Measuring the Impacts of the Superfund Sites in Jefferson County, Kentucky by using a Spatial Hedonic

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Introduction

- The hazardous waste sites of Love Canal and Valley of the Drums of the 1960's and 1970's were arguably catalysts in the passage of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in 1980.
- CERCLA, also called the Superfund program, is an environmental law imposing cleanup responsibilities for contaminated sites (Salzman and Thompson, 2003).
- Superfund sites can be classified as non-market (i.e., environmental) bads, imposing health risks and other disamenities on nearby residents.
- The Superfund sites are placed on the National Priority List (NPL), created by the EPA, based on the Hazard Ranking System (HRS) score.

Objectives

- Examine the impacts of Superfund sites on home values in Jefferson County (Louisville), Kentucky using a spatial hedonic approach. We hypothesize that there are statistical differences between standard (OLS) and spatial forms of the Hedonic Price Method.
- Evaluate the difference in home value impacts for Superfund sites in two different process statuses: final and deletion.
- Investigate the impact of multiple nearby Superfund sites on home prices.

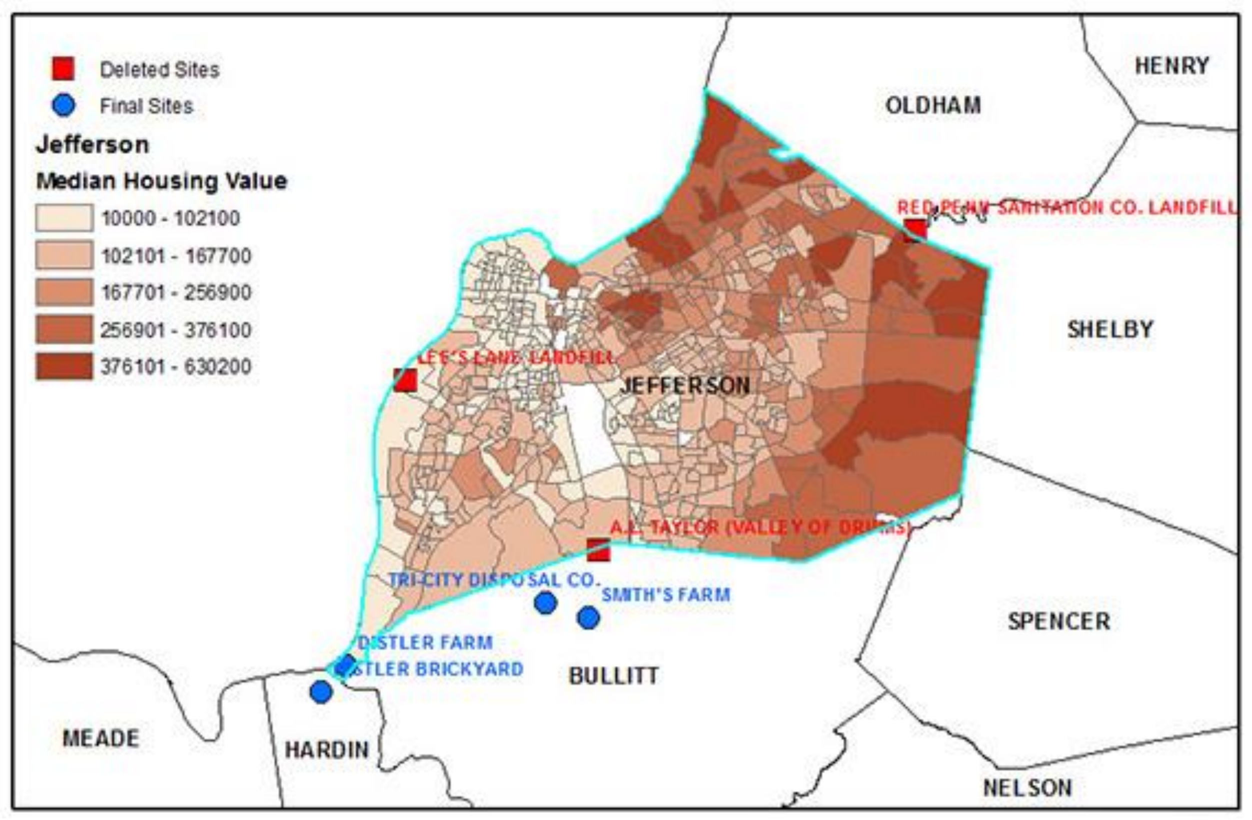

Figure 1: Median value of owner-occupied housing units and locations of Superfund sites in Jefferson County, Kentucky

Data and Methodology

- The main source of data used in this study is the U.S. Census Bureau's American Community Survey (ACS) from 2009 to 2013.
- The sample has 551 block groups in Jefferson County, Kentucky.
- This study begins with a standard hedonic model regressing owner-occupied housing prices on the characteristics of housing structures, the neighborhoods, and the environment.

$$ln(\boldsymbol{P}) = \boldsymbol{N}\beta_1 + \boldsymbol{S}\beta_2 + \boldsymbol{E}\beta_3 + \varepsilon$$

where $\boldsymbol{P}$ is a vector of owner-occupied house prices, $\boldsymbol{N}$ is a matrix of neighborhood characteristics, $\boldsymbol{S}$ is a matrix of house characteristics, $\boldsymbol{E}$ is a matrix of environmental variables (i.e., distance to and count of Superfund sites), and ε is a vector of independently and identically distributed (*iid*) error terms.

- The SAR error model is preferred for correcting the potential biasing influence of spatial autocorrelation, whereas the SAR lag model focuses on the calculation of existing spatial interactions (Anselin, 2001).
- The empirical hedonic spatial error model used here is:

$$ln(\boldsymbol{P}) = \boldsymbol{N}\beta_1 + \boldsymbol{S}\beta_2 + \boldsymbol{E}\beta_3 + \varepsilon$$

$$\varepsilon = \lambda \boldsymbol{W}\varepsilon + u$$

where $\boldsymbol{P}$, $\boldsymbol{N}$, $\boldsymbol{S}$, and $\boldsymbol{E}$ are the same as the standard hedonic model, λ is the spatial autoregressive coefficient, $\boldsymbol{W}$ is the spatial weights matrix, and u is assumed to be a vector of *iid* errors with variance σ^2. The spatial weights matrix is calculated with a contiguity-based approach (i.e., rook contiguity) with row-standardization. The distance to Superfund sites is calculated in two ways: with and without a threshold (5 miles) for Superfund effects. The distance with no threshold is calculated as *distance* = min (site1 distance, site2 distance, site3 distance, …). The distance with a 5-mile threshold is calculated as *AdjDistance* = min (*distance*, 5 miles). The threshold incorporates the assumption that the Superfund effect is limited to houses within close proximity to the sites.

Table 1. Descriptive Statistics for Dependent and Independent Variables (N=551)

Vector	Variable	Description	Mean	Std. Dev.
P	Housing Value	Median housing value for owner-occupied housing units	156679	93618
E	Distance (Deleted)	Nearest distance to the deleted Superfund sites (in miles)	6.84	2.40
	Distance (Final)	Nearest distance to the final Superfund sites (in miles)	12.31	4.05
	Count (Deleted)	Number of deleted Superfund sites within 5 miles from block centroid	0.23	0.42
	Count (Final)	Number of final Superfund sites within 5 miles from block centroid	0.03	0.21
S	Bedrooms	Average number of bedroom in owner-occupied housing units	3.02	0.40
	Complete kitchen	Percentage of complete kitchen facility in owner-occupied housing units	96.04	7.15
	Rooms	Average number of rooms in owner-occupied housing units	6.39	0.83
	Year built	Median year structure built in owner-occupied housing units	1963.27	18.96
	Heating	Percentage of utility gas for heating in owner-occupied housing units	70.29	17.01
	Attached units	Percentage of attached housing units in owner-occupied housing units	10.81	16.70
	Vehicles	Average number of vehicles in owner-occupied housing units	1.84	0.35
N	Median Income	Median household income in the past 12 months (in thousands)	51.60	27.88
	Population Density	Population density in each block group (in m2)	0.002	0.001
	Occupied units	Percentage of owner-occupied housing units	63.99	24.05
	High school	Percentage of regular high school diploma	23.02	10.74
	College	Percentage of associate's degree and bachelor's degree	23.67	12.41
	Unemployment	Percentage of unemployment	11.20	8.69
	Hispanic	Percentage of population who are Hispanic	4.32	7.50
	Black	Percentage of population who are black	22.89	28.73
	Distance to CBD	Distance from each block group centroid to the CBD (in miles)	7.29	3.76

Notes: *P* is the vector of housing prices, *E* is a vector of environmental variables, *S* is a vector of housing structural characteristics, and *N* is a vector neighborhood characteristics.

Results and Discussions

Table 2. Estimates from Standard and Spatial Hedonic Models for Deleted Sites (N=551)

	Hedonic (Deleted)		Spatial Error (Deleted)		Hedonic (Final)		Spatial Error (Final)	
Variable	No Threshold	**Threshold**	No Threshold	**Threshold**	No Threshold	**Threshold**	No Threshold	**Threshold**
Distance to sites	**0.017*** (-0.006)**	-0.002 (-0.023)	**0.036***** (-0.023)	-0.005 (-0.038)	-0.0001 (-0.004)	0.066 (-0.065)	**0.018**** (-0.008)	**0.252***** (-0.091)
Count	–	-0.031 (-0.045)	–	-0.109 (-0.071)	–	0.062 (-0.058)	–	**0.363**** (-0.161)
Median income	0.006*** (-0.001)	0.006*** (-0.001)	0.004*** (-0.001)	0.004*** (-0.001)	0.0057*** (-0.0007)	0.006*** (-0.001)	0.004*** (-0.001)	0.004*** (-0.001)
Bedrooms	-0.190*** (-0.095)	-0.210** (-0.095)	-0.135 (-0.088)	-0.136 (-0.085)	-0.2173** (-0.097)	-0.22** (-0.097)	-0.139 (-0.088)	-0.139 (-0.093)
Occupied units	-0.003*** (-0.001)	-0.003*** (-0.001)	-0.003*** (-0.001)	-0.003*** (-0.001)	-0.0032*** (-0.0010)	-0.003*** (-0.001)	-0.002*** (-0.001)	-0.002*** (-0.001)
Complete kitchen	0.012*** (-0.002)	0.012*** (-0.002)	0.007*** (-0.003)	0.007*** (-0.003)	0.0118*** (-0.0024)	0.012*** (-0.002)	0.007*** (-0.003)	0.006** (-0.003)
Rooms	0.317*** (-0.037)	0.326*** (-0.037)	0.249*** (-0.041)	0.245*** (-0.043)	0.3305*** (-0.0378)	0.332*** (-0.037)	0.246*** (-0.043)	0.243*** (-0.048)
Year Built	0.002* (-0.001)	0.002 (-0.001)	0.004*** (-0.001)	0.004*** (-0.001)	0.0019 (-0.0014)	0.002 (-0.001)	0.004*** (-0.001)	0.004*** (-0.001)
College	0.005*** (-0.002)	0.006*** (-0.002)	0.003** (-0.002)	0.003** (-0.002)	0.006*** (-0.0017)	0.006*** (-0.002)	0.003* (-0.002)	0.003 (-0.002)
Unemployment	-0.008*** (-0.002)	-0.008*** (-0.002)	-0.006*** (-0.002)	-0.006*** (-0.002)	-0.0081*** (-0.0019)	-0.008*** (-0.002)	-0.006*** (-0.002)	-0.005*** (-0.002)
Black	-0.003*** (-0.001)	-0.003*** (-0.001)	-0.002** (-0.001)	-0.002** (-0.001)	-0.0029*** (-0.0006)	-0.003*** (-0.001)	-0.002** (-0.001)	-0.002 (-0.001)
Lambda	–	–	0.585*** (-0.105)	0.642*** (-0.121)	–	–	0.633*** (-0.109)	0.713*** (-0.123)
R-squared	0.803	0.800			0.800	0.800		
Log likelihood			13.104	9.835			10.307	12.282

*****, **, * Significant at p = 0.01, 0.05, and 0.10 respectively**
Parenthesis represents robust standard error

- We find that the standard hedonic pricing model, ignoring spatial dependence or autocorrelation, provides biased results.
- In both standard and spatial error models, the variables of median income, rooms, complete kitchen, and college have positive impacts on median housing prices, whereas the variables of occupied units and unemployment have negative impacts, across all four specifications.
- Estimates based on the no-threshold spatial model indicate that median housing values are decreased by proximity to both final and deleted Superfund sites. We also find significant impacts from final sites in the threshold spatial model, although we find no significant impacts from deleted sites.
- Curiously, in the spatial threshold model, housing values increase as additional final sites are located within five miles of the housing unit.

Conclusions

- We find that the standard hedonic pricing model, ignoring spatial dependence or autocorrelation, provides biased results.
- Findings in this study further contribute to existing literature suggesting that spatial dependence should be considered in hedonic models for measuring the impact of proximity to Superfund sites on local property values.
- One possible extension is to follow other recent hedonic price analyses in taking advantage of panel or pooled cross-sectional data for considering quasi-experimental research designs.
- Further study could also involve comparisons of the spatial error model with a quasi-experimental design and pooled cross-sectional data.