

The Limits of Limited Liability: Evidence from Industrial Pollution

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Introduction

- **Two perspectives on limited liability**

- **“The limited-liability company is one of man’s greatest inventions.”**

— *The Economist*, 2016

- **“Financialized governance can encourage managers to endanger stakeholders** — for example, by compromising product quality, the health and safety of customers or employees, **or even the solvency of the corporation.**”

— *Admati*, 2017, *JEP*

- **Current policy debate about the role of the firm in society**

- “American corporations exist only because the American people grant them charters. **Those charters confer valuable privileges — such as limited legal liability for their owners — that enable businesses to turn a profit.** What do Americans get in return? **What are the obligations of corporate citizenship in the U.S.?**”

— *Sen. Elizabeth Warren*, August 2018, *Wall Street Journal*

Introduction

- Limited liability has been a bedrock of financial market development since the industrial revolution
- Limited liability can also incentivize agents to subject stakeholders to large risks that may outweigh their ability to repay them
- We study how limited liability *in the parent-subsidiary context* impacts industrial pollution output

What We Do

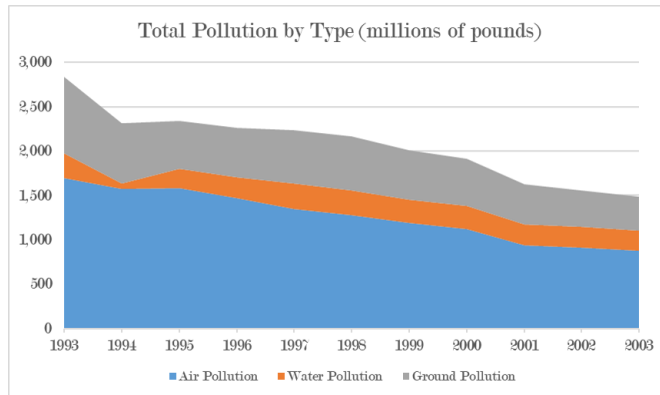
- We study the effect of a Supreme Court (SCOTUS) case that strengthened limited liability protection on the output of industrial pollution
 - *United States v. Bestfoods* invalidated standards that some lower courts had adopted to hold parent companies liable for the ground pollution of their subsidiaries
 - We combine plant-level data on toxic chemicals and economic data to evaluate the effect of the increase in legal protection
- 1 Does the increase in legal protection lead firms to engage in more behavior that is likely to have negative consequences for local stakeholders?
 - 2 Does the reduction in expected legal costs lead to more economic activity?
 - 3 Which types of firms change their behavior?

What We Find

- Following the *Bestfoods* decision, plants located in areas that increased liability protections **increased pollution emissions and decreased pollution abatement activities**
 - Pollution emissions increase by 10% relative to the sample average
 - Pollution abatement activities decrease by 12% relative to the unconditional likelihood
- Effects are similar for chemicals that are known to cause harm to humans and for unclassified chemicals
 - Nervous, urinary, developmental and hematological systems
- We find **no evidence** that the increased pollution comes as a result of **increased economic activity**
 - Plant-level output and employment
- Cross-sectional evidence suggests that distressed firms engage in (real) risk-shifting towards other stakeholders
 - Less solvent subsidiaries
 - Parent companies with more tangible assets, higher leverage and that are less solvent

Industrial Pollution

- Industrial Pollution is major source of greenhouse gas emissions (21% of U.S. greenhouse gas emission in 2015)



Background of CERCLA

- In 1980, the discovery of several sites where toxic waste had been dumped caused U.S. Government to pass the Comprehensive Environmental, Response and Liability Act (CERCLA)
 - Love Canal, NY and Kentucky Drums Valley were sites where substantial toxic chemicals had been dumped causing major environmental degradation and human health problems
- Empowered U.S. Environmental Protection Agency (EPA) to designate locations as cleanup sites and force the polluter to pay
- Created a “Superfund” to cover costs when the party responsible for the pollution couldn't pay

Example: Love Canal [1/2]



- Used by Hooker Chem. Corp. to dump 22K tons of chemicals
- Covered with clay; sold to Niagara Falls Board of Ed. for \$1 in 1953
- Hundreds of homes and two schools built on the site

Example: Love Canal [2/2]



- 1977: Chemicals begin to seep out after a large storm
- Health effects: High white blood cell counts, chromosome damage, high rate of miscarriages and birth defects, etc.
- Designated a NPL site in 1980; cleanup lasted 21 years and cost \$400 million

Cleanup Cost Example —Berkeley Pit

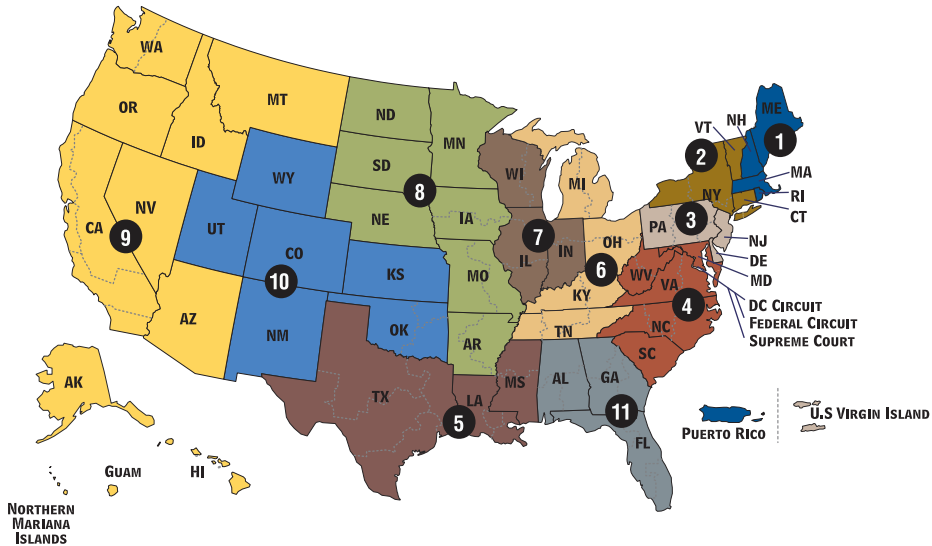
- Berkeley Pit was one of the biggest early CERCLA sites — Added as a cleanup site in 1983
- Cleanup still ongoing — unclear if it will ever be completely clean



Jurisprudence and CERCLA

- Final CERCLA bill was a “last minute compromise” that did not clearly specify important aspects of enforcement
 - Policy specified that the “owner or operator” of the polluting facility was responsible — not an obvious definition with parent-subsidary relationships
- When Courts are faced with a legal ambiguity and there is no clear precedent from SCOTUS, judges can create jurisprudence that are binding for individual court “Circuits”
 - Geographic subdivisions of 3–9 contiguous states
- Different circuits can come to different conclusions for the same legal question — a “circuit split”
- Circuit splits persist until the SCOTUS clarifies the split, splits can persist for a long time
 - Currently SCOTUS receives 7,000–8,000 petitions per year, but only decides ~150

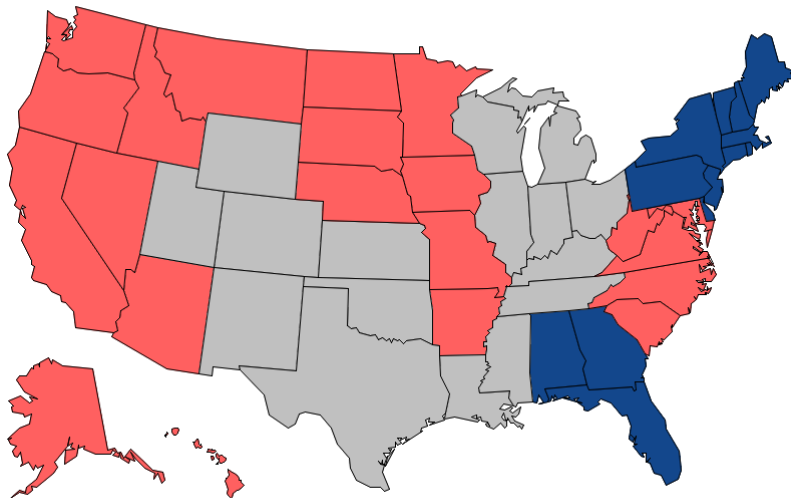
U.S. Court Circuits



United States v. Bestfoods

- Between 1980 and 1998 different Appellate Circuits adopted different legal tests to determine parental liability for the pollution of subsidiaries
- ① **Authority-to-Control (ATC)** — imposed liability on parents that had the power to control the activities of the polluter.
- ② **Actual-Control (AC)** — imposed liability on the parent if the subsidiary did not act independently.
- ③ **Veil Piercing** — imposed liability if the corporate veil could be pierced under state law
- In 1998, SCOTUS ruled that the AC and ATC tests were not valid, but that (1) Veil Piercing was a sufficient standard or (2) *direct* operation of the facility had to be shown
 - Parent companies experienced a *relative increase* in legal protection for plants located in ATC and AC states

Treatment and Control States

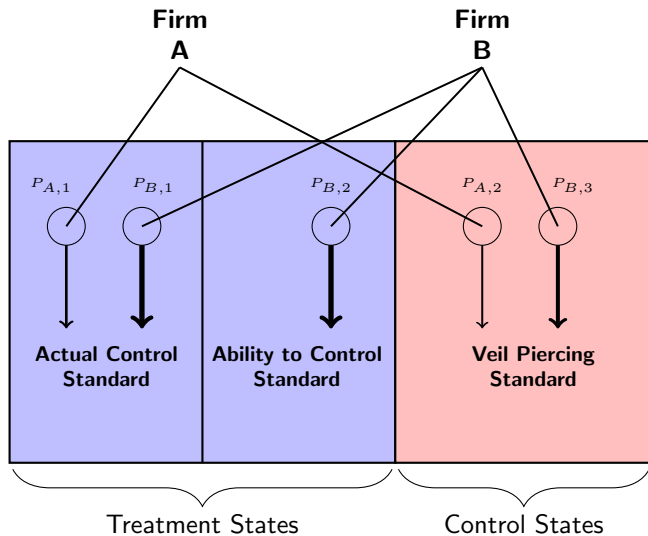


treatment_group

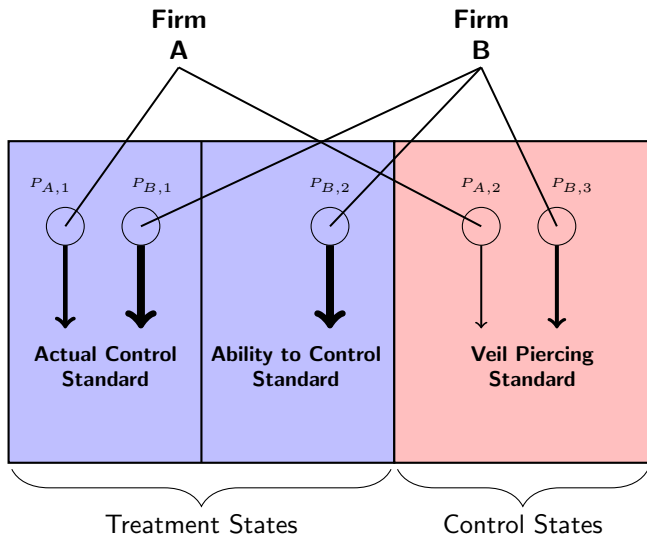
Corporate Veil Piercing (Control Group)
Ability to Control (Treatment Group 2)

Actual Control (Treatment Group 1)

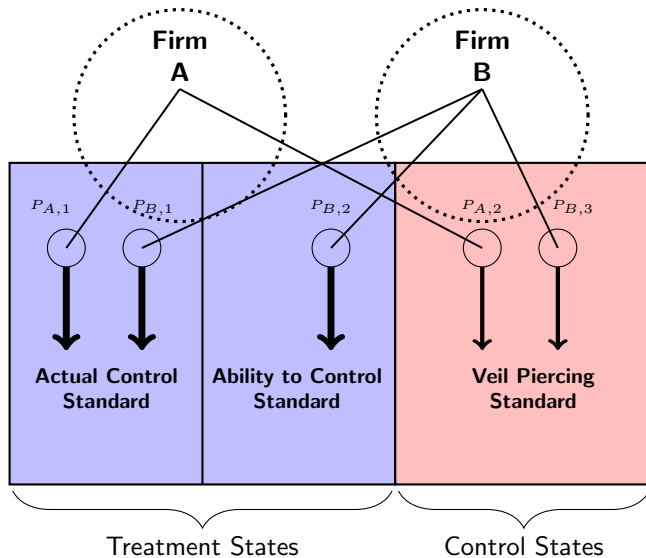
Identification Strategy Visually



Identification Strategy Visually



Identification Strategy Visually



Data: Emissions data

- Chemical emissions data comes from the EPA Toxic Release Inventory (TRI) (1994–2003)
 - Plant-chemical level data that reports pounds of ground, water, and air emissions
- Plants required to report if
 - Employ more than 10 people
 - Use a meaningful quantity of one of 600 chemicals
 - Operate in certain industries
- 6,953 parent companies, on average 3 subsidiaries, using on average 4 chemicals
- Major Industries: Chemical manufacturing (25%), fabricated metal manufacturing (11%), primary metal manufacturing (9%), transportation equipment manufacturing (7%), merchant wholesalers, non-durable (4.5%), utilities (4.5%)

Data: Abatement, Output, and NETS Data

- Facilities report data on efforts to reduce pollution (abatement) across 7 categories of activities
 - Most common activities are “good operating procedures” and “process modifications”
- Facilities also report “production ratios”
 - A measure of facility output e.g. $\frac{\# \text{Refrigerators Produced}_t}{\# \text{Refrigerators Produced}_{t-1}}$
- Plant level employment data from the National Establishment Time Series
- Dun & Bradstreet Paydex score to measure plant-level working capital solvency
 - Ranges 0 – 100 where 80 indicates that a plant typically pays its suppliers on time
- Some cross-sectional tests use parent company balance sheet info from COMPUSTAT

Market reaction to Bestfoods

- *High Exposure* = 1 if parent company has more subsidiaries in treated states

All Firms						
	Oral Arguments			Decision (unanimous)		
	(1)	(2)	(3)	(1)	(2)	(3)
Window	(-1,+1)	(-1,+5)	(-1,+10)	(-1,+1)	(-1,+5)	(-1,+10)
<i>High Exposure</i>	0.00344 (0.00268)	0.00826* (0.00428)	0.0148** (0.00619)	-0.00274 (0.00274)	-0.00220 (0.00436)	-0.00368 (0.00580)
Observations	771	771	771	771	771	771
R-squared	0.002	0.005	0.007	0.001	0.000	0.001
Multi-plant Firms						
	Oral Arguments			Decision (unanimous)		
	(1)	(2)	(3)	(1)	(2)	(3)
Window	(-1,+1)	(-1,+5)	(-1,+10)	(-1,+1)	(-1,+5)	(-1,+10)
<i>High Exposure</i>	0.00586* (0.00304)	0.0109** (0.00488)	0.0160** (0.00660)	-0.000830 (0.00313)	-0.00347 (0.00511)	-0.00236 (0.00721)
Observations	501	501	501	500	500	500
R-squared	0.007	0.010	0.012	0.000	0.001	0.000

- Market reacted positively for firms that benefited most from the increase in legal protection

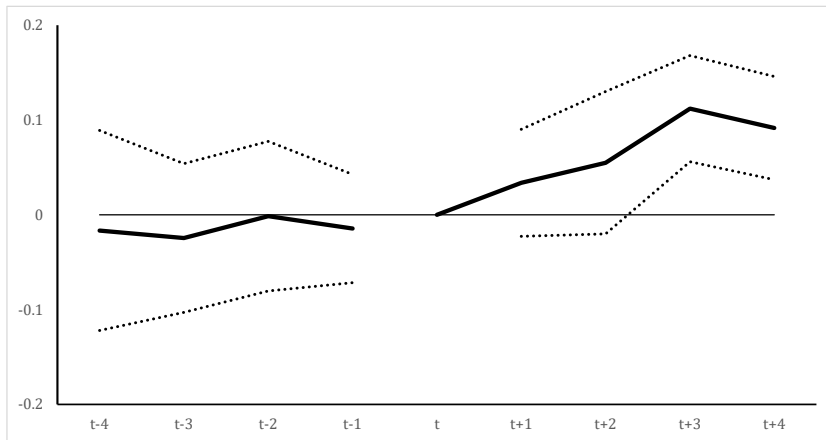
Main Results

	Ln(1+ Lbs Ground Pollution)									
	All Subs						Subs w/ Public Parent		Non-Subs	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Bestfoods</i>	0.0469*** (0.0145)	0.0534*** (0.0162)	0.0861*** (0.0193)	0.0812*** (0.0188)			0.220*** (0.0309)	0.224*** (0.0415)	-0.0063 (0.0259)	-0.0184 (0.0324)
<i>ATC</i>					0.0925*** (0.0281)	0.0873*** (0.0239)				
<i>AC</i>					0.0773*** (0.0177)	0.0727*** (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

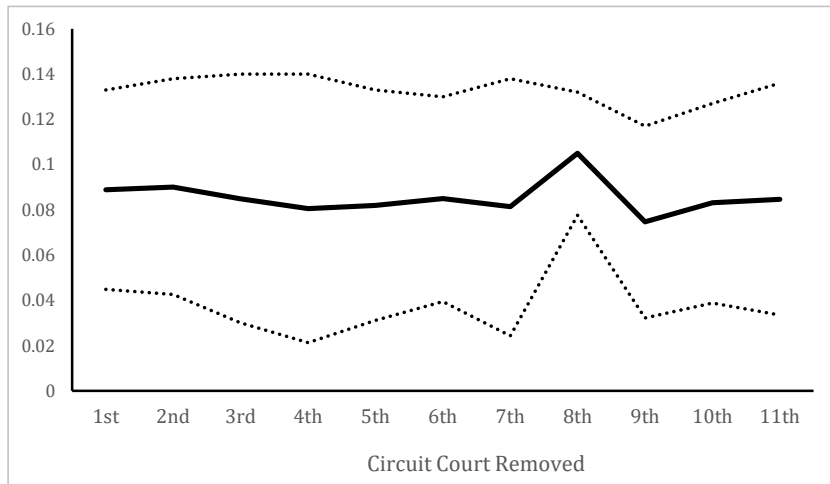
$$\bar{y}_{\text{all}} = 0.90, \bar{y}_{\text{public}} = 1.3$$

- Following the *Bestfoods*, ground pollution increased by 10–17% of the sample average for plants located in treated circuits
- Effects are similar for both of the two treatment groups

Dynamics of Treatment Group



Robustness to Removing Circuit Courts



Human Harm

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)
<i>Bestfoods</i>	0.0721*** (0.0210)	0.0685** (0.0219)	0.188*** (0.0413)	0.174*** (0.0453)	0.0989*** (0.0270)	0.0919*** (0.0273)	0.269*** (0.0536)	0.312*** (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

- Increase in ground pollution comes from both chemicals that are known to cause harm and unclassified chemicals

Possible Channels

- Is increase in pollution a consequence of increased economic activity or a because of reduced incentives to reduce pollution?
 - Not necessarily mutually exclusive
- Do plants cut back on pollution reduction investment?
- Does production change?
- Does employment change?
- Which types of plants/firms are responsible for the effect?

Pollution Abatement

	I (Abatement - Operations)				I (Abatement - Process)			
	All Subs		Subs w/ Public Parent		All Subs		Subs w/ Public Parent	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Bestfoods</i>	0.0000 (0.0058)	0.0006 (0.0077)	0.0000 (0.0098)	-0.0013 (0.0127)	-0.0083** (0.0033)	-0.0076** (0.0028)	-0.0163*** (0.0039)	-0.0176*** (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

$$\bar{y}_{\text{operations}} = 0.08, \bar{y}_{\text{process}} = 0.05$$

- Analyze the two most common types of abatement activities
 - Operating practices — improved maintenance, better record keeping
 - Process abatement — improved chemical reaction conditions, better use of equipment
- Substantial decline in abatement activities related to process

Increased Economic Activity

	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)
<i>Bestfoods</i>	0.0097 (0.0073)	0.0028 (0.0062)	0.0078 (0.0097)	0.0103 (0.0100)	-0.0146 (0.0178)	-0.0174 (0.0203)	-0.0535* (0.0267)	-0.0449 (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

- No evidence that economic activity increases

Which Types of Firms Respond?

- We use variation in the characteristics of plants and parent companies to further understand the mechanism
- Results are **stronger** in **subsidiaries** that paid their suppliers late before *Bestfoods*
 - The subsidiaries that are **more likely to go bankrupt**, potentially **giving liability to parents**
- Results are **stronger** in **parent companies** that had more tangible assets
 - The firms that are **more likely to have fixed assets**, and potentially **gain the most from reducing abatement investment**
- Results are **stronger** in **parent companies** that had a lower Altman's Z-Score before *Bestfoods*
 - The firms that are **less solvent**, and potentially **largest incentive to shift harm to local communities**

Conclusion

- Studied the effect of increase limited liability protections for parent companies on the pollution related activities of their subsidiaries
- When parents are less likely to be liable
 - Subsidiaries release more toxic pollution
 - Engage in fewer pollution abatement activities
- No evidence that the increase in pollution is a consequence of increased economic activity
- Firms most likely to have a short term incentive to risk-shift are most responsible for our effects

Summary Statistics

	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
1 (Ground Polluter)	503,279	0.12	0	0.33	156,949	0.16	0	0.36
$\frac{\text{Ground Pollution}}{\text{Total Pollution}}$	503,275	0.08	0	0.25	156,947	0.11	0	0.30
1 (Abatement - Operating)	503,279	0.08	0	0.27	156,949	0.09	0	0.28
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

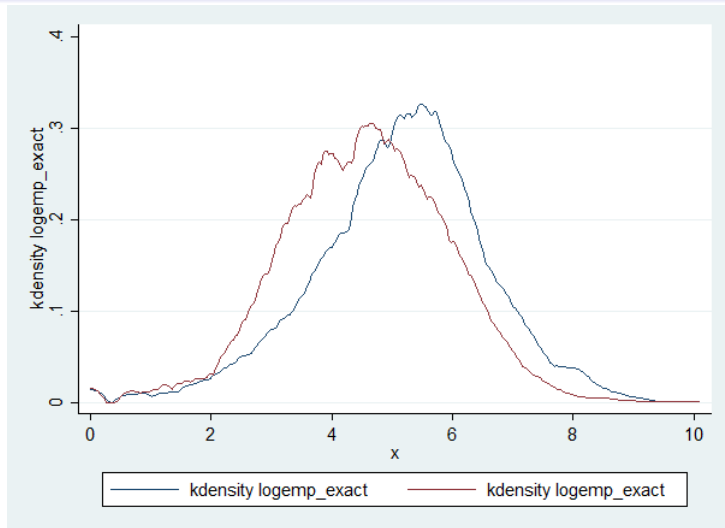
Air and Water Pollution

	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)
<i>Bestfoods</i>	0.0156 (0.0163)	0.0214 (0.0173)	0.0164 (0.0309)	0.0177 (0.0343)	0.0366 (0.0207)	0.0241 (0.0217)	0.0382 (0.0344)	0.0324 (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

Robustness to Measurement

Panel A								
	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)
<i>Bestfoods</i>	0.242** (0.101)	0.187 (0.119)	0.729*** (0.175)	0.960*** (0.219)	0.0084* (0.0038)	0.0070 (0.0044)	0.0289*** (0.0041)	0.0305*** (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

Plant Size



Legal Standard Details

- Veil piercing normally entails showing that there was intentional abuse of the corporate form
- Actions that *could* give rise to liability
 - Parent company leasing the site from the subsidiary
 - Parent company involved in a joint venture for the facility with the subsidiary
 - Direct control of the facility operations by an employee of the parent
- Actions that *could not* give rise to liability
 - Appointing a subsidiary's officers and directors
 - Monitoring a subsidiary's performance
 - Supervising a subsidiary's finances and approving budgets or capital expenditures
 - Articulating general policies and procedures for the subsidiary

Literature

- Impacts of limited liability on managerial behavior

- Economic theory — Coase (1960), Shavell (1984), Laffont (1995), Boyer and Porcini (2004), Tirole (2009)
- Legal theory — Easterbrook and Fischel (1985), Clark Jr and Hickok (2016)
- Empirical (banking) — Grossman (2001), Koudijs and Salisbury (2016)

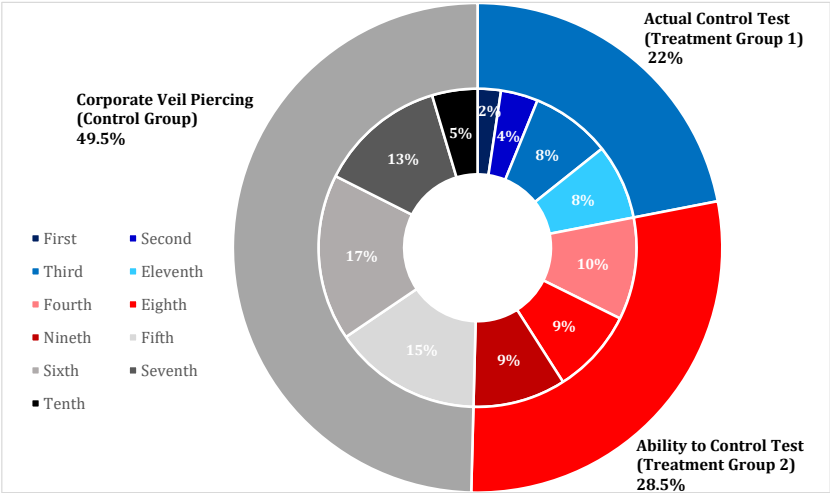
- Economics of industrial pollution

- Social costs of pollution — Chay and Greenstone (2003), Greenstone and Gallagher (2008), Zivin and Neidell (2012)
- Strict liability standards and environmental behavior — Alberini and Austen (2002), Stafford (2002)
- Managers rationally pollute — Shapira and Zingales (2017)

- Literature examining the prevalence of risk-shifting

- Evidence for risk-shifting — Esty (1997), Eisdorfer (2008), Landier et al. (2015), Denes (2017)
- Evidence against risk-shifting — Andrade and Kaplan (1998), Gormley and Matsa (2011), Gilje (2016)
- Financial constraints and other stakeholders — Dionne et al (1997), Philips and Sertios (2013), Cohn and Wardlaw (2016)

Distribution of Observations



Plant Solvency

	Ground Pollution		1 (Abatement - Process)	
	(1)	(2)	(3)	(4)
Low Plant Paydex				
<i>Bestfoods</i>	0.0859** (0.0365)	0.0893* (0.0491)	-0.0170** (0.0062)	-0.0168** (0.0069)
Observations	154,256	153,809	154,256	153,809
R-squared	0.666	0.677	0.524	0.547
High Plant Paydex				
<i>Bestfoods</i>	-0.0503* (0.0270)	-0.0563 (0.0325)	0.00829 (0.0143)	0.0194 (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

- Results concentrate in the subsidiaries that are in poorer financial health
 - Those subsidiaries that are most likely to incur parent liability

Parent Company Asset Tangibility

	Ground Pollution		1 (Abatement - Process)	
	(1)	(2)	(3)	(4)
High Parent Tangibility				
<i>Bestfoods</i>	0.270*** (0.0566)	0.291*** (0.0539)	-0.0179*** (0.0053)	-0.0220** (0.0070)
Observations	97,577	97,177	97,580	97,180
R-squared	0.750	0.756	0.410	0.442
Low Parent Tangibility				
<i>Bestfoods</i>	0.124* (0.0601)	0.152*** (0.0347)	-0.0144* (0.0067)	-0.0091 (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

- Results concentrate in parent companies with more tangible assets
 - Those parents that are more likely to benefit from reducing capital related expenditures

Parent Solvency

	Ground Pollution		1 (Abatement - Process)	
	(1)	(2)	(3)	(4)
Low Parent Z-Score				
<i>Bestfoods</i>	0.378*** (0.0756)	0.389*** (0.111)	-0.0300*** (0.0078)	-0.0300*** (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				
<i>Bestfoods</i>	0.125** (0.0489)	0.111* (0.0554)	-0.0090 (0.0083)	-0.0116 (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

- **Results concentrate** in the parent companies that have are less solvent
 - Those parents for which a dollar shifted from long-term pollution abatement has the highest short term value