The Impact of Hazardous Waste Sites on Housing Prices: A county Level Study

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Abstract

The effects of hazardous waste on health have long been a topic of study in both the health and economics fields. A number of studies have also looked at the effect of hazardous waste sites on housing values. These studies utilize individual housing units, in specific geographic areas for their analysis. This study studies the effect of hazardous waste sites on the median housing values using a county level approach. It is shown that the location of hazardous waste site in a county affects the median value of residential houses in the county, and that the number of sites in a county is more important than the mere location.

Keywords: Hazardous, waste sites, housing values, hedonic, population.

Introduction

Housing and the determinants of housing value have long been of interest to public policy makers. The importance of housing to the American economy cannot be overemphasized. House ownership is considered one of the great American dreams, hence a sign of family economic success. In addition to this, housing starts and purchases have been used to measure how well the economy is performing; hence the popular tax incentives for home ownership.

From the point of view of households, housing is considered an important "investment." In many cases, the decision to buy a house, or to locate somewhere, is simultaneously, a decision to buy the attributes of the neighborhood in which the house is located. For instance, when a household buys a house, it acquires the cost of travel to important facilities such as schools, and hospitals. It also acquires the crime rate, noise level, and beauty of the neighborhood.

Obviously, neighborhood attributes can be desirable or undesirable. If households consider the attribute desirable, it increases the value of houses in the neighborhood. If, on the other hand, the attribute is considered undesirable, it imposes a negative effect on the price of the house. For instance, a household may be willing to pay a higher price for house with view to the ocean, than for a similar house without such a view. Similarly, a household may be unwilling to pay the same price for a house located in a high-crime neighborhood as for an identical house located in a low-crime neighborhood.

Economic researchers have focused on the effects of housing attributes, including lot size, number of rooms, type of walls, distance to schools, recreation, and the central business district, among other factors, on the prices of single family detached homes. Most of the emphasis is on structural attributes, however, many recent articles have studied neighborhood attributes.

Li and Brown (1980) studied the effects of neighborhood attributes on the sale prices of single-family houses in Boston. They focused on proximity to the ocean, rivers, and expressway interchanges, and found these to be highly significant. Nelson, Genereux, and Genereux (1992), Michaels and Smith (1990), and Kohlhase (1991) studied the effect of landfills and waste sites on housing values. Harrison and Rubenfeld (1978) studied the impact of clean air on the value of houses. Other studies have looked at the effects of Metrorail location (Gatzlaff and Smith, 1993), Natural hazards (Murdoch, Singh, and Thayer, 1993), and historic site designation (Ford, 1989). Studying the effects of environmental contamination on condominium prices, Case, Colwell, Leishman, and Watkins (2006) show that condos located in contaminated areas usually sell at a discount, but that this effect does not appear until long after the contamination becomes public.

This indicates that knowledge about the contamination is more significant than the mere location of the site in the community. Many of the studies include variables for the central business district, and school quality or accessibility in their analysis.There is no consensus on the effects of some neighborhood attributes. Nelson, Genereux, and Genereux (1992) imply that some environmental attributes may impose negative or positive effects depending on the level of development of their location. For instance, a landfill located in a remote area may spurn economic development and provision of essential facilities to the area, hence increasing the value of houses. It may, on the other hand, create a health hazard impression reducing the utility from locating in those areas, hence pushing down the value of housing. Keil (1995) shows that house prices are affected, and that they may not rebound even with assurances that the sites will be cleaned in the future. Alberini (2007) studied the effects of participation in state voluntary cleanup programs on housing values. They found that participation increases property values, and depends on the size of the site, and its location relative to residential properties.

While numerous studies have been undertaken to understand the effects of these environmental attributes on the value of houses, the emphasis so far has been on individual housing units. Sale prices or appraised values are generally used as the dependent variable. The impacts of neighborhood on median housing values in a district have not been adequately studied. This paper seeks to fill the void by studying the effects of hazardous waste on median housing values in a district. A county-level data is used.

Despite the possibility that the impact of neighborhood attributes on housing value may not be similar for purchasers of single-family homes, and renters of multi-family apartments, the results of studies based on single-family houses are applied to multi-family rental apartments.

A couple of reasons cause us to believe that these two groups react differently to neighborhood attributes. Firstly, buying a house involves a large initial outlay of cash in the form of down payments, legal, and appraisal fees. And even after this, commits the purchaser to a long period of subsequent payments, extending in some cases to thirty years. Secondly, purchasing a house implies some degree of immobility for the household in the short-run. A purchaser of a house is less likely to move out of the neighborhood if a negative externality is introduced soon after the purchase, than an apartment renter would be. For these reasons, the purchaser would be expected to be more concerned about neighborhood attributes than the apartment renter.

The Problem

The problems associated with improperly disposed hazardous waste have long been known, however, the incidents at James River (Valley of the Drums) in Kentucky and the Love Canal in New York in 1978 brought to public attention the severity of this problem. Public outcry that followed the Love Canal incident led to the passage of various environmental legislations, including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (Lester and Bowman, 1983). This Act, popularly known as "Superfund" provided for $1.6 billion dollars to aid EPA in identifying and removing hazardous waste from active and inactive sites which may pose a threat to human health or the environment (Greenberg and Anderson, 1984). The fund was to be by taxing certain oil, petroleum, and chemical products. In 1986, the Superfund Amendment and Reauthorization Act (SARA) extended this mandate and added an additional $8.5 billion to complete the job. The EPA was given the responsibility to identify the hazardous waste sites, rank them, and develop a National Priority List with a minimum of 400 sites for prompt cleanup (National Research Council, 1994).

Both the number of sites and the cost of cleanup were grossly underestimated, and by 1990, EPA estimated that the cost would be $27 billion. Other estimates put it at between $100 billion and $500 billion. The enormous increase in the estimated amount required to cleanup the steadily increasing hazardous waste sites, coupled with the difficulty of identifying the responsible persons, especially for the inactive sites have forced some individuals to question the emphasis on private-sector responsibility for cleanup. They argue that cleaning up hazardous waste benefits the whole community either through better quality of life. Nowhere is the impact of cleaning up an environment more pronounced than in the value of housing. This paper studies the effect of identification of hazardous waste site by EPA on housing values. It is important to point out that the effect would depend on how the community views this identification. For instance, if it is viewed as positive because it has been placed on the priority list for immediate cleanup, then it may have a positive effect on housing values. If, however, knowledge about the sites lead to fears about human health, thereby causing people to want to move away from that community, then it could have a negative effect on housing value.

Theoretical Basis

This paper applies the hedonic price method in determining the impact of hazardous waste on housing value. Since it was popularized by Rosen (1974), this method has been used extensively to study the effects of housing attributes on housing value, and in some cases, to estimate the demand for the various attributes themselves. Bloomquist (1982), Jeffrey P. Cohen (2007), Hamilton and Schwann (1995), Irwin (2002), and Chattopadhyay, Braden, and Patunru (2005) are a few such studies.

A household is assumed to maximize the utility function of the form:

$$U = U(Z, X, h) \qquad 1$$

subject to the budget constraint:

$$Y - P_1X - P_2(Z, h) = 0 \qquad 2$$

where Z is a vector of structural and neighborhood attributes, X is a composite of other non-housing commodities consumed by the household, and h is hazardous waste. $U_z > 0$ for desirable structural attributes, and $U_z < 0$ for undesirable structural and neighborhood attributes. Similarly, $U_h > 0$ if hazardous waste site is desirable, and $U_n < 0$ if it is undesirable.

The hedonic model further assumes that a relationship exists between the attributes of a house and value of the house. This relationship can be expressed as:

$$V = V(Z_i, h) \qquad (i=1,2,3,\ldots,n) \qquad 3$$

Properly specifying and partially differentiating equation (3) with respect to any of the attributes assuming that others constant should give the implicit price of the attribute. Hence,
$\partial V/\partial Z_i = P_{zi}$ and $\partial V/\partial h = P_h$, where P_{zi} is the implicit price of structural or neighborhood attribute i, and P_h is the implicit price of hazardous waste site in the county. P_{zi} and $P_h > 0$ for desirable attributes but < 0 for undesirable attributes.

Data Description

Data for this study are for the southern region of the United States. They were derived from various sources, however, most of the data are from the Bureau of the Census, Population Census publications of 2000. Data on hazardous waste sites on the proposed National Priority List for superfund cleanup activities from the Environmental Protection Agency's web site. Table 1 shows the distribution of hazardous waste sites on the NPL by states in the Southern United States in 2000.

The dependent variables are the median housing value, and the median gross rent. A county-level data is used. The independent variables include variables that describe the structure of the houses, the location of the houses, and the households at the location of the houses. Also included are variable for hazardous waste sites. The variables are defined in Table 2.

Empirical Model

The choice of functional form in the study of housing markets has presented some difficulty for economists for quite some time. The problem is that a choice of an inappropriate function could affect the result of the study. Many researchers have used the linear, semi-log, or log-linear models to estimate statistical relationships. This is due more to convenience than any statistical reasoning.

This study uses the Box-Cox (1962) transformation to estimate the impact of structural and neighborhood attributes on multi-family apartment rental rates. This functional form has been heavily used in the housing literature to estimate housing demand. For example, Bloomquist (1982), Megbolugbe (1986), and Akpom (1996) Gayer, Hamilton, and Viscusi, (2000). The Box-Cox transformation used is of the form:

$$V_i(\lambda) = \alpha + \sum\beta_{ij}Z_{ij}(\mu) + \sum\delta_i h_i(\phi) + \varepsilon_i$$

where V_i is the median value (or rent) of housing in county i, Z_i is a vector of structural and neighborhood attributes of houses in county i, and h_i is hazardous waste site in county i. α is the constant. β, and δ are the estimated weights associated with housing attributes, and hazardous waste sites. $V_i(\lambda)$, $Z_i(\mu)$, and $h_i(\phi)$ are the Box-Cox transformations:

$$
\begin{aligned}
V_i(\lambda) &= (V_i^{\lambda} - 1)/\lambda, && \lambda \neq 0 \\
&= \ln V_i && \lambda = 0 \\
Z_i(\mu) &= (Z_i^{\mu} - 1)/\mu, && \mu \neq 0 \\
&= \ln Z_i && \mu = 0 \\
h_i(\phi) &= (h_i^{\phi} - 1)/\phi, && \phi \neq 0 \\
&= \ln h_i && \phi = 0
\end{aligned}
$$

ε_i is the error term which is assumed to be normally distributed with mean zero and constant variance, s^2. This functional form yields various commonly used functional forms as special cases. Due to the difficulty of conducting a complete search for the best functional form on the basis of the maximum likelihood function, a choice was made between the linear, log-linear, and semi-log forms. The linear form was selected on the basis of the maximum likelihood estimate.

Results and Analysis

Our empirical results are presented in Table 3 and Table 4. Table 3 contains the results of the regression using a dummy variable defined as 1 if a hazardous waste site is located in the county, and 0 if not. Table three contains the result of the regression that uses the number of sites in the county. Two regressions are estimated in each case - one for rented houses and another for owner-occupied houses. This will enable us compare the results for the two groups.

The R-squares for all the regressions range from about 0.70 to about 0.74. Most housing characteristics are statistically significant with signs that are consistent with other hedonic studies. AGE, ROOMS, SEWER, MEDINC, POP and SATL are statistically significant, and are positively related to mean housing value. BLACK is negatively related to mean housing value in all the regressions.

Some of the variables show differences in the two housing markets. NOPLUMB, WATER, and WSC are significant in the renters market but not in the owners market. NOPLUMB is negatively related to rent, while WATER and WSC are positively related to rent. NOKITCH on the other hand is negatively significant in the owner's market but not in the renter's market.

The impact of hazardous waste is measured using location of superfund sites in the county. Two measures were used. One, SITE measures the presence of a site in the county, the other, NUMSITE, measures the number of sites in the county. SITE has negative sign in both the renters' and owner's markets, but is not significant in either market. This implies that the mere presence of a hazardous waste site within a county does not significantly impact the value of housing. The measure of the number of sites located within the county, NUMSITE, is negatively significant in both the renters' and owners' markets. For example, an increase in the number of hazardous waste sites in a county reduces mean rent by about $7, and reduces mean value of owner-occupied houses by about $2,445. The impact of hazardous waste is, however, weaker in the renter's market (10 percent level of significance) than in the owner's market (5 percent level of significance). This may be due to the fact that renters do not feel the type of attachment that owners feel to the area. While renters' tenures may be temporary, owners' tenures tend to be permanent.

Conclusion

This paper explores the effect of location of hazardous waste site within a county on the value of both rental and owner-occupied property in the county. The article uses the hedonic property model in estimating the effects of superfund site on housing values at the county level. It is shown that announcement of a site on the NPL reduces housing values. This appears to relate to the fact that the announcement provides additional information to residents of the county who generally view this as a negative externality.

It is shown that though the location of hazardous waste site in a county reduces the median residential property values, the mere location of the site in a county is not as important as the number of sites in the county.

Table 1: Number of hazardous waste sites on the Environmental Protection Agency's National Priority List (NPL) - 2000.

STATE	NO OF COUNTIES	NO OF HAZARDOUS WASTE SITES
ALABAMA	67	13
ARKANSAS	75	10
DELAWARE	14	3
FLORIDA	42	67
GEORGIA	159	15
KENTUCKY	120	14
LOUISIANA	79	11
MARYLAND	23	16
NORTH CAROLINA	100	25
OHIO	88	28
OKLAHOMA	77	10
SOUTH CAROLINA	46	24
TENNESSEE	96	12
TEXAS	254	32
VIRGINIA	95	29
WEST VIRGINIA	55	8

Table 2: Definition of variables

Variable	Definition
RENT	Median gross rent on all renter-occupied housing units.
VALUE	Median value of all owner-occupied housing units.
AGE	Percentage of all units built between 1980 and March, 1990.
ROOMS	Percentage of housing units with four or more bedrooms.
NOPLUMB	Percentage of housing units lacking complete plumbing facilities.
WATER	Percentage of housing units with public water system or private company.
SEWER	Percentage of units with public sewer.
NOKITCH	Percentage of housing units lacking complete kitchen facilities.
MEDINC	Median income in the county.
POP	Population of the county.
BLACK	Percentage of population that is black.
WSC	West-South Central region including AR, LA, OK, and TX
SATL	South Atlantic region including DE, FL, GA, MD, NC, SC, VA, and WV.
SITE	1 if a hazardous waste site is located in the county.
NUMSITE	Number of hazardous waste sites located in the county.

Table 3: Summary statistics

Variable	Min	Max	Mean	Std. Dev.
RENT	240.0	1534	404.4	84.6
VALUE	3303.0	231000	49108.1	20207.3
AGE	4.2	63.3	25.4	8.4
ROOMS	3.2	38.8	11.3	4.2
NOPLUMB	***0.0***	***19.0***	***3.0***	***2.7***
WATER	2.3	99.9	68.1	22.6
SEWER	0.0	99.6	44.7	22.3
NOKITCH	0.0	15.3	2.4	1.9
MEDINC	3746.5	81050	30235	7967.9
POP	67.0	3460589	75891.4	152586.6
BLACK	0.0	86.2	17.1	18.3
WSC	0.0	1.0	0.3394	0.4737
SATL	0.0	1.0	0.3974	0.4895
SITE	0.0	1.0	0.0412	0.1988
NUMSITE	0.0000	7.0000	0.0621	0.3752

Table 3: Regression result using presence of hazardous waste site.

Variable	RENT	VALUE
AGE	3.4272***	732.863***
	(21.2376)	(18.6014)
ROOMS	5.0127***	1453.229***
	(13.5566)	(16.0981)
NOPLUMB	-4.4166***	-243.356
	(4.2314)	(0.9550)
WATER	0.1992**	14.235
	(2.3320)	(0.6826)
SEWER	0.8867***	115.029***
	(9.7480)	(5.2862)
NOKITCH	0.5661	-600.613*
	(0.4460)	(1.9381)
MEDINC	2.4649***	613.202***
	(12.6551)	(12.8951)
POP	0.0651***	14.507***
	(7.1783)	(6.5556)
BLACK	-0.6972***	-78.627***
	(9.5552)	(4.4139)
WSC	18.9987***	-572.628
	(5.3940)	(0.6659)
SATL	44.4014* **	8217.948***
	(11.7385)	(8.8989)
SITE	-1.7755	-977.429
	(0.2729)	(0.6153)
Adj. R-Square	0.7370	0.6987
F-value	302.6974	250.6148
Number	1293	1293

***Significant at the .01 level, **Significant at the .05 level, *Significant at the .10 level

Table 4: Regression result using number of Super Fund sites

Variable	RENT	VALUE
AGE	3.4090***	727.26***
	(21.1231)	(18.4743)
ROOMS	5.0055***	1450.12***
	(13.5591)	(16.1041)
NOPLUMB	-4.4466***	-253.70
	(4.2642)	(0.9974)
WATER	0.1990**	14.18
	(2.3326)	(0.6815)
SEWER	0.8753***	111.28***
	(9.8031)	(5.1093)
NOKITCH	0.5785	-594.68*
	(0.4563)	(1.9233
MEDINC	2.4548***	609.79***
	(12.6106)	(12.8426)
POP	0.0739***	17.32***
	(7.1572)	(6.8829)
BLACK	-0.6996***	-79.34***
	(9.5989)	(4.4627)
WSC	18.9645***	-579.99
	(5.3910)	(0.6759)
SATL	44.4431***	8236.57***
	(11.7646)	(8.9386)
NUMSITE	-7.2246*	-2445.28**
	(1.6876)	(2.3418)
R-Square	0.7376	0.6999
F-value	303.5818	252.0394
Number	1293	1293

***Significant at the .01 level, **Significant at the .05 level, *Significant at the .10 level

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