

# Redeploying dirty assets: The impact of environmental liability

Jason Chen

*Journal of Financial Economics*, 2025

Presented by Byunghun Han

08/12/2025

# Contents

- 1 Introduction
- 2 Institutional Background
- 3 Research Design
- 4 Results
- 5 Conclusion

# 1. Introduction

## Motivation

- In response to climate change, firms are under growing pressure to divest polluting assets.
- Policies are designed to improve the liquidity of polluting assets and facilitate such divestitures.
  - ▶ Their environmental implications remain unclear.
- Duchin et al. (2024, JF) suggest that these policies might be ineffective.
  - ▶ Emissions are just transferred from sellers to buyers following the divestiture.
- However, their ex-ante effects should be also considered.
  - ▶ How firms adjust their environmental behavior when they **anticipate** being able to sell polluting assets **more easily** or at **higher** prices

# 1. Introduction

## Motivation

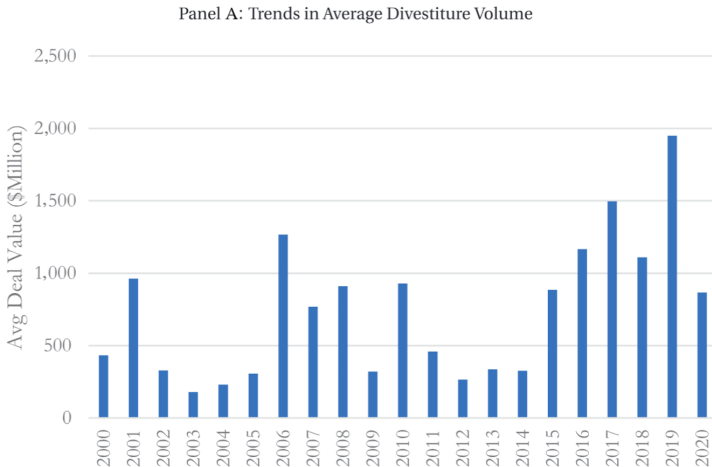


Figure 1: Average value of divestitures of polluting assets (Duchin et al., 2024 JF)

# 1. Introduction

## Motivation

- This paper investigates the environmental implications of improving the liquidity of polluting assets, with a focus on their **ex-ante** effects.
- DiD Setting: Small Business Liability Relief and Brownfields Revitalization Act in 2002
  - ▶ "Brownfields Act"
  - ▶ Exempting purchasers from **prior** cleanup liabilities and **disproportionately** affecting certain firms

# 1. Introduction

## Hypothesis Development: Net Worth Channel

- Brownfields Act → Purchaser's liability for contamination ↓
- Positive effects for current landowner:
  - ① Demand for industrial land ↑ → Real estate prices & asset value ↑ (Sigman, 2010; Howland, 2000)
  - ② Liquidity of market for industrial land ↑ → More efficient resource allocation & productivity (Gavazza, 2011; Bernstein et al., 2019)
  - ③ Liquidation value of land ↑ → Higher collateral value & Lower cost of capital (Williamson, 1988; Shleifer and Vishny, 1992)
- Therefore, current landowner's net worth and financial health ↑!

# 1. Introduction

## Hypothesis Development: Net Worth Channel

- Firms with low net worth have high "risk-shifting" incentives (Shavell, 1986).
  - ▶ Pollute now, and discharge liability in bankruptcy
- Improved financial health  $\Rightarrow$  Risk-shifting incentives  $\downarrow$
- The firm has less incentive to engage in risky behavior (i.e., excessive pollution).
- H1A: The Brownfields Act will lead to a **decrease** in toxic emissions from current landowners.

# 1. Introduction

## Hypothesis Development: Liability-Shifting Channel

- Brownfields Act  $\rightarrow$  Purchaser liability  $\downarrow$  & Current landowner's share of liability  $\uparrow$ 
  - ▶ Assuming total cleanup liability is fixed
- Landowner's potential cost & risk  $\uparrow$ 
  - ▶ Higher cost of capital and more difficult to obtain financing $\Rightarrow$  Current landowner's net worth  $\downarrow$
- The firm will preemptively reduce pollution to minimize its own potential costs.
- H1A: The Brownfields Act will lead to a **decrease** in toxic emissions from current landowners.

# 1. Introduction

## Hypothesis Development: Easier Divestment Channel

- Brownfields Act  $\rightarrow$  Purchase liability  $\downarrow$   $\rightarrow$  Easier to sell polluted assets
- The current landowner can now offload the contaminated asset and its cleanup burden to a future, liability-exempt purchaser.  
 $\Rightarrow$  Moral hazard
- The firm's incentive to control pollution is weakened, as the consequences can be shifted to others.
- H1B: The Brownfields Act will lead to an **increase** in toxic emissions from current landowners.

# 1. Introduction

## Research Question

- How does a policy designed to promote the divestment of polluting assets affect a firm's pollution incentives and environmental behavior?
  - ▶ Ex-ante consequences
- Answer:
  - 1 Reduction in toxic emissions
  - 2 Improved financial health and firm value
  - 3 Increased abatement investment

⇒ Through "Net Worth Channel"

## 2. Institutional Background

### Environmental Cleanup

- U.S. Environmental Cleanup Laws: CERCLA vs. RCRA
  - ▶ CERCLA applies broadly to any site contaminated by hazardous substances.
  - ▶ RCRA focuses on cleanup actions for facilities that treat, store, or dispose of hazardous waste (TSDFs).
  - ▶ The two statutes are often used as substitutes, and the EPA applies only one statute to enforce cleanup liability for a given site.
- Problem of purchaser liability
  - ▶ A land purchaser can inherit the cleanup liability for contamination caused by previous owners.
  - ▶ Costs range from tens of millions to billions of dollars and are unpredictable.
- This substantial and uncertain liability acted as a **key barrier** to industrial property transactions, leading to numerous contaminated sites (**Brownfields**) being abandoned.

## 2. Institutional Background

### Brownfields Revitalization Act

- Purpose of the Act
  - ▶ To solve the abandoned brownfields problem by facilitating industrial land transactions through the reduction of purchaser cleanup liability
- Key Legal Changes
  - ① Clarifying the "Innocent Landowner" (ILO) Defense
    - ▶ Resolve legal uncertainty by establishing clear standards for pre-purchase due diligence
  - ② Creating the "Bona Fide Prospective Purchaser (BFPP)" Defense
    - ▶ Introduced to protect a purchaser from cleanup liability even if they were aware of potential contamination if they meet certain criteria

## 2. Institutional Background

### Brownfields Revitalization Act

- The purchaser liability protections offered by this act apply **only to CERCLA** and do not extend to RCRA liability.
- This legal distinction serves as the core basis for separating the treated and control groups in this study.

## 2. Institutional Background

### Measuring exposure to the Brownfields Act

- Core Logic
  - ▶ Because the Brownfields Act **only mitigates CERCLA liability**, its benefits are concentrated among firms exposed primarily to CERCLA.
- Control Group: RCRA-Regulated Plants (TSDFs)
  - ▶ Hazardous waste treatment, storage, and disposal facilities (TSDFs) are subject to RCRA regulation.
  - ▶ Purchasers of these plants **remain exposed** to the risk of RCRA cleanup liability even after the Brownfields Act.
- Treated Group: Non-TSDF Plants
  - ▶ General industrial plants that are **not TSDFs** are **primarily** subject to CERCLA regulation.
  - ▶ Purchasers of these plants can **fully** benefit from the liability relief provided by the Brownfields Act.

### 3. Research Design

#### Data

- EPA's Toxic Release Inventory (TRI) Program
  - ▶ Amount of toxic emissions from air, water, and ground
- EPA's P2 database
  - ▶ Pollution abatement efforts at the chemical level and into eight categories
  - ▶ Production ratio
- National Establishment Time Series (NETS)
  - ▶ Plant-level data on employment and transaction of industrial real estate
- Securities Data Company (SDC)
  - ▶ Firm-level asset sales
- Compustat
  - ▶ Firm-level financial variables

# 3. Research Design

## Descriptive Statistics

| Variable                            | Mean    | Median | SD       | N       |
|-------------------------------------|---------|--------|----------|---------|
| <b>Panel A: TRI</b>                 |         |        |          |         |
| Toxic Emissions (000s)              | 35.653  | 0.402  | 140.685  | 279,284 |
| ℙ(Toxic Emissions)                  | 0.845   | 1.000  | 0.361    | 279,284 |
| ℙ(Abate)                            | 0.117   | 0.000  | 0.322    | 279,284 |
| ℙ(Spill Prevent)                    | 0.026   | 0.000  | 0.159    | 279,284 |
| ℙ(Good operating)                   | 0.057   | 0.000  | 0.232    | 279,284 |
| ℙ(Process Mod.)                     | 0.033   | 0.000  | 0.180    | 279,284 |
| #Spill Prevent                      | 0.031   | 0.000  | 0.207    | 279,284 |
| #Spill Prevent                      | 0.063   | 0.000  | 0.268    | 279,284 |
| #Process Mod.                       | 0.037   | 0.000  | 0.208    | 279,284 |
| Production ratio                    | 0.955   | 1.000  | 0.442    | 271,610 |
| Norm. Prod.                         | 1.064   | 1.000  | 0.666    | 279,284 |
| <b>Panel B: Compustat &amp; SDC</b> |         |        |          |         |
| Z-score                             | 3.225   | 2.614  | 2.998    | 6,474   |
| Tobin's Q                           | 1.586   | 1.283  | 0.928    | 6,644   |
| Total Assets (\$ Mil)               | 6102.9  | 1257.4 | 13 511.2 | 7,320   |
| Leverage                            | 0.323   | 0.270  | 0.253    | 6,641   |
| Net Worth                           | 0.365   | 0.375  | 0.254    | 7,320   |
| ℙ(Divest)                           | 0.166   | 0.000  | 0.372    | 8,269   |
| <b>Panel C: NETS</b>                |         |        |          |         |
| EMP                                 | 470.756 | 205.00 | 741.428  | 16,672  |
| Age                                 | 24.035  | 14.00  | 27.064   | 16,672  |
| ℙ(Sell RE)                          | 0.008   | 0.00   | 0.089    | 16,672  |
| ℙ(Close Plant)                      | 0.014   | 0.00   | 0.119    | 16,672  |
| ℙ(Move Plant)                       | 0.009   | 0.00   | 0.096    | 16,672  |

Figure 2: Descriptive Statistics

### 3. Research Design

#### Regression Framework

- DiD framework

$$Y_{c,p,i,t} = \beta Treated_{i(p)} \times Post_t + \alpha_{pc} + \alpha_{ct} + \alpha_i + \varepsilon_{c,p,i,t}$$

- ▶ Toxic chemical  $c$ , Firm  $i$ , Plant  $p$ , and Year  $t$
- ▶  $Y_{c,i,t}$ : Pounds of toxic chemical
- ▶  $Treated=1$  for treated firms
- ▶  $Post=1$  if year  $t$  is after the Brownfields Act

- $\beta$  captures the effect of the Brownfields Act on toxic emissions.

## 4. Results

### Baseline Results

| Outcome:                    | Toxic emissions     |                      |                     |                   |                   |                    |                     |
|-----------------------------|---------------------|----------------------|---------------------|-------------------|-------------------|--------------------|---------------------|
|                             | (1)                 | (2)                  | (3)                 | (4)               | (5)               | (6)                | (7)                 |
| Treated <sub>i</sub> × Post | -0.073**<br>(0.036) | -0.081***<br>(0.025) | -0.071**<br>(0.029) |                   |                   |                    | -0.062**<br>(0.032) |
| Treated <sub>p</sub> × Post |                     |                      |                     | -0.039<br>(0.025) | -0.028<br>(0.023) | -0.042*<br>(0.023) | -0.029<br>(0.024)   |
| Chemical × Year FE          | Yes                 | Yes                  | Yes                 | Yes               | Yes               | Yes                | Yes                 |
| Plant × Chemical FE         | Yes                 | Yes                  | Yes                 | Yes               | Yes               | Yes                | Yes                 |
| Firm FE                     | Yes                 | Yes                  | Yes                 | Yes               | Yes               | Yes                | Yes                 |
| Industry × Year FE          | No                  | Yes                  | Yes                 | No                | Yes               | Yes                | Yes                 |
| State × Year FE             | No                  | No                   | Yes                 | No                | No                | Yes                | Yes                 |
| N                           | 279,284             | 279,272              | 279,272             | 279,284           | 279,272           | 279,272            | 279,272             |

Figure 3: The Effect of the Brownfields Act on Asset Sales

- In response to the reform, treated firms (plants) reduce emissions relative to control firms.
  - ▶ Emissions reduction of 7% (3%)
- Column 7 consistent with the net worth channel
  - ▶ Driven by a firm-wide effect rather than a plant-specific one.
  - ▶ An improvement in financial health impacts all of a firm's plants.

## 4. Results

### Timing of the Baseline Result

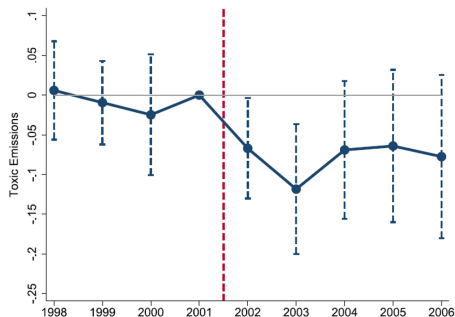


Figure 4: Pollution Dynamics

- No pre-existing trend
- Following the reform, emissions by treated firms start to decline relative to control firms.

## 4. Results

### Robustness Test: Placebo Test

- The main findings could be driven by contemporaneous industry shocks that differentially impact emissions of treated and control firms.
- Solution: Randomly assign treatment status across plants with parent firms in the same industry.

## 4. Results

### Robustness: Placebo test

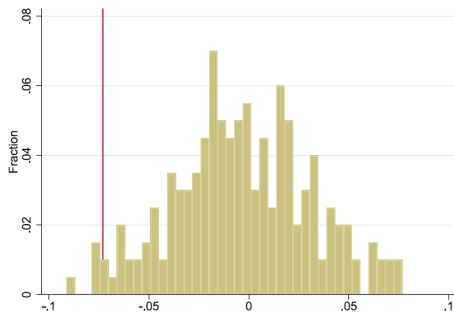


Figure 5: Placebo Test

- The placebo point estimates are centered around zero (mean = -0.003).
- Contemporaneous industry shocks are unlikely to explain my results.

## 4. Results

### Abatement Activities

- According to the EPA, investing in abatement activities is the preferred strategy for managing toxic waste.
- If the reform reduces emissions by encouraging landowners to **mitigate** environmental risks, we should expect to see an **increase** in pollution abatement efforts among affected landowners following the reform.
- Abatement activities (Akey and Appel, 2021; Naaraayanan et al., 2020)
  - ① Spill prevent: Installing equipment like overflow alarms or improving material handling procedures
  - ② Process mod: Modifying equipment, layout, or piping
  - ③ Good Operating: Improving operational procedures, such as maintenance schedules and record keeping

## 4. Results

### Abatement Activities

| Outcome:            | ℓ(Spill prevent)<br>(1) | #Spill prevent<br>(2) | ℓ(Process mod)<br>(3) | #Process mod<br>(4) | ℓ(Good Operating)<br>(5) | #Good Operating<br>(6) |
|---------------------|-------------------------|-----------------------|-----------------------|---------------------|--------------------------|------------------------|
| Treated × Post      | 0.015*<br>(0.009)       | 0.590**<br>(0.245)    | 0.004<br>(0.006)      | 0.141<br>(0.142)    | -0.013<br>(0.009)        | -0.215<br>(0.168)      |
| Chemical × Year FE  | Yes                     | Yes                   | Yes                   | Yes                 | Yes                      | Yes                    |
| Plant × Chemical FE | Yes                     | Yes                   | Yes                   | Yes                 | Yes                      | Yes                    |
| Firm FE             | Yes                     | Yes                   | Yes                   | Yes                 | Yes                      | Yes                    |
| R <sup>2</sup>      | 0.445                   |                       | 0.401                 |                     | 0.554                    |                        |
| N                   | 279,284                 | 279,284               | 279,284               | 279,284             | 279,284                  | 279,284                |

Figure 6: The Effect on Abatement Investment

- After 2002, treated firms **increased** their efforts to prevent spills and leaks relative to control firms.
  - 0.051  $\Rightarrow$  57.7% increase compared to the sample mean
- Investments in spill and leak prevention **better** reflect efforts to reduce risk compared to other abatement strategies.
  - Mitigating landowner's risk-taking incentives

## 4. Results

### Channels

- So far, the results suggest the reform reduces emissions and increases abatement efforts among treated firms.
- Now, this paper conduct additional tests to ensure that the effect is through "Net Worth Channel."
  - ▶ Prediction: The net worth of affect firms should **increase** following the reform.
  - ▶ Liability-shifting channel  $\Rightarrow$  Decrease net worth
- Measures of Net Worth
  - ① Altman's Z-score: Inversely related to the risk of bankruptcy
  - ② Book value of equity scaled by total assets
  - ③ Tobin's Q: Firm value

## 4. Results

### Net Worth Channel

| Outcome:                  | Z score            |                    |                    | Net worth         |                   |                   | TobinQ             |                    |                    |
|---------------------------|--------------------|--------------------|--------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|
|                           | (1)                | (2)                | (3)                | (4)               | (5)               | (6)               | (7)                | (8)                | (9)                |
| Treated $\times$ post     | 0.433**<br>(0.188) | 0.464**<br>(0.192) | 0.514**<br>(0.213) | 0.024*<br>(0.012) | 0.021*<br>(0.012) | 0.026*<br>(0.014) | 0.155**<br>(0.071) | 0.177**<br>(0.072) | 0.156**<br>(0.074) |
| Year FE                   | Yes                | Yes                | No                 | Yes               | Yes               | No                | Yes                | Yes                | No                 |
| Firm FE                   | Yes                | Yes                | Yes                | Yes               | Yes               | Yes               | Yes                | Yes                | Yes                |
| State $\times$ Year FE    | No                 | No                 | Yes                | No                | No                | Yes               | No                 | No                 | Yes                |
| Industry $\times$ Year FE | No                 | Yes                | Yes                | No                | Yes               | Yes               | No                 | Yes                | Yes                |
| R <sup>2</sup>            | 0.736              | 0.739              | 0.739              | 0.820             | 0.821             | 0.824             | 0.682              | 0.688              | 0.680              |
| N                         | 6,474              | 6,474              | 5,893              | 7,320             | 7,320             | 6,698             | 6,644              | 6,644              | 6,036              |

Figure 7: Net Worth Channel

- The reform **positively** impacts the net worth of industrial firms.
  - The treated firms experienced a statistically and economically significant increase in each measure of net worth.

## 4. Results

### Cross-sectional Heterogeneity

- Which channel (Net Worth vs. Liability-Shifting) is the primary driver?
  - ▶ Strong pollution-shifting incentives  
⇒ Firms that financially **weak** and can **easily** avoid cleanup costs through bankruptcy.
- Net Worth channel
  - ▶ Firms with high pollution-shifting incentives are **most** sensitive to changes in their financial health.
  - ▶ An increase in net worth directly reduces their main incentive to pollute.  
⇒ **More pronounced** in these firms
- Liability-Shifting channel
  - ▶ For these firms, the threat of increased liability is not credible.
  - ▶ They can simply discharge any shifted liability in bankruptcy.  
⇒ **Minimal** or **non-existent** in these firms

## 4. Results

### Cross-sectional Heterogeneity

- Measures for pollution-shifting incentives
  - ① Financial distress
  - ② Firm size
  - ③ Contingent environmental liabilities
    - ▶ Disclosure of such liabilities  $\Rightarrow$  Firms tend to engage in risky environmental practices
  - ④ Paydex score
    - ▶ Low score  $\Rightarrow$  Worse financial health and higher risk of solvency

## 4. Results

### Cross-sectional Heterogeneity

| Outcome:                                  | Toxic emissions     |                   |                     |
|-------------------------------------------|---------------------|-------------------|---------------------|
|                                           | (1)                 | (2)               | (3)                 |
| <b>Panel A: Financial distress</b>        | <b>Distressed</b>   | Non-distressed    | Triple-Dif          |
| Treated $\times$ Post                     | -0.118**<br>(0.053) | 0.022<br>(0.035)  | 0.013<br>(0.038)    |
| Treated $\times$ Post $\times$ Distressed |                     |                   | -0.140**<br>(0.062) |
| N                                         | 140,241             | 139,043           | 279,284             |
| <b>Panel B: Firm size</b>                 | <b>Small</b>        | Large             | Triple-Dif          |
| Treated $\times$ Post                     | -0.155*<br>(0.093)  | -0.007<br>(0.031) | 0.001<br>(0.029)    |
| Treated $\times$ Post $\times$ Small      |                     |                   | -0.182*<br>(0.096)  |
| N                                         | 139,745             | 139,539           | 279,284             |

Figure 8: Differential Effects by Pollution-Shifting Motives

- The decline in emissions is driven by:

- 1 Firms with higher bankruptcy risk
- 2 Small firms

⇒ Firms with strong pollution-shifting incentives

## 4. Results

### Cross-sectional Heterogeneity

| <b>Panel C: Environmental liability</b>   | Disclosed           | Do not disclose   | Triple-Dif          |
|-------------------------------------------|---------------------|-------------------|---------------------|
| Treated $\times$ Post                     | -0.157**<br>(0.063) | 0.029<br>(0.074)  | 0.068<br>(0.059)    |
| Treated $\times$ Post $\times$ Contingent |                     |                   | -0.229**<br>(0.099) |
| N                                         | 107,224             | 72,136            | 179,360             |
| <b>Panel D: Paydex Score</b>              | LowPaydex           | HighPaydex        | Triple-Dif          |
| Treated $\times$ Post                     | -0.150*<br>(0.083)  | -0.005<br>(0.042) | -0.027<br>(0.045)   |
| Treated $\times$ Post $\times$ LowPaydex  |                     |                   | -0.118<br>(0.086)   |
| N                                         | 82,575              | 82,123            | 164,698             |
| Chemical $\times$ Year FE                 | Yes                 | Yes               | Yes                 |
| Plant $\times$ Chemical FE                | Yes                 | Yes               | Yes                 |
| Firm FE                                   | Yes                 | Yes               | Yes                 |
| Proxy $\times$ Year                       | No                  | No                | Yes                 |
| Firm $\times$ Plant FE                    | No                  | No                | Yes                 |

**Figure 9:** Differential Effects by Pollution-Shifting Motives

- The decline in emissions is driven by firms with:
  - ① Higher contingent environmental liabilities
  - ② Worse financial health and higher risk of solvency

⇒ Firms with strong pollution-shifting incentives

## 4. Results

### Economic Activity

| Outcome:                   | Production ratio  |                   |                    | Log(Norm. Prod.)  |                  |                  | Log(EMP)         |                   |                   |
|----------------------------|-------------------|-------------------|--------------------|-------------------|------------------|------------------|------------------|-------------------|-------------------|
|                            | (1)               | (2)               | (3)                | (4)               | (5)              | (6)              | (7)              | (8)               | (9)               |
| Treated $\times$ Post      | 0.036*<br>(0.021) | 0.026*<br>(0.015) | 0.029**<br>(0.014) | 0.034*<br>(0.019) | 0.022<br>(0.021) | 0.023<br>(0.021) | 0.124<br>(0.077) | 0.127*<br>(0.076) | 0.131*<br>(0.074) |
| Firm FE                    | Yes               | Yes               | Yes                | Yes               | Yes              | Yes              | Yes              | Yes               | Yes               |
| Chemical $\times$ Year FE  | Yes               | Yes               | Yes                | Yes               | Yes              | Yes              | No               | No                | No                |
| Plant $\times$ Chemical FE | Yes               | Yes               | Yes                | Yes               | Yes              | Yes              | No               | No                | No                |
| Industry $\times$ Year FE  | No                | Yes               | Yes                | No                | Yes              | Yes              | No               | Yes               | Yes               |
| State $\times$ Year FE     | No                | No                | Yes                | No                | No               | Yes              | No               | No                | Yes               |
| Plant FE                   | No                | No                | No                 | No                | No               | No               | Yes              | Yes               | Yes               |
| Year FE                    | No                | No                | No                 | No                | No               | No               | Yes              | No                | No                |
| R <sup>2</sup>             | 0.235             | 0.268             | 0.277              | 0.647             | 0.650            | 0.653            | 0.878            | 0.879             | 0.880             |
| N                          | 271,610           | 271,601           | 271,601            | 266,423           | 266,412          | 266,412          | 36,702           | 36,700            | 36 700            |

Figure 10: Economic Activity: Production and Employment

- The reform has a modest but positive effect on production and employment.
  - ▶ Net Worth channel
    - ⇒ Liquidity and asset prices  $\uparrow$
    - More efficient allocation of resources
    - Productivity  $\uparrow$

## 5. Conclusion

- This paper investigates the ex-ante environmental consequences of policies that increase the liquidity of polluting assets by reducing purchaser liability.
- Key Mechanism: Net Worth Channel
  - ▶ Higher asset values improve landowners' financial health, which in turn reduces their incentives to engage in risky pollution activities.
- Policies promoting divestiture by increasing demand for brown assets can create a "win-win" outcome, reducing emissions by enhancing landowners' net worth and providing novel insights for effective environmental policy design.