The Location of Toxic Release Inventory Facilities in Maricopa County: Economics, Collective Action—and Being Asian

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Introduction

An ongoing question in environmental justice (EJ) research is whether the disproportionate co-location of environmental disamenities with minority residents is due to efficient workings of the market, or something more invidious.

One difficulty in sorting this out is the often-limited availability of data on population characteristics at the time of the disamenity-producing entity's location. Researchers often must rely on population characteristics at some point *after* location, meaning that current co-location may be due to market-based decisions of residents, rather than locater decisions. This research provides evidence directly relevant to this problem.

Starting with the Toxic Release Inventory Facility (TRIF) data for 401 separate facilities in Maricopa County (EPA 2003), the researchers found location date for 222. This allows multivariate regression analysis under a clear time-based causal structure permitting identification of residential characteristics *before* TRIF location, ensuring that findings do not indicate the movement of residents into the TRIF's ambit, but location of the TRIF among the residents.

The analysis finds that, even controlling for other factors, there is environmental injustice based on Asian ethnicity. Several economic costs matter and the potential for collective action does decrease the likelihood of TRIF location, but the rate of poverty does not seem to be important in these data, though it often is in the EJ literature.

Method

The work presented here takes advantage of a unique dataset which identifies Toxic Release Inventory facility (TRIF) location dates. This allows certainty that we are not analyzing cases where groups of people, for whatever reasons, have moved to the environmental disamenity. Instead, we are able to use the most recent census data **before** a TRIF's location to understand how population characteristics may affect TRIF locations controlling for other important factors. Figure 1 shows the causal time-line allowed by our data.

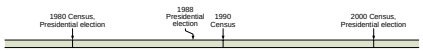

Figure 1: Temporal Relationships Among Data

We use GIS methods to examine the spatial relationships between the sites of newly locating TRIFs relative to population characteristics as measured by the US Census over 3 decades, 1980, 1990, and 2000. We also use GIS to examine the spatial relationships among these newly locating TRIFs and land-use, transportation infrastructure, political boundaries, and political behavior.

Figure 2 shows the TRIFs located in the Phoenix metropolitan portion of Maricopa County, differentiating those with identified start dates from those without. Because a large number of TRI observations were excluded from the analysis for lack of a facility start date, we tested the distribution of these observations for clustering using the GeoDa spatial data analysis software package. We found that whether we could determine start date was not statistically significantly different from random.

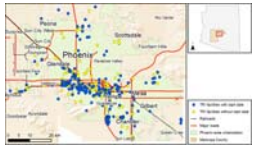

Figure 2: Phoenix Metropolitan Area TRIFs

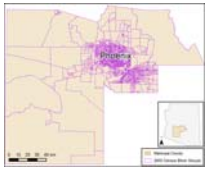

Figure 3: Census 2000 Block Groups

Census tracts (1980) and block groups (1990 & 2000) are the units of analysis. As can be seen from Figure 3, Census areas vary drastically in size. Therefore, the dependent variable analyzed is new TRIFs per square kilometer.

The theory used is fundamentally based in economics and public choice. Under the assumptions of neoclassical microeconomics, TRIF location decisions should be caused by costs. The types of costs to be considered are

- Traditional economic costs
- Potential compensation costs that may arise in the event of legal action
- Political costs that may be caused by the likelihood for successful collective action by residents

If there is no environmental injustice, then, controlling for all cost factors, race and ethnicity should have no effect in TRIF locations.

We use several variables to control for each of these categories, as described in the next column.

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Traditional Economic Costs

Controls for traditional economic costs include

- A measure of the distance to the nearest railroad (measured from the Census unit centroid), *DistanceRR*
- A measure of the distance to the nearest major road (also measured from the centroid), *DistanceMajorRd*
- Measures of land type as a proxy for land cost because land cost was unavailable, measured as *%Agriculture*, *%Urban*, *%Recreation*, and *%Water (%Desert*, measuring unimproved land which should be a cheap land type, is the reference group)
- TRIFs already existing in the location

Potential Compensation Costs

Controls for potential compensation costs include

- A measure of population density, *People/km²*
  - The greater the population density, the greater the likelihood of harm requiring compensation
- The number of persons in the Census unit, *TotalPop*
  - Controlling for density, the larger the number of people, the larger the required compensation is likely to be
- The average household income, *MeanHHY*
- The average house value, *MeanHouseValue*
  - The richer the average resident and the more expensive the average house, the higher the likely compensation per incident

Potential Collective Action/Political Costs

An insight of Hamilton's (1995) model is the explicit inclusion of costs to the firm posed by effective collective action of residents. Hamilton (1995) controls for this component using voting rates, and we also measure this using percent of adults voting in the closest preceding US Presidential race for each decade ('80 for the 1980 Census, '88 for 1990, and '00 for 2000) with the variable *%VotePres*. However, his work inspired us to go beyond this fairly basic measure of what is, after all, individual political engagement rather than collective action and to use a public choice perspective to consider what other factors should impact collective action. Thus, we use the following factors

- Percent of adults voting in the closest preceding US Presidential race for each decade with the variable *%VotePres*
- Closeness to political boundaries, *BoundaryDistance*
  - A strategic firm would choose to locate on political boundaries. For example, by locating on a boundary between two cities rather than in the middle of a city, a strategic firm could disenfranchise roughly half of affected residents
- Homeownership because homeowners, who have a higher stake in the effects of disamenities, are more likely to engage in political action against disamenity location in their neighborhoods, so we measure the percentage of housing units that are owner-occupied with *%HouseOwners*
- Poverty and low educational attainment should generally decrease the ability effectively to engage in political action, so we control for these factors through the use of *%LessThanHS* and *%Less150Poverty*, measuring the percent of each Census unit's residents that have attained less than a high-school diploma, and the percent of residents living at less than 150% of the poverty line
- Inability to speak the dominant language of government in the area would greatly decrease the ability to engage effectively in political action to stave off unwanted development in one's neighborhood. So, we measure the percent of those in an area whose primary language is Spanish and who speak English poorly or not at all, *%PrimarySpanish*
- Age of residents because demographic analysis indicates that older adults are more likely to engage in political action (see, for example, Centre for Research and Information on Canada, 2003). On the other hand, underage children are much less likely than normal to engage in political action (at least in part because they do not vote). Therefore, we measure *%Age55-74* and *%Age0-15*
- Homogeneity under the theory that homogeneity may allow groups to overcome collective action problems (measured as squares of variables measuring race, ethnicity, and language)

Race/Ethnicity

Under economic models, race and ethnicity should have no impact on TRIF location decisions once all costs are controlled for. Under theories of environmental discrimination, these factors will matter even after controlling for cost factors. To test these competing hypotheses, we include

- *%Black*
- *%Hispanic*
- *%Asian*
- *%Amerind*

Preliminary Findings

Table 1 shows descriptive statistics for the analyzed data.

Table 1: Descriptive Statistics of Analyzed 1980, 1990 and 2000 Maricopa County Census Units

Variables	Mean	Std Dev	Minimum	Maximum
DV: TRIF/km²	0.012	0.117	0.000	3.090
%Black	3.501	6.944	0.000	91.757
%Hispanic	20.156	22.519	0.000	100.000
%Asian	1.725	2.797	0.000	33.668
%AmerInd	1.767	5.497	0.000	96.259
DistanceRR	6.237	6.285	0.002	50.108
DistanceMajorRd	2.559	2.592	0.000	32.310
%Agriculture	5.468	16.276	0.000	100.000
%Urban	83.837	25.135	0.000	100.000
%Recreation	2.363	7.274	0.000	93.914
%Water	0.538	2.339	0.000	33.116
%Desert	7.791	17.066	0.000	99.831
People/km²	2,014.9	1,457.9	0.072	21,858.3
TotalPop	1,569.7	1,317.0	4.0	14,658.0
MeanHHY	57,297.4	31,416.6	0.0	345,957.0
MeanHouseValue	120,271.9	88,124.6	0.0	1,250,000.0
ExistTRIFs/km²	0.042	0.264	0.000	3.153
%VotePres	41.787	17.159	0.000	219.281
BoundaryDist	2.182	2.101	0.000	28.710
%HouseOwners	64.938	26.844	0.508	100.000
%LessThanHS	20.737	17.649	0.000	100.000
%Less150Pov	21.025	18.024	0.000	100.000
%PrimarySpanish	4.660	8.462	0.000	91.667
%Age55-74	15.953	13.055	0.000	100.000
%Age0-15	23.157	10.379	0.000	60.000

The following figures show some simple spatial correlations between some of the important concepts in the model and the locations of TRIFs.

Figure 4: Political Boundaries and Transportation Infrastructure

Figure 5: Percent Asian, Census 2000

Figure 6: Percent of Population age 0 to 15, Census 2000

Figure 7: Percent of Voting-Age Population that Voted in the 2000 Presidential Election, Census 2000

Figure 8: Population Density, Census 2000

The Model to be Estimated

Tobit analysis is used because the location of new TRIFs is a rare event over the space and time-period studied. The conceptual model to be analyzed (ignoring the functional form imposed by Tobit) is the following:

(Eq 1) $TRIF/km^2 = \beta_0 + \beta_1 \%Black + \beta_2 \%Hispanic + \beta_3 \%Asian + \beta_4 \%Amerind$
$- \beta_5 DistanceRR - \beta_6 DistanceMajorRd - \beta_7 \%Agriculture - \beta_8 \%Urban$
$- \beta_9 \%Recreation - \beta_{10} \%Water - \beta_{11} People/km^2 - \beta_{12} TotalPop$
$- \beta_{13} MeanHHY - \beta_{14} MeanHouseValue + \beta_{15} ExistTRIFs/km^2 - \beta_{16} \%VotePres$
$- \beta_{17} BoundaryDistance - \beta_{18} \%HouseOwners + \beta_{19} \%LessThanHS$
$+ \beta_{20} \%Less150Poverty + \beta_{21} \%PrimarySpanish - \beta_{22} \%Age55\text{-}74$
$+ \beta_{23} \%Age0\text{-}15 - \beta_{24} (\%Black)^2 - \beta_{25} (\%Hispanic)^2 - \beta_{26} (\%Asian)^2$
$- \beta_{27} (\%Amerind)^2 - \beta_{28} (\%PrimarySpanish)^2 + \beta_{29} 1980 + \varepsilon$

The signs shown in conceptual equation 1 are those expected when theories leading to variable inclusion are supported. An indicator variable for 1980 is included because of the switch from Census Tracts in 1980 to Census Block Groups in later years.

Conclusions

Table 2 shows the results of the analysis

Table 2: Tobit Model Analytic Results

Variable	Parameter Estimate	Effect of a 10-Unit Change	10-Unit Effect as Percent Change from Mean	t-statistic
Discrimination				
%Black	-0.0014	-0.0000	-3.8%	-0.08
%Hispanic	0.0140	0.0004	37.7%	1.06
%Asian	0.1566	0.0049	421.5%	2.12 *
%AmerInd	0.0160	0.0005	43.0%	0.64
Economic Costs				
DistanceRR	-0.0052	-0.0002	-13.9%	-0.38
DistanceMajorRd	-0.0399	-0.0012	-107.3%	-1.31 +
%Agriculture	-0.0038	-0.0001	-10.2%	-0.86
%Urban	0.0026	0.0001	7.0%	0.67
%Recreation	-0.0301	-0.0009	-81.1%	-1.58 +
%Water	0.0125	0.0004	33.7%	0.60
ExistTRIFs	0.5204	0.0161	1400.8%	3.60 *
Legal Costs				
People/km²	-0.0008	-0.0000	-2.1%	-6.13 *
TotalPop	0.0001	0.0000	0.3%	2.12 ~
MeanHHY (000s)	0.0052	0.0002	14.1%	1.30 +
MeanHouseVal (000s)	-0.0023	-0.0001	-6.2%	-1.44 +
Collective Action				
%VotePres	-0.0121	-0.0004	-32.5%	-1.85 *
BoundaryDistance	0.0048	0.0001	12.9%	0.17
%HouseOwners	-0.0053	-0.0002	-14.2%	-1.38 +
%LessThanHS	0.0055	0.0002	14.7%	0.73
%Less150Poverty	0.0002	0.0000	0.6%	0.04
%PrimarySpanish	0.0243	0.0008	65.3%	0.93
%Age55-74	0.0047	0.0001	12.7%	0.60
%Age0-15	0.0175	0.0005	47.2%	1.69 *
%PrimarySpanish²	-0.0005	-0.0000	-1.4%	-0.74
%Black²	-0.0001	-0.0000	-0.3%	-0.34
%Hispanic²	-0.0002	-0.0000	-0.6%	-1.65 *
%Asian²	-0.0126	-0.0004	-33.8%	-1.52 +
%AmerInd²	-0.0003	-0.0000	-0.7%	-0.84
Other Controls				
Yr1980	0.6188	-0.0192	1665.6%	2.49 *
Intercept	-2.0296	0.0629		-3.20 *
Model Fit				
Log of Likelihood Function	-364.09			

* statistically significant, p<0.05, one-tailed test
~ statistically significant, p<0.05, two-tailed test
\+ statistically significant, p<0.10, one-tailed test

The findings indicate the following:

- Traditional economic costs are, as expected, important factors in new TRIF locations
  - Some of the most important factors are the location of major roads and whether a Census unit already contains TRIFs or not
- Potential legal costs are also important
  - For example, increased population density decreases the likelihood of TRIF location
- Potential collective action is important
  - Voting behavior, homeownership, and homogeneity all effect the TRIF location decision
  - Unfortunately, increases in the percent of children, who lack a direct political voice and who are more affected by pollutants, increases the likelihood of a new TRIF
- **But, even controlling for all cost factors, Asian ethnicity has a large and statistically significant impact on the location of new TRIFs**

This research does not support the idea that, controlling for all costs, race and ethnicity have no effect. However, the reason that Asian ethnicity has the most important racial effect in Maricopa County between 1980 and 2003 is unclear to us. We are consulting with scholars at ASU's Asian Pacific American Studies program to begin to understand this conundrum.

References

Centre for Research and Information on Canada (August 2003). Citizen participation and Canadian democracy: An overview. PowerPoint presentation available online at http://www.cric.ca/pwp_re/cric_studies/citizen_participation_and_cdn_democracy_aug_2003.ppt
Environmental Protection Agency (2003). TRI State Data Files for Arizona, Toxic Release Inventory (TRI) Program. USEPA. http://www.epa.gov/tri
GeoDa (2006). Spatial Analysis Lab, University of Illinois, Urbana-Champaign, https://www.geoda.uiuc.edu
Hamilton, J. T. (1995). Testing for environmental racism: Prejudice, profits, political power? Journal of Policy Analysis and Management, 14(1): 107-132.