Economic Impact of Environmental Health Risks on House Values in Southeast Region: a County-Level Analysis

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Abstract

A simultaneous model of house values, cancer mortality and total releases is simultaneously estimated to study effects of environmental health risks. Health risks include county level total releases, number of Superfund sites and cancer mortality in the Southeastern U.S. Benefits of superfund cleanup and reduced releases are also estimated.

Introduction

Environmental health risks have attracted much attention from the public in recent decades. Environmental risks arise from air, water and land pollution that come from automobiles, agricultural activities or from undesirable facilities such as hazardous waste sites and industries in the area or even in the region. In this paper, we attempt to measure the economic impact of environmental health risks originating from point sources such as waste sites and industrial facilities.

Concerns about environmental health risks may be reflected in lowered property values, which have a negative impact on individual economic welfare. The idea is that people are willing to pay more to reduce environmental risks. However, the compensating differentials are not directly observed in the marketed goods. One method that has been developed to estimate the risk-money tradeoff is the hedonic price model (HPM) using housing market data (Rosen, 1974). The model assumes that housing is consists of a bundle of characteristics. Hedonic prices are defined as the implicit price of characteristics and can be estimated from observed house prices and specific quantities of characteristics embodied in the houses. The effect of environmental risks on property values can be measured by regressing house values on its characteristics including environmental health risks.

The purpose of this paper is to estimate the effect of environmental health risks on property values in the Southeastern United States. We include environmental disamenities such as Superfund sites and toxic chemical releases, as proxies for environmental health risks. We also include cancer mortality as a factor that can impact house values; however, cancer mortality may also be a function of demographic characteristics and environmental disamenities. Furthermore, toxic chemical releases may be explained by county characteristics; we hypothesize that firms that pollute may be located in areas where poor or minorities live. Thus, we employ a simultaneous Full Information Maximum Likelihood modeling approach to jointly estimate housing prices, cancer mortality, and total chemical releases using county level dataset from the southeast United States to perform the analysis.

Literature review

There has been an intensive literature that uses HPM to investigate the effect of environmental goods represented by distance from toxic sites on property values.

Michaels et al (1990) used the hedonic model to investigate the impact of hazardous waste sites on house prices in suburban Boston and found that property values increased with distance from the house to the nearest hazardous waste site. Kohlhase (1991) studied the impact of toxic sites in Houston on property values before and after the sites were listed in Superfund National Priorities List (NPL) and reported that toxic sites had significant impact on house prices after being listed as NPL sites, and distance from the house to nearest site had positive relationship up to 6.2 miles. Nelson et al. (1992) examined the effect of landfills in Minnesota on house sales. They concluded that landfills had a negative impact on house values for homes within two miles and value of a house located on the landfill boundary could decrease by more than 12 per cent. Kiel and McClain (1995) used data for sales in Massachusetts to examine the impact of an incinerator on sale prices and found that the impact of the incinerator was significant during the construction and ongoing operation stages. Hite et al. (2001) studied the impact of the presence of four landfills in Ohio on the property values of houses nearby. The authors found that property values are negatively impacted by the proximity of both open and closed landfills.

A number of studies have focused on the effect of environmental health risk beliefs on property values. McClelland et al (1990) estimated the effect of health risk beliefs on property values in Los Angeles area. They found that health risk beliefs had a substantial negative correlation with property values and risk beliefs decrease when moving from hazardous waste sites. Gayer et al. (2000) examined the effect of cancer risk from Superfund sites on house prices before and after the EPA released its assessment of site risks. They found that residents' willingness to pay to reduce risks decreased after the assessment was released. McCluskey et al (2001) studied the impact of perceived risks on property value, where perceived risk was assumed to be a function of lagged perceived risk and media coverage of the hazardous waste sites in Dallas County, Texas. The authors found that perceived risk had a negative relationship with house prices and media coverage increased perceived risk.

Environmental health risks

Sources of air, water, and land pollution are categorized into two groups: point and nonpoint. Point sources consist of stationary facilities or processes that generate a significant amount of air pollution from their activities. Point sources include major industrial facilities like chemical plants, power plants, steel mills, oil refineries, and hazardous waste incinerators. A nonpoint source is essentially any source of pollutant that is not a point source. Nonpoint sources include emissions from automobiles or runoff from land-disturbing activities like agriculture, forestry, mining, and urban development. The focus of this paper is environmental risks imposed by point sources.

To help the public assess the environmental risks associated with exposure to toxic chemicals in their areas, government has provided information by launching a program called Toxics Release Inventory (TRI). TRI is managed by the U.S. Environmental Protection Agency (EPA) contains yearly information on toxic chemical releases and other waste management from industrial facilities. TRI was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. Under EPCRA, major industrial facilities in the

U.S. are required to report annually their environmental releases of approximately 650 toxic chemicals to EPA.

To deal with hazardous waste, the government has set up the Superfund program managed by EPA to clean up any uncontrolled hazardous waste sites posing a current or future threat to human health and the environment. Any land that has been contaminated by hazardous waste is a candidate for cleanup as a Superfund site. The most hazardous sites are listed in National Priorities List.

Environmental exposure to toxic substances from hazardous waste sites or toxic chemical releases from industries poses health risk to people. Human health effects may be cancer or noncancer-related, such as reproductive dysfunction or birth defects, and respiratory and immune system damage. Cancer is defined as a disease of heritable, somatic mutations affecting cell growth and differentiation, characterized by an abnormal, uncontrolled growth of cells (EPA). Cancer has been linked to exposure to toxic substances since there are chemicals called carcinogens are capable of inducing cancer.

In addition to these direct indicators, cancer mortality and cancer incidence are other indirect indicators of health risks. People can measure health risks by examining cancer statistics in their areas since cancer mortality is observable and information is readily available.

Theoretical framework

We use the hedonic price model to investigate county cross-sectional relationships between house values and environmental health risks. House value in each county reflects the value people place on a bundle of characteristics associated with housing unit. The hedonic housing price is a function of house characteristics, neighborhood characteristics, school characteristics, county characteristics, and environmental characteristics as follows

$$P = f(H, N, C, E)$$

where P is house price, H is a vector of the house characteristics, N is a vector of the neighborhood characteristics, C is a vector of the county characteristics, E is a vector of the environmental disamenities and environmental risks.

We hypothesis that there are endogenities in housing values, cancer mortality and chemical releases. We expect house values to be negatively affected by chemical releases and cancer risks, and positively related to desirable characteristics. There is a possibility that releases are endogenous because toxic sites could be located in areas where poor people live.

Empirical model

People exposed to local environmental risks arising from Superfund sites and toxic chemical releases from the industrial facilities suffer potential health impacts. We use several variables to measure environmental health risks. Total releases including air release, water release, and land release to represent health effects imposed on people. The health effects may be cancer or noncancer.

Individuals may be exposed to environmental health risks arising from hazardous waste sites. Another variable to represent health risks is number of Superfund sites on National Priority List within a county.

If individuals assess the environmental health risk by a statistically actual number, cancer mortality or cancer incidence could be potential candidates for environmental health risk proxies. Housing values may therefore reflect the valuation of people on the level of health effects of hazardous substances, allowing us to include cancer cases as an explanatory in the hedonic housing equation. County level cancer mortality data is the only publically available data, which we use in the analysis.

A number of previous studies has used house sale price as dependent variable in hedonic price model (Gayer, et al., 2000, Kiel and Zabel, 2001, Kohlhase, 1991, McCluskey and Rausser, 2001, Nelson, et al., 1992). This paper uses median value of owner-occupied units for each county as the dependent variable since house sale prices are not available in census data that we use. Median value of units has been used by some authors to estimate the impact of environmental goods on housing (Nelson, 1978, Schulze and King, 2001, Zabel and Kiel, 2000). An advantage of owners' valuation of their house is that it provides values for houses whether or not they sell; therefore it eliminates the likelihood of sample selection bias (Kiel and Zabel, 1997). Kiel and Zabel (1997) tested the accuracy of owner-estimated values and concluded that hedonic equations based on owners' valuation would provide unbiased estimates of the changes in house prices.

The semi-log specification of the hedonic price model with an additive error is used in this paper. House value is a function of environmental health risks including total release and number of Superfund sites, cancer mortality, and other explanatory variables. Environmental risks and other variables are also explanatory variables for cancer mortality. Another equation in the system is total toxic release as a function of county characteristics. The system is solved simultaneously by using Full Information Maximum Likelihood (FIML).

The system of equations estimated is written as

$$V = \exp(\alpha_P + \sum_i \beta_i DS_i + \gamma_P DU + \sum_k \delta_k H_k + \Sigma_j \sigma_j DE_j + \sum_m \zeta_m C_m + \pi CM + \eta_P TR + \mu_P NPL + \theta HR) + \varepsilon_P \quad (1)$$

$$CM = \exp(\alpha_{CM} + \sum_i \psi_i DS_i + \gamma_{CM} DU + \Sigma_j \varsigma_j DE_j + \sum_m \xi_m C_m + \eta_{CM} TR + \mu_{CM} NLP) + \varepsilon_{CM} \quad (2)$$

$$TR = \exp(\alpha_{TR} + \sum_i \rho_i DS_i + \gamma_{TR} DU + \sum_m \tau_m C_m + \mu_{TR} NLP) + \varepsilon_{TR} \quad (3)$$

where V is a county's median owner-occupied housing unit; DU and DS are dummy variables for urban county and state, to control for fixed effects; H is a vector of house characteristics including number of rooms, building year; DE represents demographic, labor market and economic characteristics of a county including age distribution, percentage of college graduates, percentage employed in manufacturing, construction, and mining, percent of African American, median age; C is county characteristics including median income, poverty rate, density, crime rate, and unemployment rate; TR is total release, which is the sum of air release, water release, and land release / person up to year 2000; HR is a dummy for county with high chemical release; NPL is the number of Superfund hazardous waste sites on final National Priorities List /1000 sq mile within a county; CM is cancer mortality at county level in year 2000; ε is error term. To help control for spatial correlation, we include the geographic coordinates of each county's centroid, as recommended by Case (1991) and others.

Based on the assumption that people are provided with adequate information, it is expected that differences in level of environmental risks across counties will be captured in house value differentials.

Data

The data for this paper are at county level and combined from several sources. House values and housing characteristics come from U. S. Census Bureau 2000. County and demographic characteristics are taken from U.S. Census Bureau 2000, and Bureau of Economic Analysis. Crime rate is derived from Federal Bureau of Investigation Uniform Crime Statistics. The number of Superfund sites on Final National Priorities List is obtained from the CERCLIS database, Superfund Information System, EPA. Cancer mortality comes from National Center for Health Statistics.

Air releases, water releases, and land releases are derived from TRI database, the Right-to-Know network (www.rtk.net). These are total releases of all chemicals reported to EPA by major industrial facilities in the county into the air, water, and land. Air releases include stack emissions, which occur through confined air streams, such as stacks, vents, ducts or pipes, and fugitive emissions such as equipment leak, evaporative losses from surface impoundments and spills, and releases from building ventilation systems (TRI). Water releases include surface water discharges to streams, rivers, lakes, oceans and other bodies of water and underground injection, which is the subsurface emplacement of fluids through wells. Land releases include all the chemicals disposed on land within the boundaries of the reporting facility.

The total releases from TRI cover about 650 substances accounting for less than 1% of the over 75,000 chemicals manufactured in the U.S. according to EPA's Toxic Substances Control Act Inventory (SCORECARD). TRI also does not address all sources of releases and other waste management activities of TRI chemicals. The TRI releases contains annual data covering years 1987 to 2002. Year 1987 is the first year the TRI program began to operate.

The data set includes 755 counties of 9 States in the Southeast region including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. Since cancer mortality is missing for Issaquena County, Mississippi, the final data set consists of a sample of 754 observations.

Table 1 presents variable definitions and descriptive statistics for all variables in the model. The mean value of owner-occupied housing unit was $70,684. The main explanatory variables are environmental health risks, namely total release (TOTREL), number of Superfund sites (NPL), counties with high chemical release (HIGHREL), and cancer mortality (CANCER). The mean value of TOTREL was 4,500 pounds of chemical per person and of NPL was 0.16 per thousand of square mile. The mean cancer mortality was 218 per hundred thousand persons. Each of the four environmental health risk variables is expected to have negative impacts on house values. This means that as environmental health risks increase, there will be a reduction in property values.

The environmental disamenities represented by TOTREL and NPL are expected to have positive effects on cancer mortality. That is, higher total releases and more Superfund sites increase the possibility and amounts of carcinogens released, which induces cancer.

Total releases are assumed to be positively affected by the number of NPL sites. Another assumption is that total releases have a negative relationship with household income (INCOME) and a positive relationship with poverty rate (POVERTY). This means that total release increases in poor areas.

Table 1. Variable definitions and descriptive statistics (N=754)

Variables	Definitions	Mean	Standard Deviation
VALUE	Median value of owner-occupied housing units ($000)	70.6842	23.7657
DLA	Dummy for Louisiana State	0.0848	0.2788
DAR	Dummy for Arkansas Sate	0.0994	0.2994
DU	Dummy for urban and rural counties (DU=1 for urban, DU=0 for rural)	0.3156	0.4650
X_COORD	X coordinate of the center of county	85.6280	4.4445
Y_COORD	Y coordinate of the center of county	33.3647	2.2629
ROOM	Median rooms of owner-occupied housing units	5.7134	0.3012
YEAR	Median year built of owner-occupied housing units	1978	4.7398
COLENL	Percent of college or graduate school enrollment	22.0533	12.4343
UNEMP	Percent of unemployment (16 years and over)	3.6276	1.1750
CRIME	Crime rate (crimes per 1,000 population)	32.9936	21.4941
POVERTY	Percent below poverty level	17.4947	6.4180
INCOME	Median household income in 1999 ($000)	37.4429	8.5096
AGE	Median age	36.3794	3.5640
MALE	Percent of male	49.1384	2.1657
BLACK	Percent of African America	24.0540	19.2554
CANCER	Cancer deaths/100,000 population in 2000	218.3224	26.6914
AGE40_59	Percent of population aging from 40 to 59	26.1745	2.0433
CONSTR	Percent of people with construction, extraction and maintenance occupations	12.5538	2.7009
AGREMP	Percent of people with agricultural, forestry, fishing and hunting, and mining occupations	4.4275	3.8541
PROTRAN	Percent of people with production and transportation occupations	22.3466	7.2724
TOTREL	Total release (100 thousand pounds/person)	0.0045	0.0173
NPL	Number of Superfund sites/1000 sq mile	0.1552	0.6367
HIGHREL	Dummy for counties with TOTREL > 0.05	0.0119	0.1087

Empirical results

Table 2 presents the house value, cancer mortality, and total release regression results for the FIML equations. The results are corrected for heteroscedasticity. All environmental health risk variables of interest are of expected signs, except for NPL. The TOTREL and CANCER coefficients are statistically significant at 1% level, that of HIGHREL is significant at 5% level while that of NPL is not statistically significant. Increases in total releases and cancer the death rate would result in lowered property values. An increase of 1 pound of total releases per person would reduce house value by $3.15 and increase cancer mortality by 1 death over 1 thousand persons lowers the value of housing unit by $238.80. If the county is listed as high release (total release by person is 50,000 pounds), house value would decrease by $16,660. The latitude (Y_COORD) and longitude (X_COORD) variables are statistically significant at 1% level. A positive coefficient of latitude is interpreted to mean that house values rise when moving to the North and a negative coefficient of longitude indicates that property value increases when moving to the East. Other variables significantly increasing house values include year built, household income, college or graduate school enrollment, crime rate, percent of male, median age, and Louisiana State. The value of property falls with the number of rooms and percent of agricultural and forestry occupations.

In the cancer mortality equation, TOTREL and NPL have the expected positive signs. The coefficient for TOTREL is statistically significant at 1% level but that of NPL is not significant. An increase in total releases of 1 pound would increase the cancer death rate by 0.0044 per one hundred thousand persons. Cancer mortality also rises with percentage of male, Africa American, age from 40 to 59 and crime rate and decreases with income, median age, and college and graduate school enrollment.

Total releases increase significantly when moving to the East and in the state of Arkansas. Interestingly, household income has a positive effect on total release. This may be explained if industrial facilities emitting chemical substances pay their employees well. Total releases also rise with the percentage of workers employed in the production and transportation sectors.

Value of statistical life

An important implication of model is to calculate value of statistical life based on the correlation between house values and cancer mortality. The assumption here is that there is a tradeoff between risk and dollars in property values. The negative coefficient of CANCER in table 2 means that people are willing to pay a higher price for houses located in areas with lower cancer mortality rates. The marginal willingness to pay for decreased cancer risk is calculated from the CANCER variable coefficient in table 2.

$$\text{Willingness to pay}_i = \frac{\partial\, \text{VALUE}_i}{\partial\, \text{CANCER}_i} = \pi\text{hat}*\text{VALUEhat}_i$$

where i indicates county.

Table 2. Nonlinear Full Information Maximum Likelihood Estimates

Variable	House value equation		Cancer mortality equation		Total release equation	
	Parameter estimate	Standard Error	Parameter estimate	Standard Error	Parameter estimate	Standard Error
int	1.313610	2.257200	4.733804***	0.200800	-5.48771	3.708400
DLA	0.120516***	0.025800	0.041665**	0.020400	-	-
DAR	-	-	-	-	1.386643***	0.401500
X_coord	-0.004310***	0.001510	0.001412	0.001340	-	-
Y_coord	0.015022***	0.002520	0.000351	0.002560	-0.142690*	0.082100
du	-0.014290	0.012500	-	-	-	-
rooms	-0.102170***	0.018400	-	-	-	-
year	0.004415***	0.001110	-	-	-	-
inch	0.000026***	0.000001	-0.000004***	0.000001	0.000068*	0.000039
collenl	0.002294***	0.000384	-0.000680*	0.000400	-	-
crime	0.001730***	0.000345	0.000946***	0.000217	-	-
male	0.013717***	0.003030	0.012619***	0.001110	-	-
cancer	-0.003380***	0.000431	-	-	-	-
totrel	-4.456290***	1.343700	1.995577***	0.694500	-	-
NPL	0.005755	0.009090	0.001226	0.010200	0.220169	0.158200
agremp	-0.007640***	0.001880	-	-	-	-
age	0.015974***	0.001590	-0.004450**	0.001960	-	-
unempl	-0.009420	0.006040	-	-	-	-
highrel	-0.164990**	0.073200	-	-	-	-
age40_59	-	-	0.005249*	0.002800	-	-
black	-	-	0.001279***	0.000252	-	-
constr	-	-	-0.000280	0.001620	-	-
protrans	-	-	-	-	0.083151**	0.036700
poverty	-	-	-	-	0.004977	0.041800
N=754						
Log Likelihood: -9321.63						

*** Significant at 99%, ** Significant at 95%, * Significant at 90%

The mean willingness to pay is estimated to be \$238.80. However, this is the willingness to pay for cancer death per household. To calculate the willingness to pay for an individual, the willingness to pay for household must be divided by the mean number of persons per household. With the mean household size of 2.591 at county level (the 2000 Census), the mean willingness to pay per individual is calculated at \$92.165.
The value of statistical life is computed using the equation

$$\text{Value of statistical life} = \frac{\text{Willingness to pay}}{\text{Size of risk reduction}}.$$

The willingness to pay of \$92,165 represents the amount of money an individual in the sample would be willing to pay to reduce cancer deaths by one per 100,000 populations. This results in the value of statistical life per person of \$9.2 million in 2000 dollars.

The estimate of the value of statistical life is consistent with the findings of other studies in housing market using hedonic price model to investigate the relationship between house prices and cancer risks. In their 2000 paper, Gayer et al. estimate the willingness to pay of residents to avoid cancer risks at Superfund sites and calculate the statistical value of cancer to be \$4.6 million in 1996 dollars. Analyzing how changing information on cancer risk of Superfund sites affects house price, Gayer et al. (2002) report the value of statistical cancer case of \$8.3 million. Our estimate is similar to the calculations from labor market and automobile market. Viscusi (1993) reviews labor market studies and reports a range for value of statistical life from \$3 million to \$7 million in

1990 dollars. Atkinson and Halvorsen (1990) calculate the value of statistical life at $3.4 million 1986 dollars using the hedonic price model for automobiles.

Welfare estimate

In this section we conduct a rudimentary benefit cost analysis to estimate the welfare effects of cleaning up Superfund sites and reducing industrial point source releases. The assumption is that all Superfund sites are completely cleaned up and total toxic releases are decreased by half. The benefits and costs associated our assumptions are calculated to obtain net benefits. This represents the welfare gain from reducting environmental health risks.

Predicted house values and cancer mortality rates are calculated by simultaneously solving the system of Eq.(1)-(3). The paper applies the Quasi-Newton method to obtain house value and cancer mortality prediction. The simulations are reported in Table 3. If all Superfund sites are eliminated and total release is reduced by half, the median house value rises by $124.37 and per county cancer death rates drop by 0.124.

Table 3: House value and cancer mortality simulations

Variable	Original level of TOTREL and NPL		New level of TOTREL and NPL	
	Mean	Standard Error	Mean	Standard Error
House value	70,190.000	21,577.790	70,314.370	21,577.440
Cancer mortality	218.112	12.421	217.988	12.432

Benefits

Benefits from environmental risk reduction are estimated from the change in house value and cancer death rate. Table 4 presents benefits for the difference in house value and cancer rate. House value increase is multiplied by total number of housing units in the sample to obtain benefits from house value change. There are around 15 million owner-occupied housing units in 9 States and the total benefits are $1,881 million. Benefits from the cancer mortality decrease are calculated by multiplying the number of lives saved by the value of statistical life, where the number of lives saved is computed by multiplying the cancer rate reduction by the total of persons living in owner-occupied houses. Cancer rate decrease yields benefits of $449 million per year. If we assume that such benefits will accrue over the foreseeable future, we can get a rough estimate of the net present value of all future benefits as a perpetuity. Based on a 3% interest rate, the value would be about $15 billion dollars.

Table 4: Estimated benefits

Variable	Change in Value	Sample Size	Benefits ($)
Capitalized House Value	124 ($/housing unit)	15,176,155 housing units	1,881,843,220
Annual Cancer Mortality	-0.124 (death/100,000)	39,321,417 persons	449,383,240
NPV Cancer Mortality in Perpetuity			14,966,666,667
Total NPV Benefit			17,297,893,127

Costs

Costs associated with the new level of TOTREL and NPL are costs from cleanup of Superfund sites. There are 81 Superfund sites on final NPL in the sample. Average cost of site cleanup activities is presented in Table 5. The average cost of cleanup actions per site is around $32 million in 1988 dollars or around $46 million in 2000 dollars. Total cost of cleanup for all sites in the sample would be $3.7 billion.

Table 6: Average cost of cleanup actions per NPL site

Cost category	Average total cost per site (1988 US dollars)
Remedial investigation/Feasibility study	1,300,000
Remedial Design	1,500,000
Remedial Action	25,000,000
Net present value of operation and maintenance	3,770,000
Total	31,570,000

Source: Office of Program Management, Office of Superfund Remediation Technology Innovation, EPA.

Total costs for reduction of releases is not readily available. However, EPA annually spends about $7.8 billion in monitoring and regulatory costs for all US facilities. For the sake of expediency, we will assume that costs will increase incrementally for the Southeastern U.S. by about $1 billion per year to reduce releases, adding a NPV of about $33.3 billion to the total for NPL sites above, for a grand total of about $37 billion.

The net benefit of environmental health risk reduction is the difference in benefits and costs. In this case the difference between $17 billion in benefits is outweighed by the $37 billion in costs. However, our benefit estimate underestimates the true benefit significantly, as it includes only owner occupied housing and cancer mortality. Arguably, costs of treating cancer, as well as the other chronic illnesses related to toxic releases, such as respiratory diseases and birth defects will incur an even greater cost to society, and reductions in these conditions associated with reduced releases should result in an actual net benefit.

Conclusions

In this paper, we investigate the effects of environmental health risks on house value in the Southeast at the county level. A unique data set consisting of 754 counties in Southeast region is used for the analysis. Several variables represent for environmental health risks including total chemical releases, number of Supperfund sites, and cancer mortality. We assume that there are endogenities in the model. A system of equations is set up to capture indirect impacts of variables and FIML is used to estimate the system. We go on to simulate cleanup of sites using a quasi-Newton method to solve the system. Our findings are that house value responsed negatively to total release and cancer mortality. A reduction of total release of 1 pound per person leads to an estimated increase of $3.15 in house value and a decrease of cancer mortality by 1 death over 1 thousand persons leads to an increase of $238.80 in housing value.

The value of statistical life and capitalized house values are used to estimate benefits of cleanup. Based on these, a simple cost benefit analysis suggests that cleanup costs exceed the benefits, when only house values and cancer mortality are accounted for. The results suggest that in future research, we will need to include other kinds of health costs in order to estimate the true benefit of environmental cleanup.

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