Firm Structure, Environmental Regulation, and Manufacturing Activities[*]

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Introduction

The firm structure (i.e., multi-plant) plays an important role in determining plant location decisions

Multi-plant firms
- employ 78% of the manufacturing workforce
- produce 88% of output
- are likely to emit pollution over 100 tons per year
- hence are easily targeted by environmental regulations

Thus, multi-plant firms may respond differently than single-plants firm in response to regulatory controls

Research Questions

The impact of environmental regulation (i.e., Clean Air Act Amendments) on plants' shutdown decisions
- whether a multi-plant firm is more or less likely to close its affiliated plant than a single-plant firm does in the presence of environmental pressures

Data

Plant level data in the US manufacturing industry from 1990-2008.

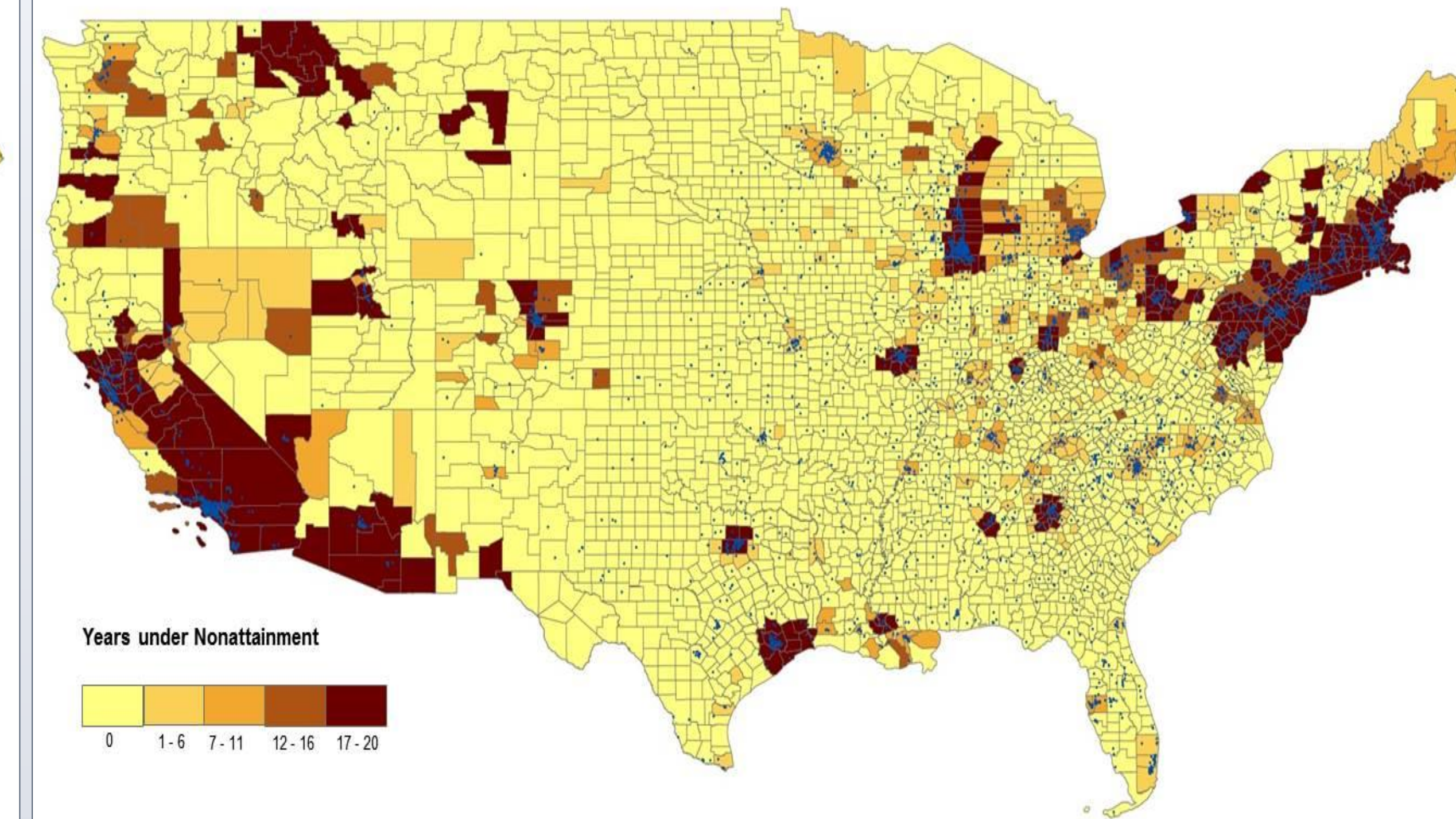| Data Sources	
Plant data	National Establishment Time Series database
County data	County Business Pattern, Environmental Protection Agency
Industry data	Census of Bureau
Variables of Interest	
Plant death	= 1 if a plant is closed at time t, = 0 otherwise
Multi-plant	= 1 if exists any other plants affiliated with the same headquarters at time t, = 0 otherwise
Regulation	= 1 if county is subject to any pollutant-specific (i.e., SO2, CO, O3, and TSPs) nonattainment status at t, = 0 otherwise
Size	log (employment)
Productivity	log (deflated sales per employment)
Age	plant operation years
Export dummy	= 1 if a plant exports, = 0 otherwise
Takeover	= 1 if a plant changed headquarters at time t, = 0 otherwise
Hdq. externality	# of existing plants affiliated with the same headquarters, in the same industry j and located in the same county at time t
Agglomeration	# of existing plants in the same county but outside of its own industry
Road density	road length per land area by county
Unemployment Rate	unemployment rate by county-year
Industry-county wage	wage rate by county-industry-year
Industry entry costs	$= 1 - \min\{entry\ rate_{jt}, exit\ rate_{jt}\}$

Maps

Death of Multi-Plant Firms

Years under Nonattainment

| 0 | 1-6 | 7-11 | 12-16 | 17-20 |
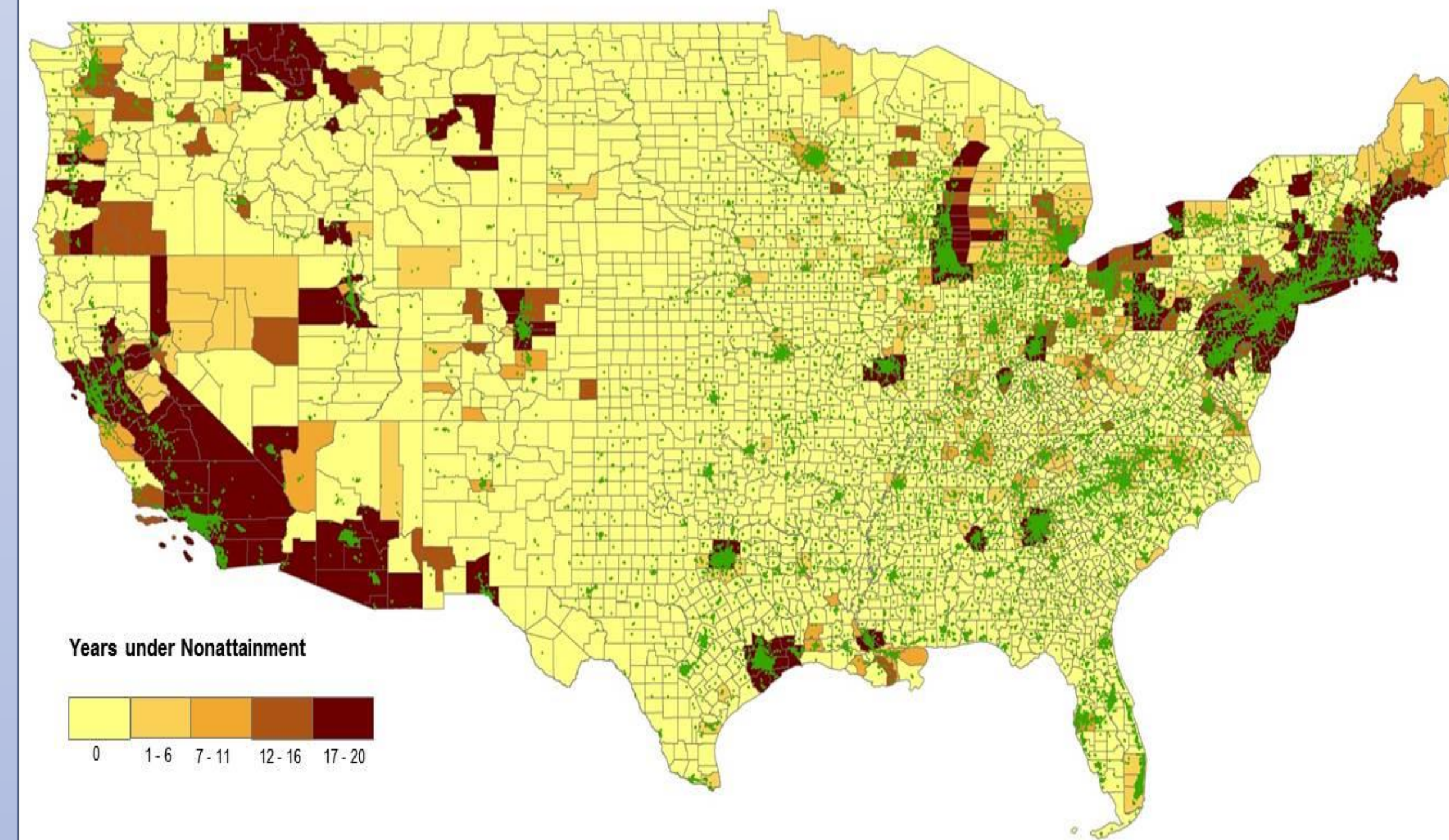
Death of Single-Plant Firms

Years under Nonattainment

| 0 | 1-6 | 7-11 | 12-16 | 17-20 |

Methodology and Results

Dependent Var.: Death	(1)	(2)	(3)	(4)
Multi-Plant	0.0139***	0.0127***	0.0131***	0.0129***
	(0.0024)	(0.0025)	(0.0025)	(0.0025)
Reg.	-0.0148***	-0.0124***	-0.0119***	-0.0121***
	(0.0039)	(0.0039)	(0.0041)	(0.0041)
Reg.× Multi-Plant	0.0147***	0.0155***	0.0153***	0.0156***
	(0.0038)	(0.0039)	(0.0039)	(0.0039)
Size	-0.0035***	-0.0030***	-0.0030***	-0.0030***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Productivity	-0.0029**	-0.0031**	-0.0028**	-0.0033**
	(0.0012)	(0.0013)	(0.0013)	(0.0014)
Age	0.0001	-0.0008***	-0.0009***	-0.0008***
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Export Dummy	-0.0138***	-0.0137***	-0.0125***	-0.0137***
	(0.0015)	(0.0015)	(0.0015)	(0.0015)
Takeover	0.0219***	0.0204***	0.0205***	0.0204***
	(0.0026)	(0.0026)	(0.0026)	(0.0026)
Hdq. Externality	0.0064***	0.0068***	0.0063***	0.0075***
	(0.0014)	(0.0014)	(0.0014)	(0.0014)
Agglomeration	-0.0007	0.0002	0.0001	0.0007
	(0.0007)	(0.0008)	(0.0007)	(0.0010)
Road Density	0.0008	0.0014	0.0026**	0.0027**
	(0.0009)	(0.0010)	(0.0013)	(0.0014)
Unemployment Rate	-0.0001	0.0010**	0.0011**	0.0012***
	(0.0003)	(0.0004)	(0.0004)	(0.0004)
Industry-County Wage	0.0138***	0.0007	0.0076***	-0.0001
	(0.0023)	(0.0030)	(0.0024)	(0.0031)
Industry Entry Costs	-0.0195	-0.1058	-0.0448	-0.0900
	(0.0460)	(0.0904)	(0.0497)	(0.0904)
Year Fixed Effect		Y	Y	Y
Industry Fixed Effect		Y		Y
State Fixed Effect			Y	Y
Pseudo R^2	0.0198	0.0340	0.0337	0.0358

Probit model:
$$\Pr(Death_{it} = 1|\bar{X}_t)$$
$$= \Phi\big(\beta_0 + \beta_1 Reg.\times MultiPlant + X_{it} + \Theta_{jt} + \Lambda_{cjt} + \varepsilon_{ijt}\big)$$
where
i: plant
j: industry
c: county
t: year
X_{it}: plant characteristics
Θ_{jt}: industry-by-year vars.
Λ_{cjt}: county-by-industry time variant factors
ε_{ijt}: the stochastic error term

Note: the coefficients give the marginal effects of changing the independent variables estimated from probit models. All specifications have 90,265 observations. Standard errors in parenthesis are adjusted for clustering at the plant level. Industry dummies are calculated at the 2-digit SIC level. *** significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

Robustness Checks

The results are robust to the following robustness checks:
- Lags of environmental regulations
  - current-year nonattainment status
  - one-year lag nonattainment status
  - two-year lag nonattainment status
- Pollutant-specific nonattainment status
  - SO2, CO, O3, and TSPs, respectively
- Measures of headquarters externality
  - # of existing plant affiliated with the same headquarters and located in the same county
  - # of existing plant affiliated with the same headquarters and located in the same county within the same industry in the 2-digit SIC or 3-digit SIC
- Measures of agglomeration
  - # of existing plants located in the county
  - # of existing plants located in the county but not affiliated with the same headquarters
- Cluster standard errors
  - cluster at the 2-digit SIC, 3-digit SIC, and headquarters
- And more needs to be done

Conclusions

- Multi-plant firms are more likely to close an affiliated plant than single-plant firms, even in the presence of environmental pressures, conditioning plant, county, and industry characteristics.
- Headquarters externality facilitates plant closure decisions
- Changes of plant ownership are positively correlated with plant shutdown probabilities

An appealing research direction is to explore how multi-plant firms respond to tightened environmental controls
- do they shift production resources from plants in regulated areas to those in unregulated ones
- or do they relocate or close the whole dirty plants

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