Valuing Damages at Acton Using Hedonic Methods and Home Prices

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Environmental Economics

Findings

- Activist Model has some problems.
- Nyanza site affects regression housing prices of Acton.
- Within 10 mile radius, average WTP for Acton cleanup is $6,635 in 2011 dollars ($2,712 per home in 1980).
- Total cleanup value is approximately $173.6 million in 1980 dollars.
- Total cleanup value is approximately $424.7 million in 2006 dollars.

Hedonic Regression Method

- Decomposes the characteristics that determine house price and obtains the contributory value of each

- We identified those attributes most likely to influence price and used a linear regression to determine the contributory value of each characteristic

- Allowed us to put a value on living nearer to or farther from a hazardous waste site

Variables

- Included those variables in our model that represent the best predictors of house price
  - Similar to the Activist Model we included: Size, Age, Lot Size, Quality of Schools, Accessibility to Radial Highways
  - We also included: House Condition, Natural Log of Distance from Acton and Nyanza, and Nitrogen Oxide Concentration Squared
  - Note: Variable names used in models are in appendix.

Problems with Activist Model

- Model assumes WTP is proportional to distance.
- Model does not appropriately account for Nyanza.
- Positive Coefficient for NOX implies that increasing NOX is something people are willing to pay for.
- Current house condition provides meaningful additional data and is not included.

Activist Model Coefficients

Regression Statistics

	R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,81)
	0.832	0.815	0.148	90	0	1.990

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	-16.301	4.023	-4.052	0.000	-24.306	-8.296
dista1	0.020	0.010	1.984	0.051	0.000	0.040
ln3_	0.035	0.020	1.770	0.080	-0.004	0.075
ln8_	0.661	0.050	13.319	0.000	0.563	0.760
lnoxo	548.228	105.019	5.220	0.000	339.274	757.183
lrad	0.625	0.146	4.296	0.000	0.336	0.915
n40_	0.013	0.003	5.015	0.000	0.008	0.019
n41_	-0.023	0.007	-3.132	0.002	-0.037	-0.008
yrblt	0.006	0.001	6.345	0.000	0.004	0.008

ln_Price = -16.3007 + 0.0198 dista1 + 0.0354 ln3_ + 0.6615 ln8_ + 548.2281 lnoxo + 0.6254 lrad + 0.0134 n40_ - 0.0227 n41_ + 0.0062 yrblt

Transforming Variables

- Effect of distance on price will be greater closer to the site, so the distance variables were transformed using the ln. (Michaels, R.G., Smith, V.K. (1990). "Market-segmentation and valuing amenities with hedonic models - the case of hazardous-waste sites", Journal of Urban Economics 28, 223-242.)

- Effect of NOX will be greater the higher the concentration so this variable was transformed to NOX^2. (Harrison and Rubinfeld (1978), "Hedonic Housing Prices and the Demand for Clean Air," Journal of Environmental Economic Management 5, 81–102.)

Accounting for Nyanza

- There are 22 data points in the 90 used by the activist to create the regression are within 10 miles of Nyanza.

- 10 are less than 2 miles farther from Nyanza than Acton.

- Low values of these houses would be attributable to a combination of Nyanza and Acton.

- BASF datapoints are also close, but did not affect the regression on an expanded dataset.

Expand to 10 mile radius

- Tried remove those Nyanza points from 90 but too many are removed to create a reasonable hedonic regression for Acton.

- Expand datapoints to the 10 mile radius to include more points close to Nyanza.

- Checked BASF, Cambridge, and Industriplex but none are significant to data in 10 mile radius.

Data between Nyanza and Acton

- Regression for all houses that are within 12 miles of both Acton and Nyanza. (see appendix for model)
  - Negative coefficient for distance from Acton
  - Positive coefficient for distance from Nyanza
- Lots of colinearity as expected so this is not a great model but it implies that it may be better to live near Acton because it allows one to live further from Nyanza.

Our Hedonic Regression Model

Regression Statistics

	R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,172)
	0.741	0.728	0.159	182	0	1.974

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	32.704	10.032	3.260	0.001	12.901	52.506
dcondz	0.040	0.017	2.350	0.020	0.006	0.074
ln3_	0.054	0.017	3.178	0.002	0.020	0.087
ln8_	0.581	0.040	14.540	0.000	0.502	0.660
lndist1	0.069	0.028	2.452	0.015	0.013	0.125
lndist3	0.169	0.040	4.235	0.000	0.090	0.248
lrad	0.158	0.045	3.518	0.001	0.069	0.246
n41_	-0.019	0.006	-3.196	0.002	-0.031	-0.007
NOX_2	-25.329	9.297	-2.724	0.007	-43.680	-6.978
yrblt	0.005	0.001	6.331	0.000	0.003	0.007

$$ln\_Price = 32.7038 + 0.04\ dcondz + 0.0537\ ln3\_ + 0.5809\ ln8\_ + 0.0691\ lndist1 + 0.1694\ lndist3 + 0.1576\ lrad - 0.0193\ n41\_ - 25.329\ NOX\_2 + 0.005\ yrblt$$

Calculating Willingness to Pay

- For 182 houses within 10 miles of Acton, calculated the expected house price as follows:
  - Exp(32.7038 + 0.04 dcondz + 0.0537 ln3_ + 0.5809 ln8_ + 0.0691 lndist1 + 0.1694 lndist3 + 0.1576 lrad - 0.0193 n41_ - 25.329 NOX_2 + 0.005 yrblt)

- For same 182 houses, calculated the expected price without pollution by setting lndist1 = ln(10)
  - Exp(32.7038 + 0.04 dcondz + 0.0537 ln3_ + 0.5809 ln8_ + (0.0691) **ln(10)** + 0.1694 lndist3 + 0.1576 lrad - 0.0193 n41_ - 25.329 NOX_2 + 0.005 yrblt)

Calculating Willingness to Pay

- Damage done to the occupants of a house =
  - Expected $ without hazard – Expected $ with hazard
- Averaged this value for all 182 houses for an average value of $2,712 per home
- Total damage is equal to the average damage times the total number of houses (64,000)
  - $2,712 * 64,000 = $173.6 million

Convert to 2006 Dollars

- 2006 CPI – 201.6
- 1980 CPI – 82.4
- Increase = 201.6 / 82.4 = 2.4466
- So, $173.6 million in 1980 is equivalent to $424.7 million in 2006

http://inflationdata.com/inflation/Consumer_Price_Index/HistoricalCPI.aspx

Conclusions

- Minor improvements made to activist model.
- Nyanza site affects regression housing prices of Acton.
- Within 10 mile radius, average WTP for Acton cleanup is $6,635 in 2006 dollars ($2,712 per home in 1980).
- Total WTP for clean-up is approximately $424.7 million in 2006 dollars.
- The $18 million current settlement may increase, and the business should prepare for that possibility.

Appendix: Variable Names

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

Appendix: Variable Names (cont)

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

Appendix: Variable Names (cont)

- lndist1-lndist15 = The natural log of each of the distance variables.

- NOX_2 = nitrogen oxide concentration in parts per million.

- Ln_Price is the natural log of aprice which is the house sale price.

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

Appendix: Checking for significance of BASF(Indist4) and Industriplex(Indist15)

Regression Statistics

	R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,171)
	0.743	0.728	0.158	182	0	1.974

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	34.195	10.102	3.385	0.001	14.254	54.136
dcondz	0.040	0.017	2.335	0.021	0.006	0.073
ln3_	0.054	0.017	3.170	0.002	0.020	0.087
ln8_	0.581	0.040	14.545	0.000	0.502	0.659
Indista1	0.102	0.040	2.560	0.011	0.023	0.181
Indista3	0.246	0.077	3.206	0.002	0.095	0.398
Indista4	0.064	0.054	1.171	0.243	-0.044	0.171
Irad	0.155	0.045	3.461	0.001	0.067	0.243
n41_	-0.020	0.006	-3.245	0.001	-0.032	-0.008
NOX_2	-27.062	9.404	-2.878	0.005	-45.626	-8.499
yrblt	0.005	0.001	6.190	0.000	0.003	0.006

Regression Statistics

	R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,171)
	0.742	0.726	0.159	182	0	1.974

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	32.832	10.057	3.265	0.001	12.980	52.684
dcondz	0.040	0.017	2.366	0.019	0.007	0.074
ln3_	0.054	0.017	3.204	0.002	0.021	0.088
ln8_	0.581	0.040	14.497	0.000	0.502	0.660
Indista1	0.051	0.046	1.113	0.267	-0.039	0.141
Indista15	-0.060	0.117	-0.513	0.609	-0.291	0.171
Indista3	0.119	0.106	1.117	0.266	-0.091	0.329
Irad	0.150	0.047	3.199	0.002	0.058	0.243
n41_	-0.019	0.006	-2.987	0.003	-0.031	-0.006
NOX_2	-25.159	9.323	-2.699	0.008	-43.561	-6.756
yrblt	0.005	0.001	6.327	0.000	0.003	0.007

Appendix: Checking for significance of Cambridge(Indist6)

Correlation Matrix

Variable	ln_Price	dcondz	ln3_	ln8_	Indista1	Indista3	Indista6	lrad	n41_	NOX_2	yrblt
ln_Price	1.000										
dcondz	0.355	1.000									
ln3_	0.470	0.256	1.000								
ln8_	0.745	0.189	0.338	1.000							
Indista1	-0.068	0.008	-0.162	-0.209	1.000						
Indista3	0.148	0.171	0.079	0.133	-0.273	1.000					
Indista6	-0.075	-0.101	0.194	0.084	-0.512	-0.499	1.000				
lrad	-0.048	-0.072	-0.167	-0.101	0.428	-0.622	-0.043	1.000			
n41_	-0.166	-0.101	-0.032	0.014	-0.295	0.013	0.300	0.072	1.000		
NOX_2	-0.231	-0.021	-0.350	-0.237	0.475	-0.213	-0.421	0.586	0.083	1.000	
yrblt	0.372	0.220	0.260	0.142	-0.145	-0.190	0.266	0.051	0.023	-0.023	1.000

Regression Statistics

R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,171)
0.758	0.744	0.154	182	0	1.974

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	48.755	10.761	4.531	0.000	27.514	69.996
dcondz	0.043	0.017	2.613	0.010	0.011	0.076
ln3_	0.061	0.016	3.674	0.000	0.028	0.093
ln8_	0.576	0.039	14.879	0.000	0.500	0.653
Indista1	-0.010	0.036	-0.289	0.773	-0.080	0.060
Indista3	-0.022	0.067	-0.325	0.745	-0.155	0.111
Indista6	-0.334	0.096	-3.482	0.001	-0.524	-0.145
lrad	0.109	0.046	2.396	0.018	0.019	0.199
n41_	-0.009	0.007	-1.440	0.152	-0.022	0.003
NOX_2	-38.928	9.820	-3.964	0.000	-58.313	-19.543
yrblt	0.005	0.001	6.729	0.000	0.004	0.007

Appendix: Models for Houses within 12 miles of both Nyanza and Acton

Regression Statistics

	R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,147)
	0.778	0.764	0.143	157	0	1.976

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	-17.840	20.050	-0.890	0.375	-57.463	21.783
dcondz	0.006	0.016	0.346	0.730	-0.026	0.038
ln3_	0.098	0.022	4.507	0.000	0.055	0.141
ln8_	0.524	0.039	13.345	0.000	0.447	0.602
lnDist1	0.084	0.057	1.478	0.141	-0.028	0.197
lnDist3	-0.072	0.061	-1.189	0.236	-0.192	0.048
lrad	-0.068	0.067	-1.013	0.313	-0.200	0.064
n41_	-0.060	0.012	-5.055	0.000	-0.084	-0.037
NOX_2	22.825	18.677	1.222	0.224	-14.084	59.735
yrblt	0.005	0.001	6.845	0.000	0.004	0.007

Regression Statistics

	R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,154)
	0.139	0.128	0.274	157	0	1.975

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	11.081	0.329	33.722	0.000	10.431	11.730
lnDist1	-0.192	0.083	-2.306	0.022	-0.357	-0.028
lnDist3	0.164	0.088	1.864	0.064	-0.010	0.339