

Measurement Team Assignment

Environmental Economics

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1 Assignment

Submit your presentation by November 29, 2011, 11:59 p.m. using the link on the platform.

In this assignment you will take the role of a consultant advising the W. R. Grace company (NYSE: GRA, <http://www.grace.com/>). Environmental Activists argue that the company's hazardous waste site in Acton, Massachusetts, should be cleaned up. Activists have used the hedonic market method to calculate that the willingness to pay for a cleanup of the Acton site is over \$400 million.¹

In order to respond, the company needs to understand the activists' calculation and either confirm that their number is an appropriate measure of the willingness to pay or construct its own estimate. Regardless of whether the number is large or small, management needs to have an estimate so that it can plan the firm's strategy.

You are asked to explain and evaluate the activists' work and, if you can identify improvements in technique, to construct your own estimate. You must present the results to upper management, so your results must be presented in a form that they can understand.

Begin by replicating the activists' work to check for mistakes. The activists' report is attached. Then consider whether you can improve upon that work and prepare a presentation.

¹In the case of many hazardous waste sites, and this one in particular, a partial cleanup does not make sense. So we are interested in the total willingness to pay for complete cleanup, not the marginal willingness to pay for a reduction in the toxicity of the waste at the site.

Grace has obtained the same data that the activists used, and they are available to you on the course website in the file ActonData.csv. The data were collected by David Harrison at the time he was a faculty member in the Kennedy School at Harvard University.

Present your results as a PowerPoint presentation that takes no more than twenty minutes to present. Two or three presentations will be selected for presentation to the class during the December 3, 2011, Centra Session.

The technical level of your audience is lower than yours, so you will have to explain the ideas behind your results.

Your presentation should describe the total damage done by W. R. Grace at Acton and why you chose the hedonic regression that you did in terms that a layman would understand.

Your presentation should begin with one or two slides that highlight your key conclusions, especially the bottom-line. Next, it should include some slides that address the background questions addressed. Be sure to include a slide or two describing the data variables and the units in which they were measured. The presentation should include slides that illustrate the process followed in reaching your conclusions.

You may wish to add a technical appendix to your slides to add details that would be required to answer questions that might be posed by professional economists in your audience. At the minimum, you should provide the specific hedonic regression that you used and the specific formula for computing the willingness to pay if these are not included in your main presentation.

2 Background

2.1 The Data

The Harrison data consist of observations on characteristics of 2182 houses and distance from ten hazardous waste sites. The housing information includes the sales prices and house and community attributes for a sample of transactions from November 1977 to March 1981 for the greater Boston area (exclusive of the city itself) collected by the Society of Real Estate Appraisers. The hazardous waste sites were identified from a Massachusetts Department

of Environmental Quality Engineering listing of waste sites. Distances between sites and homes were computed using the latitudes and longitudes of each. Community characteristics included accessibility (to town centers, radial highways, and nearby employment), social status, nitrogen oxide concentrations, full value property tax rate, and pupil-teacher ratio, among others. The ten hazardous waste sites in the data site vary in their actual and potential threats to homeowners. They vary in size, ranking on the National Priorities List, which serves as a basis for the EPA's contingency plans for the cleanup of Superfund sites, and discovery date. Two of the ten, W. R. Grace in Acton and Nyanza, were included on the Superfund list as of 1984, which implies that these are high risk.

We are concerned with the W. R. Grace plant site in Acton. The damage done by the hazard is proportional to the distance from the site. However, as one moves away from Acton, other sites become relevant, particularly Nyanza. You will have to take this into account in your analysis. One approach would be to delete observations that are closer to Nyanza than they are to W. R. Grace in Acton. You can consider other possible approaches as well.

2.2 The Hazards

We can reasonably assume that the danger associated with the Acton site was known to all during the time period of the data.

Until early 1982, the W. R. Grace plant in Acton manufactured various specialty chemicals and other products for industrial use. Since at least 1973, residents in South Acton have filed complaints about periodic odors and irritants in the air around the Grace plant. When Acton drilled Assabet Wells #1 and #2 in the area, the water had odors indicating significant contamination. In 1978, when Grace proposed expanding part of the plant, local and state officials undertook a more detailed examination of the company's waste disposal practices. This led to the closing of two contaminated municipal wells, reducing Acton's drinking water supply by 40 percent. On October 21, 1980, EPA and Grace signed a consent decree, representing an out-of-court settlement of a Federal suit filed against the company under the Resource Conservation and Recovery Act. The settlement required Grace to clean up and restore the quality of the aquifer supplying Assabet Wells #1 and #2 and to close out the

existing lagoons and landfill on their site.

Abatement efforts, negotiations, suits, etc. continued. In August 2006, EPA, MassDEP and W. R. Grace negotiated a settlement agreement known as a Remedial Design/Remedial Action Statement of Work. This settlement agreement was worth approximately \$18 million and requires W. R. Grace to implement and fund the clean up actions. The Remedial Design phase, including numerous pre-design studies, is currently underway. After the Remedial Design phase is completed in 2010, the final Remedial Action phase will begin.

The sources for the information in the two paragraphs above are EPA.gov and Scorecard.org. One may obtain additional details by entering “W. R. GRACE & CO., INC. (ACTON PLANT)” in Google.

The activists’ report assumes that if a house is ten miles from the W. R. Grace Acton site, then the pollutant is gone. You can accept the activists’ claim that there are approximately 64,000 homes within 10 miles of Acton.

2.3 Hedonic Specifications

The source for the lecture on hedonic market method is Harrison and Rubinfeld (1978), “Hedonic Housing Prices and the Demand for Clean Air,” *Journal of Environmental Economic Management* 5, 81–102. This article can be regarded as a tutorial on hedonic market analysis and can be consulted for ideas on the correct specification of your hedonic regression. In particular, pay attention to the issue of whether P , $\log P$ or something else should be the left-hand side variable and whether the pollutant should enter as X , X^2 , \sqrt{X} , $\log X$ or something else.

2.4 Effects of Inflation

You will need to consider inflation when comparing dollar amounts. The Harrison data are in 1980 dollars and the quote of \$18 million above is in 2006 dollars. When you discuss dollar amounts, be certain that they are comparable.

Report on Damages from the W. R. Grace plant in Acton

Executive Summary: W. R. Grace has agreed to pay approximately \$18 million to fund cleanup efforts associated with its toxic waste site in Acton, Massachusetts. We argue that a more aggressive and thorough clean-up of the site is justified. We estimate that the benefits to nearby residents associated with a complete cleanup of the Acton site are in excess of \$400 million.

2 Data

The used variables in the analysis are listed in Table 1 below.

2.1 Hedonic regression

- We used a hedonic regression to isolate the effect of distance from the Acton site on the sale price of homes
- For the purposes of calculating this regression, we only considered observations that are closer to Acton than to any of the other sites in the data. That is we only considered observations for which

$$\text{dista1} \leq \min \{ \text{dista3}, \text{dista4}, \text{dista5}, \text{dista6}, \text{dista7}, \text{dista9}, \text{dista11}, \text{dista14}, \text{dista15} \}.$$

- We ran the following regression, which accounts for characteristics of the house, including its size, age, lot size, property tax rate, quality of schools, accessibility to radial highways, NOx concentrations, and, most importantly for our purposes, the distance to W. R. Grace's Acton site:

$$\begin{aligned} \log(\text{aprice}) = & (-16.301) + (0.66148)\ln8 + (0.0061575) \text{yrblt} + (0.035355) \ln3 \\ & + (0.013354) \text{n40} + (-0.022676) \text{n41} + (0.62542) \text{lrad} + (548.23) \ln\text{oxo} \\ & + (0.019849) \text{dista1}. \end{aligned}$$

The coefficient on `distal` is positive, indicating that the closer is a house to Acton (a lower value of `distal`), the lower is its expected price, all else equal.

2.2 Willingness to pay

- With respect to a toxic waste site, the only cost-effective remedy is to clean up the site completely, i.e., to reduce the pollutants to zero. This being the case, we were able to estimate the total damage directly from the hedonic regression without having to use the results of a demand regression.
- We assumed that at a distance of ten or more miles from the W. R. Grace Acton site, there are no longer any effects associated with the pollutants.
- For all 182 houses in the data that are within ten miles of Acton (including those omitted in the calculation of the hedonic regression because they were closer to other hazardous waste sites), we calculated the expected price as follows:²

expected price with hazard

$$= \exp \left(\begin{array}{l} (-16.301) + (0.66148)\ln8 + (0.0061575) \text{yrblt} + (0.035355) \ln3 + (0.013354) \text{n40} \\ + (-0.022676) \text{n41} + (0.62542) \text{lrad} + (548.23) \text{lnoxo} + (0.019849) \text{distal} \end{array} \right).$$

- For the same 182 houses, we calculated what the expected price would be if the pollutant were gone by setting the distance variable `distal` to 10 as follows:³

expected price without hazard

$$= \exp \left(\begin{array}{l} (-16.301) + (0.66148)\ln8 + (0.0061575) \text{yrblt} + (0.035355) \ln3 + (0.013354) \text{n40} \\ + (-0.022676) \text{n41} + (0.62542) \text{lrad} + (548.23) \text{lnoxo} + (0.019849) 10 \end{array} \right).$$

- We calculated the damage done to the occupants of the house as

$$(\text{expected price without hazard}) - (\text{expected price with hazard}).$$

²Note that by using the hedonic regression to estimate the price we essentially hold constant any effects from other hazardous waste sites, allowing us to focus on the effects of Acton.

³Because we assume that if a house is ten or more miles from Acton, then the pollutant is gone, the expected price of a house calculated from the hedonic regression with distance set to ten miles and all other values set to those in the data gives the expected price of the house were the pollutant gone.

- We averaged these damages over the 182 houses to get a value for the damage averaged over all distributional effects including income, distance, etc. We get a value of \$6,430.
- To get a dollar amount for the total damage, we multiplied the estimated per-house damage by the number of houses within ten miles of the W. R. Grace Acton site, which we take to be 64,000.⁴ Thus, the total estimated damage is $\$6,430 \cdot 64,000 = \$411,520,000$.

⁴The population density for Massachusetts is 816 people per square mile (<http://www.worldatlas.com/aatlas/populations/usadensityh.htm>). Using the Massachusetts average, a ten-mile-radius circle has $3.14 \cdot 100 \cdot 816 \approx 256,000$ people. Assuming the damage per house reflects the damage to four people implies we should use $256,000/4 = 64,000$ as the number of houses.

Table 1. Variables in the Boston Hazardous Waste Data Set

Variable	Definition
dista1	distance to W. R. Grace Acton, miles
dista3	distance to Nyanza, miles
dista4	distance to BASF, miles
dista5	distance to Benzenoid Organics, miles
dista6	distance to W. R. Grace Cambridge, miles
dista7	distance to Indian Line Farm, miles
dista9	distance to Marty's GMC, miles
dista11	distance to Salem Acres, miles
dista14	distance to Agrico, miles
dista15	distance to Industriplex, miles
yrmo	year and month sold
yrblt	year the house was built
chas	dummy variable =1 for house bordering Charles River, =0 otherwise
dcondz	present condition on 0 to 5 scale with 0=poor, 5=excellent
dconsz	quality of construction or 0 to 5 scale with 0=poor, 5=excellent
nheatf	dummy variable =1 for forced air heat
nheath	dummy variable =1 for hot water heat
nheats	dummy variable =1 for steam heat
n34	percent of basement that is finished
n36	number of fireplaces
n37	dummy variable =1 if covered parking
aprice	deflated sale price (1980 dollars)
n24	dummy variable =1 for frame house
ln3	lot size (log square feet)
ln6	log number of full baths
ln8	living area in house (log square feet)
ln44	fraction of lower status
laccess	index of access to employment centers
lnoxo	nitrogen oxide concentration, parts per million
lrad	log of index of access to radial highways
n35	dummy variable =1 if pool; 0 otherwise
n40	full value property tax rate
n41	pupil to teacher ratio
n45	fraction of population African - American in census tract
