Environmental Justice Revisited: The Case of Kentucky

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Abstract

Environmental racism is the exploitation of minority or poor persons based on environmental quality. This study evaluates the economic conditions of persons located adjacent to hazardous waste (host) sites. Kentucky citizens inhabiting host sites tend not to be economically disadvantaged minorities and superfund improvements have not statistically increased housing values.

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The exploitation of minorities or poor communities based on race in a context of the environment is environmental racism (Kriesel, et. al. 1996). Early in 1980's the General Accounting Office estimated that several thousand-minority communities were located near toxic sites. The toxicity of the sites affects the health and environment of the neighborhood. If toxicity levels are sufficiently high, then the Environmental Protection Agency (EPA) will intervene and take up cleaning activities with an objective of promoting development. However, before taking any action, the site is first listed in the National Priority List (NPL), also called a Superfund site, following the standards set forth by the EPA.

The purpose of this study is to examine the communities located adjacent to hazardous waste sites (host tracts) listed in the NPL in Kentucky and to evaluate the changes in their socio-economic and demographic characteristics. Cleaning activities at these sites started in the mid-1970's, hence no information is available on the pre-cleaning socio-economic and demographic characteristics of these sites. Since most of these sites had not completed the cleaning process by 1990 (the latest year of available census information at the tract level), a direct comparison between pre-cleaning and post cleaning conditions cannot be made. Hence we follow the direction of changes of the socio-economic and demographic characteristics for these Superfund sites during the cleanup period.

The hazardous waste sites in Kentucky were started during the early 1950's and 1960's and were active until the late 70's. As these sites began to affect the environmental conditions of surrounding communities and neighborhoods during late 70's, the EPA intervened to clean these

hazardous waste sites. There are 16 sites in Kentucky that complied with the standards set forth by the NPL and that are now listed as superfund sites. Of the 16 sites, environmental remediation has been completed at six sites and remediation is nearly complete at ten sites (Appendix -1).

The widely sited report by the Union Church of Christ Commission for Racial Justice (1987) states that race proved to be significant among variables tested in association with the location of commercial hazardous waste facilities. Communities with a commercial hazardous waste facility had an average minority population that, percentage wise, was twice the average minority percentage of communities without such facilities. The commission also reported that socio-economic status appeared to be an important factor in locating hazardous waste facilities and that income and home values were substantially lower in the communities with hazardous waste facilities.

Bryant and Mohai (1992) first recognized the importance of separating racial and income effects when evaluating the socio-economic effects on communities with nearby hazardous waste facilities. Using a probabilistic (or probit) regression analysis of Detroit area data they found that, while controlling for income level, the coefficient of race was positive and significant indicating that whites live farther from environmentally hazardous facilities. Kriesel, et.al, (1996) also supports this evidence.

With respect to the defined unit of analysis, census tracts were found to be more suitable for cross sectional analysis than areas defined by zip code. Specifically, while zip code areas do change, there are no published records of such changes through time. Furthermore, a study by Bean (1991) reports that there is a higher likelihood of a census tract hosting a hazardous waste

facility if there is a significant percent of African Americans, Hispanics, and other minority persons employed in manufacturing occupations in that particular census tract.

Kohlhase (1991) analyzed the impact on Houston, Texas' housing market of EPA announcements and policy actions. After the announcement of a toxic waste site as a Superfund site, a new market for "safe" housing was created. Specifically, housing prices increased at a decreasing rate for up to 6.2 miles from where the designated sites was located. Being designated as a NPL provides new information that depresses home values near toxic sites while increasing the market for safe homes located away from the toxic site.

The work presented here concerns changes in demographic and socio-economic characteristics after implementation of the Superfund program. This study compares census tracts hosting Superfund sites (host site) to census tracts that do not host such sites (non-host sites) in Kentucky. The non-host sites serve as the counter factual in this analysis. In most cases the host site census tracts are smaller then the 6.2-mile radius limit (Kohlhase, 1991) in which Superfund remediation (restoration or cleaning) efforts are expected to have an impact on socio-economic variables.

Methodology and Data

A testable hypothesis of this work is that remediation of superfund sites promoted development in host sites that would not have occurred otherwise. The appropriate variables for measuring economic development at host sites are limited by the availability of data at the census tract level. A second hypothesis, observed in other studies, is that the proportion of non-whites in the host-sites is higher than the proportion of non-whites in non-host sites.

The socio-economic conditions that would have prevailed in the absence of the cleaning effort are referred to as the counterfactual. These conditions are be represented by non-host census tracts adjacent to the host sites. However, the conditions that would have cannot be observed directly nor can they ever be known with certainty (Mohr). Nevertheless, the counterfactual helps to identify socio-economic changes that should be consistent across both groups. Remaining differences, then, are attributed to the direct and indirect economic effects associated with the remediation of hazardous waste sites. In this case the counter factual is defined as the predicted outcome given the assumption of no treatment that serves as a non-equivalent non-random control group (Hoole, 1978).

Unfortunately, the use of counterfactuals is not perfect. Specifically, there may be several alternative explanations for changes in the observed socio-economic variables. In particular, it is not always possible to determine if the hypothesized causal relationship between remediation and the socio-economic variables used to measure development actually exists. It may be other, unanticipated events, occurring at the same time as the remediation efforts that account for the observed impacts. Given the non-random selection of the superfund sites, the group of individuals at a site may have suffered some extreme event that, within the given time frame, appears statistically important even though remediation activities were not affective (Cook and Campbell).

Demographic and socio-economic data were collected for the 1980 and 1990 census years. The data for 1990 was obtained from Environmental Systems Research Institute, Inc (ESRI), whereas the 1980 data was obtained from the Inter University Consortium for Political and Social Research (ICPSR) at the University of Michigan, Ann Arbor.

The 1990 data included all Kentucky counties and census tracts in a form that required no adjustment. In the 1980 data, there were many counties for which information was not compiled according to census tract or for which the census tract had changed relative to the tracts identified in 1990. In these cases, enumeration was done using the Block Numbering Area's (BNA) or and Enumeration Districts (ED) (Census of population and housing, 1980). To align the data (i.e., to make the census tracts in 1980 consistent with those in 1990), county maps were obtained from the Urban Policy Research Institute, University of Louisville, Louisville, Kentucky for the years 1980 and 1990 and, using a computer program called a Census tract relationship file, were used to merge or adjust the BNA's and ED's of 1980 so that they correspond to the census tracts of 1990.

Data was collected for all Kentucky host census tracts and for all census tracts adjacent to host tracts (the non-host census tracts). The data include 80 census tracts over 21 counties (13 counties with the sites and eight counties adjacent to them). Data variables include the percent nonwhite residents in a census tract, the percent of the census tract population with a high school education, the percent of residents employed in the manufacturing sector, the mean value of homes in the census tract, the number of homes with one to three and greater than four rooms, the percent of families below the poverty line, and per capita income. The variable percent non-white includes African Americans, Hispanics, Latino's and other minority groups. The variable percent of families below the poverty line was defined differently in the two time periods. The poverty level as defined by the census bureau was used to develop this variable. For the year 1980, the poverty level was $9,258 per year for a family of two adults and two children. In 1990, the poverty level was defined as $13,254 for the same family (Census Bureau). The poverty level

was rounded off to the next highest level or $10,000 for 1980 and $15,000 for 1990 due to the lack of available data.

The host and non-host census tract data was analyzed in two stages. In the first stage, differences in mean values were compared and tested to determine if they were statistically different using pair wise comparison t-tests. Three sets of comparisons were made. In the first, differences between 1990 and 1980 were computed for the host and non-host tracts. In the second, differences between the host and non-host tracts were computed for 1980 and 1990.The final set of comparisons is essentially the difference between the differences. Here, the difference in mean value for the host and non-host tracts between 1980 and 1990 are subtracted from one another.

The second stage of analysis involved the use of regression techniques. While comparison of means can tell one if a value has increased of decrease through time or if a value associated with a host census tract is higher or lower than a value in a non-host tract, a comparison of means cannot indicate functional relationships. Specifically, regression allows one to identify the statistical relationship between socioeconomic variables of interest, such as poverty, and whether the impoverished family lives in a host or non-host census tract.

Using discrete choice models, Bryant et.al. (1992) and Kreisel et.al. (1996) found that there was a statistical relationship between the non-white population of an area and the location of hazardous sites. Unfortunately, these models suffered from a statistical condition know as endogeneity, a problem that Logit estimation does not address. Specifically, being impoverished may result for a number of reasons including economic discrimination based on one's race and this discrimination and one's economic condition may necessitate living next to a hazardous

waste site. Hence, it is reasonable to expect that there is a functional relationship between living near a hazardous waste site, being non-white, and being in poverty. In this case, the dependent variable determines one or more of the independent variables (and vice versa) resulting in endogeneity where the errors of estimation are correlated with the independent variables.

Estimation techniques like Two Stage Least Squares (2SLS) are designed to account for endogeneity. Specifically, three equations, one representing the percent of non-whites in the population, on representing the population living below the poverty line, and one representing the value of the housing, are defined. 2SLS utilizes the information provided by the equations in the system (Gujarati 1988). Percent nonwhite is assumed to be a function of the percent of families below the poverty live, housing value, the percent of the population with a high school education, the percent of people in the manufacturing sector, the total population of the census tract, a dummy variable representing year (this variable holds the value of 1 if the year is 1990 and is 0 otherwise), and a dummy variable that identifies if the census tract hosts a hazardous waste site (this variable holds the value of 1 if the census tract hosts a hazardous waste site and is 0 otherwise; Equation 1). The percent of the population impoverished is assumed to be a function of the percent of non-white individuals in the census tract, the percent of the population with four years of high school or less, the percent of people employed in the manufacturing sector, and the year and host site dummy variables (Equation 2). Finally, housing value is assumed to be a function of the percent of non-white individuals, the population of the census tract, per capita income, the size of the house (one to three rooms and four or more rooms) and the year and host site dummy variables (Equation 3).

Equation 1

$$nw = \alpha_0 + \alpha_1 pov + \alpha_2 val + \alpha_3 hs + \alpha_4 manu + \alpha_5 pop + \alpha_6 site + \alpha_7 year + \alpha_8 site*pov + \alpha_9 site*val + \alpha_{10} site*hs + \alpha_{11} site*manu + \alpha_{12} site*pop$$

Equation 2

$$pov = \beta_0 + \beta_1 nw + \beta_2 hs + \beta_3 manu + \beta_4 site + \beta_5 year + \beta_6 site*nw + \beta_7 site*hs + \beta_8 site*manu$$

Equation 3

$$val = \gamma_0 + \gamma_1 nw + \gamma_2 pop + \gamma_3 pci + \gamma_4 rle3 + \gamma_5 rgt3 + \gamma_6 site + \gamma_7 year + \gamma_8 site*nw + \gamma_9 site*pop + \gamma_{10} site*pci + \gamma_{11} site*rle3 + \gamma_{12} site*rgt3$$

In Equations 1, 2, and 3 nw is the percent of the non-white population in the census tract, pov is the percent of impoverished individuals in the census tract, val is the mean value of homes in the census tract, hs is the percent of residents who completed high school, manu is the percent of the population employed in manufacturing, pop is the population of the census tract, and year is a dichotomous variable that is assigned the value of 1 for year 1990 and is 0 otherwise. In addition to these, the parameter pci is per capita income, rle3 is the number of homes with 3 or fewer bedrooms, rgt3 is the number of homes with more than 3 bedrooms, and site is a dichotomous variable that is assigned the value of 1 if that particular census tracts hosts a superfund site and is 0 otherwise. Note that a number of the continuous independent variables are multiplied by the site dichotomous variable to create interaction variables. In practice, the parameter values on the continuous independent variable are slope terms. The parameter values

of the dichotomous variables represent shifts in the intercept term. Finally, the parameter values on the interaction terms represent shifts in the respective slope terms.

The variables nw, pov, and val are the endogenous variables in this system of equations. The variables hs, manu, pop, site, year, pci, rle3, and rgt3 are all exogenous. Furthermore, this system of the equations is over identified by a value of one. The analysis was conducted using 2SLS.

Results and Discussion:

The tabular analysis of the socio-economic data for the census tracts hosting the facilities for the years 1980 and 1990 are presented in Table 1. The population in the host census tracts decreased during the period 1980 and 1990, whereas in the non-host tracts the population increased during the same period. The non-white population in the host census tracts increased by about 100 percent from 1980 to 1990 when compared with the non-host census tracts where the non-white population decreased from 18.40 per cent in 1980 to 16.26 per cent in 1990. The percent of people living below the poverty line decreased from 1980 to 1990 in both the host and non-host census tracts by about the same magnitude. Similarly, per capita income increased for both host and non-host tracts between 1980 and 1990 and the percent of high school graduates decreased. At the same time there was an increase in the number of people working in the manufacturing sectors in host and non-host census tracts and housing values increased in the host census tracts, but decreased in the non-host census tracts between 1980 and 1990.

Table 2 reports t-test results for the comparison of mean values across census tracts types within a year, across years within a census tract type, and across the census tract types across the

two census years. The results of table 2 indicate that there were statistically fewer non-white individuals in host sites in 1980. This finding is counter to earlier work that shows minorities to be more populous in Superfund host sites. By 1990 the racial mix of the population in host and non-host sites was statistically the same. This would seem to suggest that non-whites migrated into host site areas between census years, however the change in non-white population across census tracts and years is not statistically significant.

Between 1980 and 1990 the population of host and non-host sites became statistically better off in terms of their income (became less impoverished). This was possibly due to the statistically higher number of individuals employed in manufacturing types of jobs and this is true despite the fact that fewer individuals were completing high school in 1990. Furthermore, the difference in income and poverty between host and non-host sites between the census years was not statistically different. Housing values were also statistically higher in non-host sites in 1980, but this difference was corrected by 1990.

Simultaneous estimation of equations 1, 2, and 3 using 2SLS yields results consistent with those in Table 2 (see Table 3). The first equation shows that the percent of impoverished persons, the percent of people in the manufacturing sector, the population of the census tract, value of homes in the census tract and the year and site dummy variables are all significant to the model. The sign of the site dummy is negative and significant indicating that the non-white population has been decreasing in the census tracts hosting the sites.

In the second equation the non-white population parameter, the percent of high school graduates in the census tract, and the year dummy variable are statistically significant. The parameter on the site dummy variable is not significant in the second equation. The non-white

variable is positive and significant indicating that when poverty rates increases, the non-white population increases by 3 per cent in the study area. However, the non-significance of the interaction variable (nonwhite and site) indicates that the poverty level does not increase in the census tracts hosting hazardous waste facilities. Furthermore, the interaction term (site and high school) is negative and significant which supports the claim that economically impoverished people do not live in census tracts hosting Superfund sites.

The third equation in the system evaluates housing value. In the study area, percent of the census tract population that is non-white, total population, per capita income, the number of houses with 3 or fewer rooms, the number of houses with 4 or more rooms, and the year dummy variable are all statistically significant to the model. The parameter estimate on the year dummy variable was negative indicating that the housing value decreased between 1980 and 1990. The parameter estimate on the site dummy variable was negative and insignificant indicating that the value of homes was not impacted by the presence of hazardous waste sites in the respective census tract. The parameter estimate on the site and population interaction variable was positive and significant indicating that the value of homes in census tracts hosting hazardous waste sites increased with an increase in the population of that census tract. This result was anticipated. However, an increase in per capita income did not result in an increase in housing value as might be expected. Finally, the larger the home in terms of rooms, the lower the value of the house if it is located in a census tract hosting a hazardous waste facility. This result is counterintuitive.

Conclusion:

This study explores issues of environmental justice by analyzing differences in demographic and socio-economic variables of Kentucky census tracts that host environmentally hazardous waste sites identified by the EPA as Superfund sites. Census data for the years 1980 and 1990 from eighty host and non-host census tracts were analyzed. Earlier studies suggest that the presence of a hazardous waste site is statistically correlated with a higher population of non-white individuals who are statistically more likely to be impoverished. The results of this study suggest that host sites in Kentucky were more likely to be populated by whites. Cleanup of host sites between 1980 and1990 resulted in an in-migration of minorities such that there is no longer any differences in the racial mix of host and non-host sites. Furthermore, while residents of Superfund host sites were made better off during the periods of site clean up (between 1980 and 1990) there was no statistical difference in economic variables between the host and non-host sites. Hence, this study does not support earlier evidence that people in host sites tend to be economically disadvantaged minorities. Nor does this study suggest that cleanup of Superfund sites has made people in these sites relatively better off economically.

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Table 1. Demographic and socio-economic characteristics of Kentucky census tracts that host hazardous waste sites and adjacent census tracts that do not host such sites for 1980 and 1990.

Variables	Host Census Tract 1980[a]	Non-host Census Tract 1980	Host Census Tract 1990[b]	Non-host Census Tract 1990
Population	3,709	3,671	3,897	4,117
# Non-White	276	762	10.13	737
# Poverty	42.62	475	13.09	475
# High School	66.99	2,362	13.03	634
# Manufacture	13.76	1,094	24.95	1,687
Housing Value	16,535	11,985	19,995	14,038
Room 1 to 3	1,560	1,340	1,088	1,096
Room > 4	39	33	297	313
Per Capita Income ($)	6,182	8,214	9563	6,537

a. U.S. Department of Commerce, 1980

b. U.S. Department of Commerce, 1990

Table 2. Differences in mean values of the demographic characteristics for Kentucky census tracts that host hazardous waste sites and adjacent census tracts that do not host such sites for 1980 and 1990 and associated t-statistics expressed as p-values.

Variables	Difference in mean values				
	Host and non-host tracts [a]		1980 and 1990 [b]		Both Sites
	1980	1990	Host	Non-host	Both Years [c]
Population	528 [d]	-165	-690	3	-693
	0.5705 [e]	0.7544	0.4702	0.9958	0.4853
% Non-White	-10.92	-5.87	2.37	-2.68	5.05
	0.0254	0.2671	0.6810	0.5117	0.3831
% Poverty	1.75	-1.79	-29.53	-25.99	-3.54
	0.6454	0.5661	0.0001	0.0001	0.4011
% High School	2.55	-3.15	-53.96	-48.26	-5.70
	0.2184	0.3395	0.0001	0.0001	0.1629
% Manufacture	0.8	2.24	11.19	9.75	1.44
	0.7438	0.4452	0.0030	0.0001	0.6816
Housing Value	-13,961	-3,571	3,460	-6,930	10,390
	0.0010	0.3618	0.4021	0.0717	0.1025
Per Capita Income ($)	-2	-682	3,381	4,061	-680
	0.9976	0.3209	0.0005	0.0001	0.4999

a. For both 1980 and 1990 from Table 1., Difference = Host – Non-host.

b. For both host and non-host sites from Table 1., Difference = 1990 – 1980.

c. Total Difference = 1990 – 1980 or Total Difference = Host – Non-host.

d. Difference in the mean.

e. Probability (P) value for the t-statistic. P-value # 0.05 is statistically significant.

Table 3. Results of two-staged least squares estimation of a three-equation system (Equations 1, 2, and 3) representing the percentage of non-white individuals in a census tract, poverty, and property value.

Parameter estimate	Equation 1 Percent Non-White	Equation 2 Poverty	Equation 3 Home Value
Intercept	-3.51	-0.75***	5.39**
Percent Non-White (nw)		0.04*	-0.25***
Percent Poverty (pov)	0.83**		
Housing Value (val)	-0.43***		
Completed High School (hs)	0.34	1.06***	
Manufacturing Occupation (manu)	0.31*	-0.02	
Population (pop)	0.54**		-2.93***
Per Capita Income (pci)			1.28***
House with 3 bedrooms or less (rle3)			2.14***
House with 3 or more bedrooms (rgt3)			0.74***

* Statistical significance from 10 to 5 percent (90 to 95% Level of Confidence)

** Statistical significance from 5 to 1 percent (95 to 99% Level of Confidence)

*** Statistical significance less than 1 percent (Greater than 99% Level of Confidence)

Table 3. Results of two-staged least squares estimation of a three-equation system (Equations 1, 2, and 3) representing the percentage of non-white individuals in a census tract, poverty, and property value (**Continued**).

Parameter estimate	Equation 1 Percent Non-White	Equation 2 Poverty	Equation 3 Home Value
Site Dummy Variable (site)	-11.37*	0.44	-3.75
Year Dummy Variable (year)	1.58***	0.41***	-1.76***
Interaction between site and nw (site*nw)		-0.004	0.19
Interaction between site and pov (site*pov)	1.64		
Interaction between site and val (site*val)	1.04**		
Interaction between site and hs (site*hs)	-1.91*	-1.91*	
Interaction between site and manu (site*manu)	0.03	0.01	
Interaction between site and pop (site*pop)	0.13		5.98***
Interaction between site and pci (site*pci)			-1.02**
Interaction between site and rle3 (site*rle3)			-4.62**
Interaction between site and rgt3 (site*rgt3)			-0.78***

* Statistical significance from 10 to 5 percent (90 to 95% Level of Confidence)

** Statistical significance from 5 to 1 percent (95 to 99% Level of Confidence)

*** Statistical significance less than 1 percent (Greater than 99% Level of Confidence)