Effects of Community Characteristics on the Spatial Redistribution of Toxic Pollution

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Environmental Information Disclosure

- Has emerged as an approach to inform stakeholders about the environmental performance of firms and empower them to create pressure on firms to improve performance
- Toxic Release Inventory (TRI) created in 1989 in the US after the Bhopal gas leak by Union Carbide.
- All manufacturing facilities above a threshold level are mandated to report their releases annually by chemical and medium of disposal and to report methods used to prevent, treat, recycle or dispose wastes.
- Information is provided at fine spatial resolution and is available to the public at zip code level.
- This information is released by the US Environmental Protection Agency to the public after a lag of two years.
- Emissions and abatement activities are self-reported but subject to audits by the EPA and penalties for incorrect reporting

Toxic Release Information

- Raises public concern about health and environmental damages
- Investors view firms with unexpectedly high toxic releases as being at risk for liabilities and regulations and having lower market value in the future
- Information about toxic releases in their community enables affected citizens to impose pressure on facilities to reduce their toxic releases
- Community members undertake collective action, lawsuits and boycotts for health and environmental damages
- Extent of community pressure will depend on socio-economic and demographic characteristic of the community

Impact of Toxic Release Inventory on Firms

- Release of names of largest polluters in the media
  - imposes reputational costs on firms that they seek to strongly avoid
  - Found to have negative effect on their stock market returns for publicly traded firms that they seek to remedy by reducing toxic releases
- Firms with higher toxic releases are found to be more likely to participate in voluntary efforts to self-regulate their emissions
- Toxic releases dropped by about 40% between 1987-2014
  - 68% in richest counties and 18% in poorest counties
  - African-American communities consistently more exposed

Key Research Questions

- Extent to which community pressure was effective in leading toxic releasing firms to move out to other destinations
- Characteristics of communities that were able to lead firms to relocate away from their communities to other destinations
- Types of firms more likely to relocate and implications of relocation on their economic and environmental performance
- Unintended effect of information disclosure contributing to environmental injustice

Impact of Information Disclosure on Communities

- Problem of reverse causality: did community demographics change after the toxic facility moved in or did the toxic facility move in due to community demographics
  - Households "vote with their feet"

- Previous studies analyze factors that "pull" a new facility into a community which could not affect pre-existing demographics at the location
  - Newborn toxic facilities are more likely to locate into poor and minority communities (Wolverton, 2009, De Silva, Hubbard, and Schiller, 2016)
  - Stringent environmental regulations at a location deter new plant siting in that location

- Other studies show that composition of community characteristics affects extent of pollution reduction by facilities (Gray and Shadbegian 2004)

Effects of Information Disclosure on Environmental Justice

- Information disclosure can lead some communities to take stronger action than others and "push" polluting facilities out and cause them to relocate to other communities that are more socially disadvantaged
- We seek to examine "push" factors and indirectly the "pull" factors that lead existing facilities to relocate
  - By raising a facility's reputational, legal, and other operating costs at its existing location, and affecting siting and expansion costs at the new location
  - and affect the facilities' environmental and economic outcomes after re-location
  - and examine if this worsens or improves the problem of environmental justice

- Pollution haven hypothesis: predicts that pollution-intensive industry will shift from countries with stringent regulation to countries with lax environmental regulation after trade barriers are reduced
- We examine the effects of other factors, such as the spatial variation in local community pressure, can have an incremental effect on relocation decisions, beyond that arising from differences in regulatory stringency across jurisdictions.

Effects of Relocation on Performance

- Re-location can improve or worsen environmental performance of facilities depending on the accompanying changes in scale of operation and technology of the facilities and in relative to the stringency of regulations, economic conditions, and community pressure at the moving destination and origin locations.

- Facilities may re-locate for various reasons, including lower costs of expanding operations, easier access to input and output markets, agglomeration, and lower pressure from regulators and communities to improve environmental performance.

- In the process of re-locating, facilities may change their technology, size, waste management and other operations that can improve or worsen their environmental performance.

- The overall effect of relocation on emissions is determined by a composite of facility-specific changes as well as changes in the external environment in which a facility operates, including community characteristics, regulatory stringency, and economic conditions.

- From an environmental justice perspective, it is not only the effect of relocation on the level of emissions of a facility that is important but also the magnitude of this effect *relative* to that of other relocating facilities. Even if all relocating facilities are reducing their emissions but those moving to socially disadvantaged communities are reducing it by less than others, then this will result in relatively higher exposure to toxic emissions for these communities in the long run.

Goals of this Research

- Examine the role of community pressure in causing toxic facilities to re-locate from their current location to alternative destinations,
  - controlling for reverse causality and for various location-specific economic and regulatory factors and facility-specific characteristics
- Analyze the causal effect of relocation on the environmental and economic performance of toxic polluters
  - and the factors that explain the heterogeneity in the magnitude of this effect across facilities
- Using panel data for 20,518 facilities that existed before 1990 and reported to TRI over 1990 to 2011 with location decisions at census tract level
- Public disclosure of TRI in 1990 provides a natural experiment to address the reverse causality problem
  - Communities unlikely to have known or responded to TRI facilities before 1990
  - Use 1990 characteristics to explain the relocation afterwards

Other Goals of this Research

- Investigate the extent to which community characteristics (measured in 1990) affect the annual relocation probability as facility characteristics and selected other relevant factors evolve.

- Distinguish between facilities that were reporting to the TRI in 1990 and those that started to report in later years to examine the effect of community pressure in prospectively inducing facilities to relocate if they expected to grow and report to the TRI in the future.

- Compare the characteristics of the destination communities to those of the origin locations to confirm that facilities tend to move down the community pressure gradient and to examine the extent to which post-TRI relocations shift the distribution of pollution toward disadvantaged socioeconomic groups.

- Analyze if the facilities become “dirtier” or “cleaner” because of relocation - how the sorting of polluting facilities shapes the spatial distribution of pollution incidence.
  - identify the effects of community socio-economic characteristics on the pollution level of facilities.

Conceptual Framework

- Provision of TRI can increase community concern and lead to public opposition
- Lead firms to relocate after weighing the costs and benefits of staying vs moving to a new destination

- Hypothesis: The extent to which information provision influences a facility's decision to relocate from its existing location depends on composition of the community, location specific and facility specific characteristics
  - the strength of concerns about toxic releases in the community
  - the ethnicity of the community
  - the ability of the community to organize itself collectively, and
  - the potential for liability for damages to human health at its existing location.
  - other factors that affect its costs of operation at the existing location : regulatory pressures and economic conditions.

Variables hypothesized to explain decision to relocate

- Strength of Community Concern: stronger with access to information and knowledge of health risks due to toxic releases
  - Income Level
  - Educational Attainment
- Ethnicity of the Community
  - Share of minority population
  - Politically active community
  - Political ideology: Share of Democrats
- Potential for Liability
  - Size of vulnerable population and bargaining power of comunity
- Location Specific Characteristics
  - Regulatory pressure: non-attainment status of county
  - Economic conditions: Wage rate, Employment rate, Number of toxic facilities
- Facility Characteristics
  - Size of the facility, Financial health of the facility, Toxic emissions level

Conceptual Framework

We denote a facility i's profit π_{ilt} at location l at time t by the reduced-form function

$$\pi_{ilt} = \pi(M_{lt}, \boldsymbol{Z_{lt}}, \boldsymbol{X_{ilt}}, \boldsymbol{e_{ilt}}) \qquad (1)$$

where M_{lt} is the cost of pollution generation imposed on the facility by local community pressure, $\boldsymbol{Z_{lt}}$ is a vector of location-specific economic and regulatory factors that affect the revenues and costs of operations, $\boldsymbol{X_{ilt}}$ is a vector of the facility's characteristics such as size and pollution level that may affect the specific gains and costs of relocation, and $\boldsymbol{e_{ilt}}$ includes the unobserved facility- and location-specific factors.

Facility i selects the profit-maximizing level of $\boldsymbol{X^*_{ilt}}$ when establishing in location l_0 given $M_{l_0 t}$ and $\boldsymbol{Z_{l_0 t}}$.

The provision of toxic release information at time t_0 can result in a change in $M_{l_0 t}$ for $t > t_0$.

Conceptual Framework

The provision of toxic release information at time t_0 can result in a change in $M_{l_0 t}$ for $t > t_0$.

Facility may find it profitable to relocate to a more favorable alternative location l_1 at a relocation cost of $C_{l_0 l_1 t}$, even after it adjusts $\boldsymbol{X_{il_0 t}}$.

Because $C_{l_0 l_1 t}$ can be substantive, a facility will move only if the reduction in community pressure related costs are greater than the cost of relocation.

r_{it} the binary indicator that equals 1 if facility *i* relocates at time *t*, and equals 0 otherwise, and by r_{it}^* the expected net benefit of the relocation. It follows that these variables are related through the expressions

$$r_{it} = \begin{cases} 1, \ r_{it}^* = \pi_{il_1 t}^*\left(M_{l_1 t}, \boldsymbol{Z_{l_1 t}}, \boldsymbol{X_{il_1 t}^*}, \boldsymbol{e_{il_1 t}}\right) - \pi_{il_0 t}^*\left(M_{l_0 t}, \boldsymbol{Z_{l_0 t}}, \boldsymbol{X_{il_0 t}^*}, \boldsymbol{e_{il_0 t}}\right) - C_{l_0 l_1 t} > 0 \\ 0, \ otherwise \end{cases} \quad (2)$$

Variables	Definition	Movers (1)	Stayers (2)
Community Characteristics at Census Tract Level in 1990			
Income Level	Log per capita income in 1000$	9.25 [0.01]	9.19 [0.61]
Educational Attainment	Fraction bachelor's degree or higher	0.13 [0.10]	0.10 [0.07]
Non-Hispanic White	Fraction non-Hispanic White	0.79 [1.01]	0.87 [3.28]
Voter Turnout	Fraction voting in presidential election (1988 and 1992 average, county)	0.63 [0.09]	0.63 [0.09]
Democrats	Fraction votes cast for Democratic Presidential candidate (1988 and 1992 average, county)	0.44 [0.10]	0.43 [0.09]
Population Density	Log population per sq. mile	7.46 [1.60]	6.70 [1.80]
Children	Fraction children under age 5	0.09 [0.33]	0.09 [0.59]
Elderly	Fraction population over age 65	0.12 [0.05]	0.13 [0.05]
Race Diversity Index	Ethnic fractionalization index. $E = 1 - \sum_i^I \left(\frac{Race_i}{Total\ Pop}\right)^2$	4.01 [1.43]	4.56 [1.32]
Renters	Fraction housing renters	0.41 [0.21]	0.37 [0.18]
Vacant Housing	Fraction vacant housing	0.08 [0.06]	0.08 [0.06]

Location Characteristics in 1990			
CAA Attainment Status	Attainment status under NAAQS (1 = Non-attn., county)	0.75 [0.43]	0.57 [0.50]
Toxic Facilities	Number of Toxic Facilities in a census tract	2.25 [2.61]	2.51 [2.66]
Wage Rate	Log industry-specific Wage Rate ($ per week, county)	6.30 [0.26]	6.25 [0.27]
Miles of Highways	Highway miles in census tract	10.13 [15.29]	15.79 [20.07]
Miles of Railways	Railway miles in census tract	7.53 [10.10]	11.83 [12.94]
Urban	Fraction urban population	0.87 [0.28]	0.76 [0.36]
Housing Value	Median Housing Value in 1000$ in a census tract	181.57 [122.91]	138.63 [94.15]

Facility Characteristics in 1990			
Size	Log number of Employees (person)	4.01 [1.43]	4.56 [1.32]
Toxic Emissions	Toxic emissions of all TRI chemicals (1000 pounds)	49.86 [1044.9]	91.59 [1507.9]
Financial Health	PayDex Score Max (scale: 0 – 100)	75.2 [8.3]	75.9 [7.5]
	PayDex Score Diff. (Max - Min, 0 – 100)	8.43 [8.06]	7.79 [7.41]
Number of Facilities units		2,678	17,840

Empirical Framework

We predict relocation, r_{it}, using a reduced-form discrete choice model with vectors of community characteristics $\boldsymbol{M_{l_0t}}$, other location-specific factors $\boldsymbol{Z_{l_0t}}$, and facility characteristics $\boldsymbol{X_{il_0t}}$ as exogenous variables to explain the likelihood of relocation by facility *i* from location l_0 at time *t*. The underlying latent variable, r_{it}^*, is given by

$$r_{it}^* = \alpha + \boldsymbol{\beta M_{l_0t}} + \boldsymbol{\gamma_1 Z_{l_0t}} + \boldsymbol{\gamma_2 X_{il_0t}} + \boldsymbol{e_{il_0t}} \qquad (3)$$

where $\boldsymbol{e_{il_0t}}$ is a disturbance term, and $r_{it} = 1$ if $r_{it}^* > 0$ and zero if $r_{it}^* \leq 0$.

The estimated coefficient for each of the variables in equation (3) is the *net* contribution of that variable to the expected payoff in the best alternative location minus the opportunity payoff of staying in a location (and also minus the cost of relocation)

Estimation Procedure

- We define "relocation" as a move by a facility across census tracts or counties (depending on specification).

- The community characteristics in $\boldsymbol{M_{lt}}$ (*Income Level, Educational Attainment, Non-Hispanic White, Renters, Vacant Housing, Population Density, Children, Elderly*) are also mostly available at the census tract level.

- To consider the potential pressures from neighboring tracts that are within a close distance of a facility and thus could be affected by its toxic releases, we draw a 1-mile circle around each facility and calculate the average demographics of the census tract where the facility is located and those of the census tracts with centroids falling within the circle.

- Thus, two facilities that are located in the same census tract may be associated with different levels of community pressure depending on their exact location within that tract.

Variable Definitions

- *Voter Turnout*, *Democrats*, *Wage Rate* and *Attainment Status* are measured at the county-level because they are not available in a spatially more disaggregated form.
- *Toxic Facilities*, *Housing Value*, and *Urban* are measured at the census tract level. *Miles of Highways* and *Miles of Railways* are also measured at the census tract level and are derived by overlaying census tract boundary information with geographic data on the location of major highways and railways throughout the US.
- Facility-level characteristics, include *Toxic Emissions*, *Size*, and *Financial Health*.
- *Toxic Emissions* is left-censored because the TRI program only requires facilities to report if their emissions of a chemical exceed a threshold
- The coefficient vector $\boldsymbol{\beta}$ is of primary interest. It predicts the direction of the relationship between the community characteristics $\boldsymbol{M_{lt}}$ and the likelihood of facility relocation.
- An important concern in identifying $\boldsymbol{\beta}$ is the possibility of reverse causality, as households may "vote with their feet" in response to the presence of toxic facilities, so that location demographics are determined by facility siting decisions rather than vice versa.
- We avoid this problem by using the 1990 value of the community demographics, $\boldsymbol{M_{l1990}}$, to explain relocations after 1990.
- The demographic characteristics predate the relocation decision of facilities and can be treated as exogenous.

Models Estimated:

- We estimate two versions of the model in equation (3) via logit regression.

- First, we explain a facility's probability of relocation over a period after the first TRI disclosure. The model uses $\boldsymbol{M_{l1990}}$ and other covariates evaluated at 1990 to predict the likelihood of relocating within *T* years after 1990. We set the value of *T* at 5, 10 and 20 years. Defining by R_{iT} the indicator variable for relocation within *T* years of 1990, the specification becomes

  - $$\ln\left(\frac{Prob(R_{iT})}{1-Prob(R_{iT})}\right) = \alpha + \boldsymbol{\beta M_{l1990}} + \boldsymbol{\gamma_1 X_{il1990}} + \boldsymbol{\gamma_2 Z_{l1990}} + \boldsymbol{\lambda_{s_l}} + \boldsymbol{\lambda_{k_i}} \qquad (4)$$

- The unit of observation is the individual facility; thus, this regression is of a cross-sectional nature. Given that the TRI data are only available to the public in one or two years after being reported by facilities, we use the 1988 *Toxic Emissions* variables to the relocation decisions from 1990 onwards

Models Estimated

Second we estimate a panel model that explains the annual probability of relocation and which adds time variation for some of the covariates. The community characteristics $\boldsymbol{M_{l1990}}$ are still measured in 1990 given that most of these characteristics are only available in census years, and interpolating values would possibly lead to reverse causality. This model is given by:

$$\ln\left(\frac{Prob(r_{it})}{1-Prob(r_{it})}\right) = \alpha + \boldsymbol{\beta M_{l1990}} + \boldsymbol{\gamma_1 X_{it-1}} + \boldsymbol{\gamma_2 Z_{lt-1}} + \boldsymbol{\lambda_{s_l}} + \boldsymbol{\lambda_{k_i}} + \boldsymbol{\lambda_t} \qquad (5)$$

where r_{it} in the panel model is a binary indicator of whether a facility *i* relocated in year *t*. The facility-specific ($\boldsymbol{X_{it-1}}$) and other location-specific ($\boldsymbol{Z_{lt-1}}$) characteristics are time varying and lagged by one year as relocation decisions are executed with a lag.

Data

- Sample includes manufacturing facilities that were operating in 1990, reported to the TRI at least once during 1988 to 2011
- We merge the TRI and the National Establishment Time-Series (NETS) database by matching their common information on the facility name, address, and 8-digit SIC code
- The census-tract demographics data are obtained from the US decennial Census.
- The highways and railways data are obtained from the National Highway Planning Network and the National Transportation Atlas database.
- The presidential voting data are obtained from Dave Leip's Atlas.
- The county economic characteristics and attainment status to NAAQS are obtained from the Quarterly Census of Employment and Wages (QCEW) from the Bureau of Labor Statistics and the EPA Greenbook, respectively. These datasets are merged with the TRI using geographic coordinates and the county FIPS code corresponding to each facility.
- In the final sample, we have an unbalanced panel of 20,518 facilities. 1,343 facilities relocated across census tracts within a county and 1,335 facilities relocated across counties between 1991 to 2010 (i.e. a total relocation rate of 13.1%).
- The locations of all facilities cover 12,219 census tracts in 2,140 counties.

Determinants of Relocation Decision over 20 years after 1990

- Positive significant effect of
  - Educational attainment
  - Population density
  - Regulatory pressure due to non-attainment status of county
  - High labor and land costs
  - Lower access to railways
  - Better financial health
  - Smaller size of facility

Dep. Var. – Binary Indicator Moved in 20 years	All Moves			Cross-County Moves	Within-County Moves
	(1)	(2)	(3)	(4)	(5)
Community Demographics in 1990					
Income Level in log	-0.021	-0.021	-0.013	-0.056	0.040
	(0.051)	(0.051)	(0.052)	(0.068)	(0.071)
Educational Attainment	3.920***	3.755***	2.476***	2.236***	2.534***
	(0.304)	(0.303)	(0.401)	(0.494)	(0.545)
Non-Hispanic White	0.004	0.003	0.002	-0.018	0.012
	(0.009)	(0.009)	(0.009)	(0.029)	(0.008)
Voter Turnout	-0.131	-0.063	0.041	-0.557	
	(0.388)	(0.389)	(0.400)	(0.520)	
Democrats	-0.143	-0.145	-0.294	0.816**	
	(0.278)	(0.277)	(0.280)	(0.366)	
Population Density in log	0.259***	0.267***	0.242***	0.115***	0.320***
	(0.018)	(0.018)	(0.033)	(0.044)	(0.047)
Facility Characteristics in 1990					
Size	-0.333***	-0.277***	-0.275***	-0.218***	-0.310***
	(0.018)	(0.019)	(0.019)	(0.025)	(0.027)
Financial Health (PayDex Score Diff.)	0.005**	0.005*	0.005*	0.004	0.005
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Financial Health (PayDex Score Max)	-0.004	-0.004	-0.003	-0.005	-0.000
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Toxic Emissions 46th - 65th percentile		-0.107	-0.105	0.039	-0.254**
		(0.079)	(0.079)	(0.100)	(0.116)
Toxic Emissions 65th - 75th percentile		0.004	0.004	-0.004	0.014
		(0.010)	(0.010)	(0.013)	(0.015)
Toxic Emissions 75th - 90th percentile		0.002	0.002	0.002	0.002
		(0.002)	(0.002)	(0.002)	(0.003)
Toxic Emissions 90th - 95th percentile		-0.002**	-0.002**	-0.002	-0.003*
		(0.001)	(0.001)	(0.001)	(0.002)
Toxic Emissions > 95th percentile		0.000	0.000	0.000	0.000*
		(0.000)	(0.000)	(0.000)	(0.000)
Toxic Emissions Zero-Emis. (1 = YES)		0.510***	0.498***	0.413***	0.556***
		(0.062)	(0.062)	(0.082)	(0.085)
Location-specific Characteristics in 1990					
Attainment Status			0.259***	0.373***	
			(0.070)	(0.094)	
Toxic Facilities			-0.014	-0.008	-0.009
			(0.011)	(0.014)	(0.016)
Wage Rate in log			0.286***	0.094	
			(0.107)	(0.139)	
Miles of Highways			0.004*	0.004	0.001
			(0.002)	(0.003)	(0.005)
Miles of Railways			-0.009***	-0.006	-0.017***
			(0.003)	(0.004)	(0.006)
Urban			-0.121	-0.176	0.099
			(0.129)	(0.164)	(0.193)
Housing Value			0.001***	0.002***	0.001**
			(0.000)	(0.000)	(0.001)
Facility	20,518	20,518	20,518	20,518	19,183
Industry FE, State FE	Y	Y	Y	Y	Y

Annual Likelihood of Relocation

- A one standard deviation increase in the share of high-educated residents in 1990 increases the annual relocation probability of a toxic-releasing facility from a mean of 0.78% to 0.86%
- A one standard deviation increase in the population density increases the probability from a mean of 0.78% to 0.96%.
- These effects are at the same scale as the effect of a one percent increase in local labor cost (proxied by industry-specific wage rate), which increases the probability by 0.15 percentage points.
- The results suggest that local community pressure has a significant impact on the relocation decision of toxic-releasing facilities.

		All Moves		Cross-County	Within-County
Dep. Var. – Dummy for Moved in year *t*	(1)	(2)	(3)	(4)	(5)
Community Characteristics in 1990					
Income Level in log	-0.020	-0.014	0.002	-0.052	0.075
	(0.048)	(0.048)	(0.049)	(0.068)	(0.069)
Educational Attainment	3.746***	3.353***	2.319***	2.452***	2.413***
	(0.274)	(0.275)	(0.372)	(0.499)	(0.519)
Non-Hispanic White	0.005	0.004	0.002	-0.013	0.012
	(0.007)	(0.007)	(0.008)	(0.016)	(0.007)
Voter Turnout	0.225	0.228	0.193	-0.376	
	(0.370)	(0.366)	(0.376)	(0.522)	
Democrats	-0.141	-0.166	-0.235	0.929**	
	(0.264)	(0.261)	(0.265)	(0.377)	
Population Density in log	0.256***	0.250***	0.221***	0.133***	0.279***
	(0.018)	(0.018)	(0.031)	(0.044)	(0.044)
Facility Characteristics with 1-yr lag					
Size	-0.317***	-0.233***	-0.234***	-0.248***	-0.233***
	(0.016)	(0.017)	(0.017)	(0.026)	(0.024)
Financial Health (PayDex Score Diff.)	0.007**	0.005*	0.005*	0.005	0.005
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Financial Health (PayDex Score Max)	-0.011***	-0.010***	-0.009***	-0.013***	-0.006
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Toxic Emissions 46th - 65th percentile		0.203	0.203	0.111	0.277
		(0.142)	(0.141)	(0.197)	(0.202)
Toxic Emissions 65th - 75th percentile		-0.020	-0.020	0.002	-0.042*
		(0.015)	(0.015)	(0.021)	(0.022)
Toxic Emissions 75th - 90th percentile		0.006*	0.006**	0.002	0.011**
		(0.003)	(0.003)	(0.004)	(0.004)
Toxic Emissions 90th - 95th percentile		-0.005**	-0.005**	-0.003	-0.009**
		(0.002)	(0.002)	(0.003)	(0.004)
Toxic Emissions > 95th percentile		0.000***	0.000***	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Toxic Emissions Zero-Emis. (1 = YES)		1.711***	1.706***	1.611***	1.798***
		(0.140)	(0.140)	(0.192)	(0.203)
Location Characteristics with 1-yr lag					
Attainment Status			0.110*	0.193**	
			(0.061)	(0.083)	
Toxic Facilities			-0.017*	-0.009	-0.021
			(0.010)	(0.012)	(0.014)
Wage Rate in log			0.308***	0.175	
			(0.088)	(0.126)	
Miles of Highways			0.003	0.003	0.002
			(0.002)	(0.003)	(0.004)
Miles of Railways			-0.013***	-0.010**	-0.019***
			(0.003)	(0.004)	(0.006)
Urban			-0.123	-0.231	0.107
			(0.123)	(0.163)	(0.188)
Housing Value			0.001***	0.001***	0.001**
			(0.000)	(0.000)	(0.000)
Facility-Year	294,015	294,015	294,015	294,015	279,534
Facility	20,518	20,518	20,518	20,518	19,183
Industry FE, State FE, Year FE		Y	Y	Y	Y

Prospective Response to TRI Reporting

- Investigate the possibility that facilities respond to TRI reporting prospectively, i.e., their relocation propensity is affected by the anticipation of reporting to the TRI rather than current inclusion in the TRI

- Find that facilities that are not yet "on the radar" but anticipate that they will be in the future should indeed be more likely to depart from high community pressure locations compared to facilities whose emissions have dropped below the threshold and may not go above it again.
  - Firms that are forward looking would expect higher future levels of community pressure for its activities compared to the later.

- With relocation taking place on the basis of future payoffs, it is the expected pressure that matters, not any pressure that the facility has faced in the past.

Community Characteristics of Destination Locations

- We find that facilities are on average relocating into communities with a lower *Income Level*, lower *Population Density*, lower share of *Democrats*, and lower propensity of being in non-attainment, especially for the cross-county movers.

- This relocation tendency is stronger for the facilities with below threshold emissions, which also tend relocate into communities with lower educational attainment and lower voter turnout.

- We find that both small and large polluters are on average relocating into communities with significantly lower score for community pressure, and that regulatory pressure contributes to this pattern.

Effects of Relocation

- Movers exhibit smaller reductions in emissions accompanied by an increase in employment.
- Emissions per employee follow the same trend as non-movers; moving facilities tend to grow
  - possibly the move is driven by a desire to increase the scale of production and as they grow, they also emit more.
- But their pollution intensity is not affected; Facilities with no emissions prior to the relocation grow in size and emissions even more than the larger relocating facilities.
- We find that facilities relocating to areas with lower community pressure grow more than those relocating to areas with higher community pressure, and their emissions change are much higher than those of the non-relocating facilities.
- In contrast, facilities that relocate to areas with higher community pressure exhibit a growth and emissions pattern that is more similar to the non-relocators.

In Summary

- Relocation is associated with facility growth, and thus also with an increase in emissions.
- But emissions per employee do not change differentially for relocating facilities compared to those who stay in the same location; it appears that facilities do not relocate to become "dirtier;" they relocate when they want to grow.
- When they do, they choose to move down the socioeconomic gradient; and those that grow the most move further down that gradient.
- In cases where facilities move into less disadvantaged communities, we observe a similar decrease in emission *intensity* than incases where facilities move into more disadvantaged communities (and even in cases where facilities that do not move at all).
- Adverse effects on environmental justice arise from the relocation pattern itself and also from the fact that moves to more socially disadvantaged localities are associated with growth in facility size, not from changes in facility emissions conditional on size.

Policy Implications

- Environmental disclosure programs affect not only existing facilities but also have an anticipatory effect on location choices of facilities that expect to increase their emissions in the future.
- Relocation does not appear to have been associated with facilities becoming dirtier and increasing emissions per employee; instead it appears to be motivated by a desire for growth by facilities.
- But relocation can be expected to increase emissions, especially for communities with disadvantaged socioeconomic groups, for which post-relocation facility growth is particularly high.
- Public disclosure of TRI has redistributive effects in the spatial allocation of pollution, by inducing facilities to relocate into socio-economically disadvantaged and low population density areas and potentially increasing their toxic emissions.
- Policy makers need to consider the potential side effects of information disclosure on distributional justice and strengthen the channels for vulnerable populations to voice their concerns about facility location in addition to strengthening zoning laws and regulations.