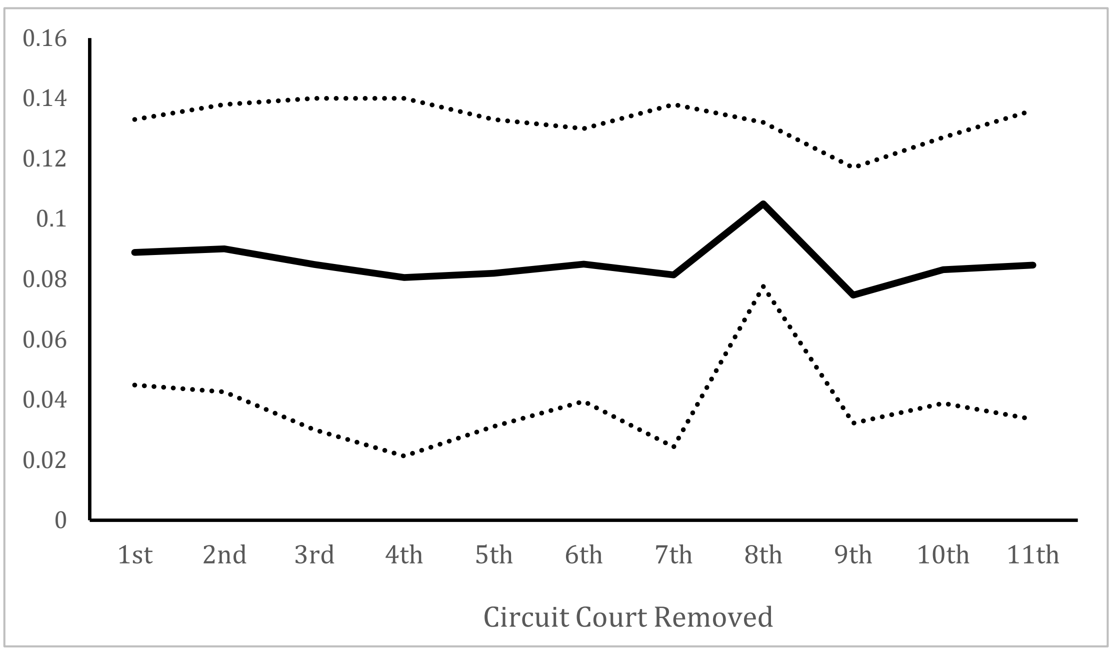

Table A.1: **Industries that Report Toxic Release Inventory**

Facilities in the following industries must report chemical emissions data (in 2015).

| NAICS Code | Description | Proportion of Sample |
|---|---|---|
| 325 | Chemical Manufacturing | 0.2506 |
| 332 | Fabricated Metal Product Manufacturing | 0.1096 |
| 331 | Primary Metal Manufacturing | 0.0912 |
| 336 | Transportation Equipment Manufacturing | 0.0693 |
| 324 | Petroleum and Coal Products Manufacturing | 0.0525 |
| 424 | Merchant Wholesalers, Nondurable Goods | 0.0438 |
| 326 | Plastics and Rubber Products Manufacturing | 0.0431 |
| 221 | Utilities | 0.0430 |
| 322 | Paper Manufacturing | 0.0394 |
| 333 | Machinery Manufacturing | 0.0386 |
| 311 | Food Manufacturing | 0.0336 |
| 334 | Computer and Electronic Product Manufacturing | 0.0317 |
| 327 | Nonmetallic Mineral Product Manufacturing | 0.0277 |
| 335 | Electrical Equipment, Appliance, and Component Manufacturing | 0.0226 |
| 562 | Waste Management and Remediation Services | 0.0201 |
| 321 | Wood Product Manufacturing | 0.0182 |
| 337 | Furniture and Related Product Manufacturing | 0.0174 |
| 339 | Miscellaneous Manufacturing | 0.0145 |
| 212 | Mining (except Oil and Gas) | 0.0081 |
| 313 | Textile Mills | 0.0074 |
| 323 | Printing and Related Support Activities | 0.0069 |
| 312 | Beverage and Tobacco Product Manufacturing | 0.0036 |
| 316 | Leather and Allied Product Manufacturing | 0.0027 |
| 314 | Textile Product Mills | 0.0019 |
| 541 | Professional, Scientific, and Technical Services | 0.0007 |
| 315 | Apparel Manufacturing | 0.0005 |
| 425 | Wholesale Electronic Markets and Agents and Brokers | 0.0005 |
| 811 | Repair and Maintenance | 0.0003 |
| 211 | Oil and Gas Extraction | 0.0002 |
| 488 | Support Activities for Transportation | 0.0002 |
| 111 | Crop Production | 0.0001 |
| 511 | Publishing Industries (except Internet) | 0.0001 |
| 113 | Forestry and Logging | 0.0001 |
| 512 | Motion Picture and Sound Recording Industries | 0.0000 |
| 519 | Other Information Services | 0.0000 |

Table A.2: **Process and Operating Abatement Activities**

This table lists abatement activities classified as process modifications or good operating practices under TRI reporting guidelines.

| | **Process Modifications** | **Good Operating Practices** |
|---|---|---|
| 1 | Optimized reaction conditions or otherwise increased efficiency of synthesis | Improved maintenance scheduling, record keeping, or procedures |
| 2 | Instituted recirculation within a process | Changed production schedule to minimize equipment and feedstock changeovers |
| 3 | Modified equipment, layout, or piping | Introduced in-line product quality monitoring or other process analysis system |
| 4 | Use of a different process catalyst | Other changes in operating practices |
| 5 | Instituted better controls on operating bulk containers to minimize discarding of empty containers | |
| 6 | Changed from small volume containers to bulk containers to minimize discarding of empty containers | |
| 7 | Reduced or eliminated use of an organic solvent | |
| 8 | Used biotechnology in manufacturing process | |
| 9 | Other process modifications | |

## Table A.3: **Effect of *Bestfoods* on Fraction of Ground Emissions**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on ground pollution using an alternative dependent variable. The dependent variable is the ratio of ground pollution to total pollution for a given chemical. $Bestfoods$ is an indicator that takes the value of 1 after 1998, (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent liability. $AC$ and $ATC$ are indicators defined similarly to $Bestfoods$, but take the value of one after 1998 for plants located in Actual Control or Ability-to-Control circuits, respectively. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | $\frac{LBS\,Ground\,Pollution}{LBS\,Total\,Pollution}$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | All Subs | | | | | | Subs w/ Public Parent | | Non-Subs | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| *Bestfoods* | 0.00453** | 0.00400 | 0.00582*** | 0.00571*** | | | 0.0146*** | 0.0146*** | -0.000644 | -0.00289 |
| | (0.00172) | (0.00232) | (0.00163) | (0.00161) | | | (0.00226) | (0.00293) | (0.00190) | (0.00371) |
| *ATC* | | | | | 0.00496** | 0.00559** | | | | |
| | | | | | (0.00190) | (0.00191) | | | | |
| *AC* | | | | | 0.00699*** | 0.00587*** | | | | |
| | | | | | (0.00172) | (0.00167) | | | | |
| Plant FE | x | x | x | x | x | x | x | x | x | x |
| Year FE | x | | | | | | | | | |
| Chem-Year FE | | x | x | x | x | x | x | x | x | x |
| Parent-Year FE | | | x | x | x | x | x | x | x | x |
| Industry-Year FE | | | | x | | x | | x | | x |
| Observations | 501,259 | 500,553 | 488,739 | 488,009 | 488,739 | 488,009 | 154,404 | 153,951 | 107,695 | 106,839 |
| R-squared | 0.552 | 0.646 | 0.673 | 0.679 | 0.673 | 0.679 | 0.723 | 0.731 | 0.657 | 0.685 |

Table A.4: **Effect of *Bestfoods* Water and Air Emissions**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of water and air pollution. The dependent variable is the log of one plus pounds of water pollution or one plus pounds of air pollution. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ln(1 + Lbs Water Pollution) | | | | Ln(1 + Lbs Air Pollution) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0156 | 0.0214 | 0.0164 | 0.0177 | 0.0366 | 0.0241 | 0.0382 | 0.0324 |
| | (0.0163) | (0.0173) | (0.0309) | (0.0343) | (0.0207) | (0.0217) | (0.0344) | (0.0283) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 488,740 | 488,010 | 154,404 | 153,951 | 488,744 | 488,014 | 154,407 | 153,954 |
| R-squared | 0.602 | 0.607 | 0.606 | 0.612 | 0.699 | 0.703 | 0.717 | 0.724 |

## Table A.5: **Robustness to Bordering States**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. The sample contains only observations that are in "bordering states" of the treatment and control groups. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ln(1 + Lbs Ground Pollution) | | | | 𝟙(Abatement - Process) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0697* | 0.0622* | 0.237*** | 0.238** | -0.00864** | -0.00531* | -0.0186*** | -0.0194*** |
| | (0.0313) | (0.0277) | (0.0507) | (0.0733) | (0.00273) | (0.00284) | (0.00393) | (0.00440) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Ind.-Year FE | | x | | x | | x | | x |
| Observations | 325,697 | 325,106 | 103,650 | 103,166 | 325,700 | 325,109 | 103,651 | 103,167 |
| R-squared | 0.689 | 0.694 | 0.738 | 0.744 | 0.463 | 0.479 | 0.418 | 0.450 |

Table A.6: **Robustness to Industries Continuously Required to Report**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. *Bestfoods* is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. The sample contains only industries required to report emissions data continuously throughout the sample. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ln(1 + Lbs Ground Pollution) | | | | 𝟙(Abatement - Process) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0812*** | 0.0750*** | 0.218*** | 0.223*** | -0.00853** | -0.00764** | -0.0175*** | -0.0176*** |
| | (0.0226) | (0.0220) | (0.0395) | (0.0430) | (0.00383) | (0.00309) | (0.00401) | (0.00374) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 418,960 | 418,270 | 125,220 | 124,775 | 418,963 | 418,273 | 125,221 | 124,776 |
| R-squared | 0.551 | 0.558 | 0.527 | 0.544 | 0.467 | 0.479 | 0.411 | 0.440 |

Table A.7: **Robustness to Removing Small Plants**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. *Bestfoods* is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. The sample contains only observations from facilities that report above median total emissions. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ln(1 + Lbs Ground Pollution) | | | | 𝟙(Abatement - Process) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.112*** | 0.109*** | 0.319*** | 0.329*** | -0.00958** | -0.00878*** | -0.0141** | -0.0161** |
| | (0.0321) | (0.0292) | (0.0488) | (0.0643) | (0.00361) | (0.00265) | (0.00483) | (0.00657) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Ind.-Year FE | | x | | x | | x | | x |
| Observations | 350,327 | 349,796 | 114,528 | 114,189 | 350,328 | 349,797 | 114,528 | 114,189 |
| R-squared | 0.695 | 0.699 | 0.754 | 0.759 | 0.452 | 0.466 | 0.407 | 0.437 |

Table A.8: **Robustness to Collapsing Observations**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The sample has been averaged at the plant-chemical level to contain one observation before the *Bestfoods* decision and one observation after the decision. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. Robust standard errors clustered by court circuit are reported in parentheses. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Ln(1 + Lbs Ground Pollution) | | | | 𝟙(Abatement - Process) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0775** | 0.0692** | 0.235*** | 0.209*** | -0.00816** | -0.00645* | -0.0176*** | -0.0154* |
| | (0.0285) | (0.0254) | (0.0399) | (0.0378) | (0.00301) | (0.00353) | (0.00403) | (0.00719) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 124,665 | 124,481 | 39,370 | 39,257 | 124,665 | 124,481 | 39,370 | 39,257 |
| R-squared | 0.675 | 0.676 | 0.735 | 0.738 | 0.540 | 0.548 | 0.506 | 0.520 |

Table A.9: **Robustness to Alternative Clustering**

This table uses OLS regressions to test the effect of the *Bestfoods* court decision on the output of ground pollution or the likelihood of firms implementing pollution abatement investment. The dependent variable is either the log of one plus pounds of ground pollution or an indicator variable that takes the value of one if the plant invested in pollution abatement for operations. $Bestfoods$ is an indicator that takes the value of 1 after 1998 (the year of the *Bestfoods* decision) for plants that are located in the circuits that had previously adopted the Ability-to-Control or Actual Control standards for parent company liability. Panel A presents regression estimates with robust standard errors clustered by state, while Panel B presents regression estimates with robust standard errors clustered by state and parent company. The fixed effects used in each specification are noted in the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

**Panel A — Clustering by State**

| | Ln(1 + Lbs Ground Pollution) | | | | $\mathbb{1}$(Abatement - Process) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0861*** | 0.0812*** | 0.220*** | 0.224*** | -0.00829** | -0.00759** | -0.0163** | -0.0176** |
| | (0.0231) | (0.0220) | (0.0371) | (0.0395) | (0.00346) | (0.00351) | (0.00623) | (0.00685) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 488,739 | 488,009 | 154,404 | 153,951 | 488,744 | 488,014 | 154,407 | 153,954 |
| R-squared | 0.683 | 0.688 | 0.741 | 0.748 | 0.470 | 0.482 | 0.418 | 0.446 |

**Panel B — Clustering by State and Parent Company**

| | Ln(1 + Lbs Ground Pollution) | | | | $\mathbb{1}$(Abatement - Process) | | | |
|---|---|---|---|---|---|---|---|---|
| | All Subs | | Subs w/ Public Parent | | All Subs | | Subs w/ Public Parent | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Bestfoods* | 0.0861** | 0.0812** | 0.220*** | 0.224*** | -0.00829* | -0.00759* | -0.0163** | -0.0176** |
| | (0.0335) | (0.0315) | (0.0562) | (0.0580) | (0.00445) | (0.00410) | (0.00789) | (0.00805) |
| Plant FE | x | x | x | x | x | x | x | x |
| Chem-Year FE | x | x | x | x | x | x | x | x |
| Parent-Year FE | x | x | x | x | x | x | x | x |
| Industry-Year FE | | x | | x | | x | | x |
| Observations | 488,739 | 488,009 | 154,404 | 153,951 | 488,744 | 488,014 | 154,407 | 153,954 |
| R-squared | 0.683 | 0.688 | 0.741 | 0.748 | 0.470 | 0.482 | 0.418 | 0.446 |