Environmental Impact Report: W. R. Grace Company, Acton, Massachusetts Site

Environmental Assessment Associates

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Agenda

- Bottom Line

- Background Questions Addressed

- Characteristics of Ideal Regression Model/Results

- Data Variables Description and Units

- Conclusions and Recommendation

Bottom Line

- Average Damage Cost per Household = $49.97

- Estimated Total Damage = $8,322,363.584
  - Amount in 2008 dollar amount

- Recommend that W. R. Grace Company should authorize total remediation of the Acton Massachusetts Site

- Recommend that extended regression analysis be done to make the model more exhaustive and robust thus making the total damage amount close to "fair"

Background Questions Addressed

- Observations on characteristics of 2182 houses and distance from ten hazardous waste sites

- Sales prices and house and community attributes for a sample of transactions from November 1977 to March 1981 for the greater Boston area

- 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.

Background Questions Addressed (Cont.)

- Settlement agreement was worth approximately $18 million (1980 dollars) and requires W. R. Grace to implement and fund the clean up actions

- Willingness to pay for a cleanup of the Acton site is over $400 million

- Inflation regarding cost of remediation from 1980 to 2006

- Take as given that there are approximately 64,000 homes within 10 miles of Acton

Characteristics of Ideal Regression Model/Results

- P-value as close to zero as possible [(1- P-value) is confidence that slope is not zero]

- T-stat value as far from 0 as possible (If zero, there is no relationship between dependent and independent variables)

- R-square as close to 1 as possible showing better fit of the model

- 95% CI if not zero, indicates slope relation is statistically significant

Willingness to Pay Confirmation of Analysis

Activities Analysis Base Model

- Value for the damage averaged over all distributional effects = $6,430
- Total estimated damage = $411, 520, 000

Environmental Assessment Associates Analysis

- Value for the damage averaged over all distributional effects = $6,429.57
- Total estimated damage = $411,492,393.41

• Difference between the Activities and EAA analysis is 0.006708445% and can be assumed to be rounding error.

Activists' analysis was recreated and used as 'Base-Model' by EAA for benchmarking purposes.

Data Variables Description and Units

- Only considered observations that are within 10 miles of the Acton site
  - 90 observations to start
- Home Price converted to (Natural) Log Price
- Pollution of x, x^2, square root of x, and $\ln(x)$ was investigated for NOx concentrations
- Inflation factor of 2.6023 was used to convert 1980 dollars to 2006 dollars
- Exclusion of observations which are closer to Nyanza but within 10 miles of Acton is recommended for future studies. (Initial results show NOx concentration variables as more influential on damage cost than proximity to Nyanza)

Recreating Damage Analysis Presented by Activists (Base Model)

| **Dependent Variable:** | | Natural_log_of_Price | | | *RunTime: Nov 28, 2011 10:57 PM* | |
| **Independent Variables:** | | dista1, ln3_, ln8_, lnoxo, lrad, n40_, n41_, yrblt | | | | |

Descriptive Statistics

Correlation Matrix

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

Average Damage per household = **$ 6,429.569**
Comment: 83.2% data can be related, high Adj.RSqr indicates better fit, statistically significant except for 'dista1', lower t-stat values indicate fairly weak relationship.

Using Price Instead of Natural Log of Price

Dependent Variable:		Price			*RunTime: Nov 29, 2011 12:48 AM*	
Independent Variables:		dista1, ln3_, ln8_, lnoxo, lrad, n40_, n41_, yrblt				

Descriptive Statistics

Correlation Matrix

Regression Statistics

	R Square	Adj.RSqr	Std.Err.Reg.	# Cases	# Missing	t(2.5%,81)
	0.798	0.778	12,872.443	90	0	1.990

Summary Table

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	-2,062,282.095	351,044.412	-5.875	0.000	-2,760,750.349	-1,363,813.841
dista1	199.677	872.769	0.229	0.820	-1,536.860	1,936.215
ln3_	2,984.667	1,742.660	1.713	0.091	-482.680	6,452.015
ln8_	53,204.658	4,333.258	12.278	0.000	44,582.834	61,826.483
lnoxo	42,902,125.889	9,163,204.763	4.682	0.000	24,670,223.018	61,134,028.760
lrad	49,084.275	12,702.236	3.864	0.000	23,810.810	74,357.740
n40_	604.969	232.367	2.604	0.011	142.633	1,067.306
n41_	-1,979.142	631.716	-3.133	0.002	-3,236.058	-722.226
yrblt	474.068	84.671	5.599	0.000	305.600	642.536

Average Damage per household = **\$ 777.308**
Comment: 79.8% data can be related, Adj.RSqr indicates decent fit compared to base model, statistically significant results, higher t-stat values indicate strong relationship between variables

Using Square of Pollution (Inoxo^2)

Dependent Variable:		Natural_log_of_Price			RunTime: Nov 29, 2011 1:56 AM	
Independent Variables:		dista1, ln3_, ln8_, lnoxo_sq, Irad, n40_, n41_, yrblt				

Descriptive Statistics

Correlation Matrix

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	-5.880	2.044	-2.877	0.005	-9.948	-1.813
dista1	0.020	0.010	1.980	0.051	0.000	0.040
ln3_	0.035	0.020	1.770	0.081	-0.004	0.075
ln8_	0.661	0.050	13.320	0.000	0.563	0.760
lnoxo_sq	7,212.578	1,381.033	5.223	0.000	4,464.756	9,960.400
Irad	0.623	0.145	4.287	0.000	0.334	0.913
n40_	0.013	0.003	5.017	0.000	0.008	0.019
n41_	-0.023	0.007	-3.133	0.002	-0.037	-0.008
yrblt	0.006	0.001	6.346	0.000	0.004	0.008

Average Damage per household = **$ 6,436.738**
Comment: 83.2% data can be related, high Adj.RSqr indicates better fit, statistically significant except for 'dista1', medium to high t-stat values indicate fair relationship.

Using Square Root of Pollution (Inoxo^0.5)

Dependent Variable: Natural_log_of_Price   *RunTime: Nov 29, 2011 2:58 AM*

Independent Variables: dista1, In3_, In8_, Inoxo_sqrt, Irad, n40_, n41_, yrblt

<u>**Descriptive Statistics**</u>

<u>**Correlation Matrix**</u>

<u>**Regression Statistics**</u>

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

<u>**Summary Table**</u>

Variable	Coeff	Std.Err.	t-Stat.	P-value	Lower95%	Upper95%
Intercept	-37.137	8.007	-4.638	0.000	-53.069	-21.205
dista1	0.020	0.010	1.987	0.050	0.000	0.040
In3_	0.035	0.020	1.770	0.080	-0.004	0.075
In8_	0.662	0.050	13.319	0.000	0.563	0.760
Inoxo_sqrt	213.750	40.955	5.219	0.000	132.262	295.238
Irad	0.626	0.146	4.301	0.000	0.337	0.916
n40_	0.013	0.003	5.014	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

Average Damage per household = **$ 6,427.304**
Comment: 83.2% data can be related, high Adj.RSqr indicates better fit, statistically significant except for 'dista1', medium to high t-stat values indicate fair relationship.

Using Natural Log of Pollution – LN(Inoxo)

Dependent Variable:		Natural_log_of_Price			*RunTime: Nov 29, 2011 3:12 AM*	
Independent Variables:		dista1, ln__Inoxo, ln3_, ln8_, lrad, n40_, n41_, yrblt				

Descriptive Statistics

Correlation Matrix

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	72.662	13.048	5.569	0.000	46.700	98.624
dista1	0.020	0.010	1.989	0.050	0.000	0.040
ln__Inoxo	20.835	3.993	5.218	0.000	12.890	28.779
ln3_	0.035	0.020	1.771	0.080	-0.004	0.075
ln8_	0.662	0.050	13.319	0.000	0.563	0.760
lrad	0.628	0.146	4.305	0.000	0.338	0.918
n40_	0.013	0.003	5.012	0.000	0.008	0.019
n41_	-0.023	0.007	-3.131	0.002	-0.037	-0.008
yrblt	0.006	0.001	6.345	0.000	0.004	0.008

Average Damage per household = **$ 49.970**
Comment: 83.2% data can be related, high Adj.RSqr indicates better fit, statistically significant except for 'dista1', medium to high t-stat values indicate fairly strong relationship.

Conclusion

- Changing pollution variables to natural logarithm of pollution (ln(Inoxo)) and natural logarithm of price to price only, drastically reduces average damage cost per household to $49.97 and $777.308 respectively.

- Considering above models, natural log of pollution gives comparable quality results to the base model, yet indicating average damage cost per household as only $49.97.

- This indicates a total cost to WRG in 2008 dollars as $49.97 x 64,000 x 2.6023 (where 2.6023 is inflation factor) = **$8,322,363.584 ~ $8.3 Millions**

Recommendations

- The model provided by Activists' is neither exhaustive nor robust. It does not substantiate underline assumptions in using non-linear fits in the regression model. Therefore, recommended WTP of $400 Million should not be accepted.

- Based on the above model, estimated damage of $8.3 million (in 2008 dollars) can be assumed.

- An extended regression study is recommended which would consider different non-linear forms for involved variables to come up with a better fit in regression model and thus a fair average damage cost.

- For simplicity Nyanza site proximity was not considered. Extended analysis should consider eliminating 42 observations that are within 10 miles of Acton but are closer to Nyanza than Acton.