Estimated Cost of Clean Up W R Grace, Acton, MA

Report to Management

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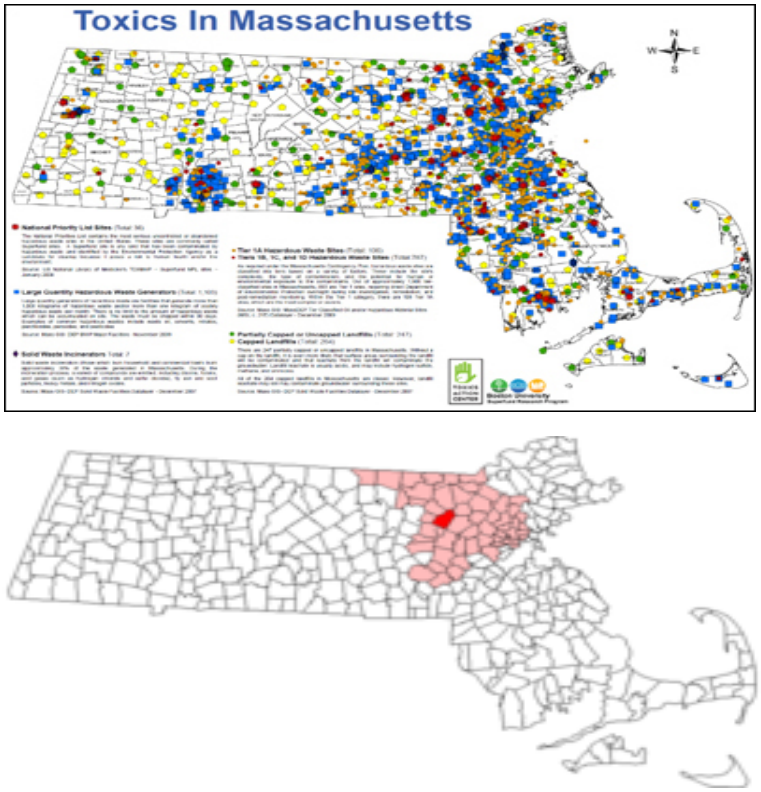


Overview

- Position of Activists
- General Issues with Hedonic Regressions
- Results of Activist's Regression
- Shortfall of Activist's Method
- Alternative Methods
- Backup Data

Position of the Activists

- Amount agreed upon by W. R. Grace is not sufficient
- In order to mitigate all risks, **complete clean-up required**
- Use of **hedonic regression model to calculate willingness to pay**
- Data
  - 2,182 homes in greater Boston area
  - Variety of real estate attributes/ factors
- Regression Model
  - 90 homes closest to Acton
  - **Willingness to pay derived from model**
- Willingness to Pay
  - Focused on 182 homes within 10 miles of Acton
  - **Calculated as difference in the model's price at existing distance from site and 10 miles from site**
  - Effects of the pollution are expected to extend 10 miles

Results of Activist Analysis: Regression Summary

Variable	Coefficient	t-Stat
Intercept	-16.301	-4.052
ln3	0.035355	1.770
ln8	0.66148	13.319
lnoxo	548.23	5.220
lrad	0.62542	4.296
n40	0.013354	5.015
n41	-0.022676	-3.132
yrblt	0.0061575	6.345
dista1	**0.019849**	**1.984**

- Model significant
  - Adj R-sq: 0.8152
- Not all variables significant
  - Significant: t>+/-1.96
- Multi-collinearity not an issue
  - Correlation matrix R-value signs match those of model

Average Difference per house	**$6,430**
Total Houses within 10 miles	64,000
Total Estimated Damage	**$411,492,393**

General Issues with Hedonic Regression to Determine Willingness to Pay

- Use of model assumes all people have prior knowledge of impact of all externalities (positive and negative) on home purchases
- Attributes must be relevant (i.e. lot size, house square footage) and proxies must be reasonable (i.e. teacher student ratio correlates to quality of schools)
- Market has no boundaries with respect to supply and demand of homes
- Multicollinearity may very well exist
- Assumes immediate price adjustments based upon changes in attributes
- Transformations and slight adjustments in model have huge impacts on calculation of willingness to pay

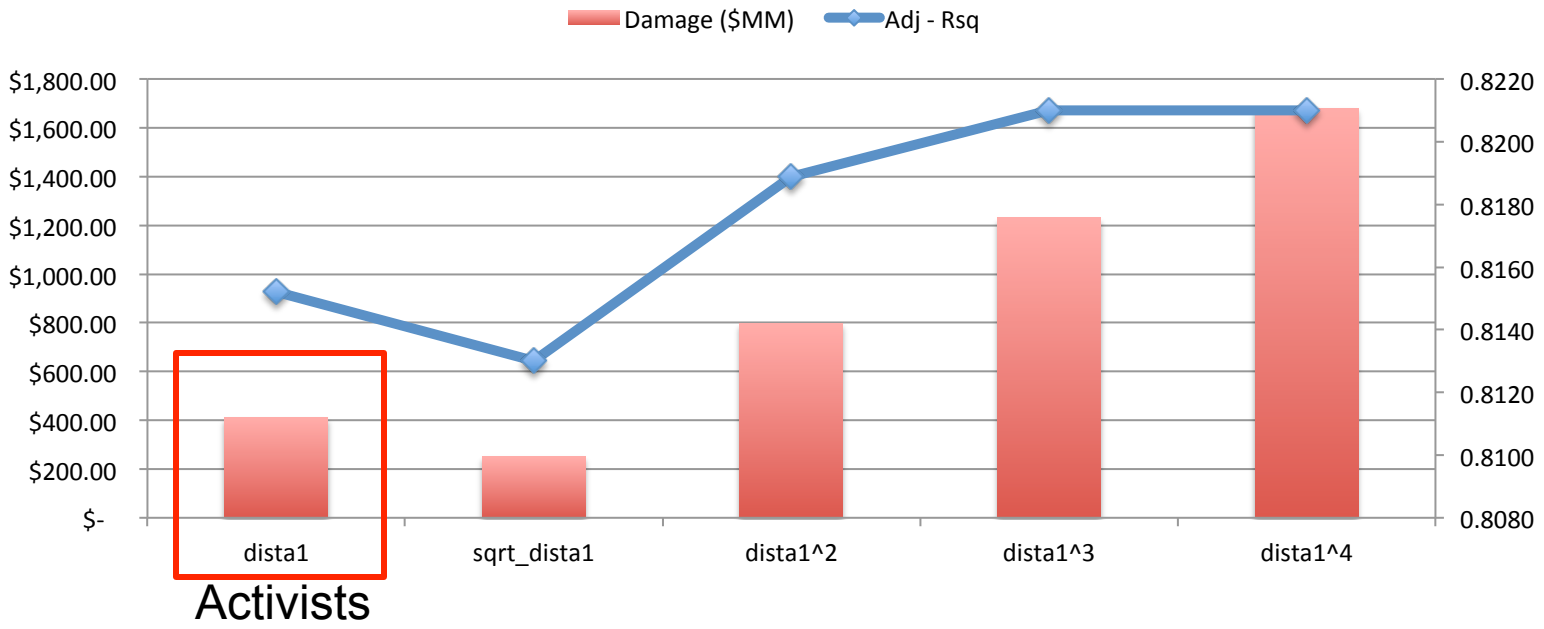
Take Away: Need to review activist data to ensure they have considered these challenges in their model.

Shortfalls of Activist Analysis: Skewed Data

① **Model is sensitive to small changes in regression equation**

- Built models with comparable Adj R-sq values
- Variability extreme as seen in the graph below
- Not all variables significant to t>1.96, only t>1.66

Hedonic Regression Sensitivity Analysis
All Models with Variable t-values > 1.66



Shortfalls of Activist Analysis: Skewed Data

② **Extending the model to different samples eliminates the significance of housing price based on distance to Grace**
- Computed regression model with sample size of n=182, distance to Grace is not significant
  - The model is likely influenced by four plants Nyanza, BASF, Grace Cambridge, and Industriplex making it virtually impossible to draw a conclusion
- Computed regression model isolating for the distance to Grace
  - Sample based on homes within 10 miles to Grace, but with no other plants within 10 miles (n=41)
  - Distance to Grace still not significant
- Due to the facts above, the model using n=90 cannot be used, ignores relevant data points outside these 90 observations.

③ **Model lacks practical significance**
- No use of technical data related to aquifer contamination
- Using air data as proxy for contamination is not valid

Alternative Methods

- **Best method is likely not hedonic regression due to high sensitivities**
- **Suggestion:** Use data set that eliminates effects of all other plants, obtain more data on homes within 10 miles of Acton but not within 10 miles of any other plants. Currently this data n=41.
- **Suggestion:** Investigate the harmful health effects from hospital bills over the existence of the plant.
- **Suggestion:** Need to develop a better, measurable proxy to quantify site contamination (i.e. well contamination downstream)
- **Suggestion:** Look at other sites throughout US with similar characteristics as barometer for clean up costs
- Use one of these models to forecast willingness to pay
- Willingness to pay will be used to estimate clean up value needed

BACK-UP

Back up Data

- **What is Nitrogen Oxide**
  - Nitrogen Oxide, aka NOx, is a group of different gases made up of different levels of oxygen and nitrogen
  - Two of the most common nitrogen oxides are: Nitrogen Dioxide and Nitric Oxide
  - NOx is given off in many forms, such as smog or particles
- **How are Nitrogen Oxides Formed?**
  - NOx is formed when certain fuels (oil, gas and coal) are burned at a high temperature, such as combustion
  - NOx is also formed from the plants that manufacture explosives
- **Why is there such a high level of Nitrogen Oxide Pollution?**
  - Because many factories, past and present, use coal-burning plants for power and/or energy or give off NOx from a certain processes
  - Because NOx is commonly formed from motor vehicles (combustion in the engine)

http://www.belleville.k12.wi.us/bhs/health/environment/nitrogen_oxide.htm

Regression Data - Activists

	1 Activist Regression Check		
Variable	**Coefficient**	**t-Stat**	**ANOVA (SSE/SST)**
Intercept	-16.301	-4.052	0.0%
ln3	0.035355	1.770	2.9%
ln8	0.66148	13.319	54.6%
lnoxo	548.23	5.220	7.2%
lrad	0.62542	4.296	1.7%
n40	0.013354	5.015	0.1%
n41	-0.022676	-3.132	3.9%
yrblt	0.0061575	6.345	12.1%
dista1	0.019849	1.984	0.8%
dista1^2			
dista1^3			
dista1^4			
ln_dista1			
sqrt_dista1			
R-Sq (SSR/SST)	**0.8318**		
Adj R-Sq	**0.8152**		
Model P-Value	**0.0000**		
Sample Size	n=	90	
	WTP Check		
	n=	182	
	Average Difference per house	**$**	**6,430**
	Total Houses within 10 miles		64,000
	Total Estimated Damage	**$**	**411,492,393**

Correlation Matrix - Activists

Correlation Data

Variable	dista1	ln_aprice	ln3_	ln8_	lnoxo	lrad	n40_	n41_	yrblt
dista1	1.000								
ln_aprice	0.213	1.000							
ln3_	0.095	0.439	1.000						
ln8_	-0.045	0.739	0.272	1.000					
lnoxo	0.205	0.106	0.048	0.000	1.000				
lrad	0.402	0.355	0.381	0.090	-0.258	1.000			
n40_	-0.540	0.041	-0.113	0.141	-0.369	-0.363	1.000		
n41_	-0.467	-0.137	0.010	0.073	0.224	-0.486	0.378	1.000	
yrblt	0.074	0.386	0.245	0.054	-0.015	0.126	-0.024	0.017	1.000

Regression Data – dista1^2

	2 Acton Closest (dista1^2)		
Variable	**Coefficient**	**t-Stat**	**ANOVA (SSE/SST)**
Intercept	-15.449	-3.826	0.0%
ln3	0.03845	1.936	12.3%
ln8	0.65752	13.364	43.1%
lnoxo	526.334	4.995	0.2%
lrad	0.630	4.410	3.3%
n40	0.013672	5.168	4.1%
n41	-0.023	-3.290	2.2%
yrblt	0.0060383	6.261	13.5%
dista1			
dista1^2	0.002565	2.377	4.8%
dista1^3			
dista1^4			
ln_dista1			
sqrt_dista1			
R-Sq (SSR/SST)	**0.8352**		
Adj R-Sq	**0.8189**		
Model P-Value	**0**		
Sample Size	n=	90	
	WTP Check		
	n=	182	
Average Difference per house	**$**	**12,439**	
Total Houses within 10 miles		64,000	
Total Estimated Damage	**$**	**796,077,909**	

Regression Data – dista1^3

Variable	4 Acton Closest (dista1^3) Coefficient	t-Stat	ANOVA (SSE/SST)
Intercept	-15.179	-3.770	0.0%
ln3	0.041	2.070	19.5%
ln8	0.652	13.280	41.8%
lnoxo	519.400	4.940	0.0%
lrad	0.654	4.640	3.7%
n40	0.014	5.250	4.8%
n41	-0.024	-3.450	1.9%
yrblt	0.006	6.130	7.6%
dista1			
dista1^2			
dista1^3	0.00032	2.540	4.5%
dista1^4			
ln_dista1			
sqrt_dista1			
R-Sq (SSR/SST)	**0.8370**		
Adj R-Sq	**0.8210**		
Model P-Value	**0**		
Sample Size	n=	90	
	WTP Check		
	n=	182	
Average Difference per house		**$ 19,220**	
Total Houses within 10 miles		64,000	
Total Estimated Damage		**$ 1,230,097,951**	

Regression Data – dista1^4

	5 Acton Closest (dista1^4)		
Variable	**Coefficient**	**t-Stat**	**ANOVA (SSE/SST)**
Intercept	-15.225	-3.790	0.0%
ln3	0.042990	2.150	20.4%
ln8	0.64791	13.170	40.9%
lnoxo	520.70	4.970	0.0%
lrad	0.67830	4.840	4.3%
n40	0.013905	5.260	4.8%
n41	-0.024396	-3.560	2.0%
yrblt	0.0058146	5.990	7.2%
dista1			
dista1^2			
dista1^3			
dista1^4	0.000038	2.580	4.1%
ln_dista1			
sqrt_dista1			
R-Sq (SSR/SST)	**0.8370**		
Adj R-Sq	**0.8210**		
Model P-Value	**0.0000**		
Sample Size	n=	90	
	WTP Check		
	n=	182	
	Average Difference per house	**$**	**26,266**
	Total Houses within 10 miles		64,000
	Total Estimated Damage	**$**	**1,681,052,679**

Regression Data – sqrt_dista1

	7 Acton Closest (sqrt_dista1)		
Variable	**Coefficient**	**t-Stat**	**ANOVA (SSE/SST)**
Intercept	-16.988	-4.240	0.0%
ln3	0.034	1.690	17.6%
ln8	0.662	13.230	43.2%
lnoxo	565.400	5.410	0.4%
lrad	0.637	4.350	3.3%
n40	0.013	4.900	4.2%
n41	-0.023	-3.120	1.6%
yrblt	0.006	6.370	8.5%
dista1			
dista1^2			
dista1^3			
dista1^4			
ln_dista1			
sqrt_dista1	0.062	1.660	4.2%
R-Sq (SSR/SST)	**0.8290**		
Adj R-Sq	**0.8130**		
Model P-Value	**0.0000**		
Sample Size	n=	90	
	WTP Check		
	n=	182	
	Average Difference per house	**$**	**3,932**
	Total Houses within 10 miles		64,000
	Total Estimated Damage	**$**	**251,619,803**