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STATE HIGHWAY ADMINISTRATION

RESEARCH REPORT

NOISE BARRIER EVALUATION STUDY

MORGAN STATE UNIVERSITY

SP308B4A
FINAL REPORT

May 2005

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16. Abstract

The main objective of this study was to determine the property value impacts of highway noise, visual disutility, and the mitigating impact of noise barriers. The study examined over 7,000 residential properties sold between 1994 and 2002 in highway corridors in Maryland. Variables for location to the highway, mitigation efforts, and visual disutility (having a direct view of the highway) were all evaluated to fully assess the impact a highway has on a properties next to or near the highway.

The findings of the study are presented starting on page 40 of the report.

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Noise Barrier Evaluation Study

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I. INTRODUCTION

This study was conducted under a contract from the Maryland State Highway Administration to determine the impact on residential property values of highway infrastructure, and noise barriers in particular. The main focus of the study was to determine the property value impacts of highway noise, visual disutility, and the mitigating impact of noise barriers.

The data were collected from housing sales in Maryland from 1995 to 2002. All properties sold within a few blocks of the highways in the study were included. Due to budgetary constraints, not all highways in the state were studied. The data are more fully described below (including the regions and highways included in the sample).

The report is divided into six sections. Section II contains a review of the literature on the impact of highways on residential property values. This section contains an overview of the current consensus concerning the impact of highways on property values and mitigation efforts. Section III contains a detailed description of the data and the methodology utilized in this study. Section IV contains the results of the statistical analysis and interpretation of these results. Section V contains a comparison of the various estimations and their strengths and weaknesses. Section VI contains concluding remarks and recommendations. There is an appendix that contains some more basic summary results from the data that might be of interest to readers of the report. The results in this section do not bear directly on the topic of the paper but enhance the understanding of the property values in the sample. Sections III and IV are highly technical and those looking for summary results might wish to start with the appendix and sections V and VI.

II. CURRENT CONSENSUS CONCERNING THE IMPACT OF HIGHWAY PROXIMITY ON PROPERTY VALUES

There have been a number of studies over the years on property values relative to proximity to urban centers or transportation infrastructure. Basic results exist for the value of being near transportation and for avoiding the noise that such infrastructure normally causes. There is no definitive answer, however, as to how much a homeowner is cost by being located next to a highway. Or, perhaps more importantly for policy makers, how much the construction of a highway damages the homeowner in the long run.

Studies began in the 1970's with federal legislation that mandated an examination of the impacts of noise pollution (if not the correction of the problem). Early studies concentrated primarily on local models of property values that sought to determine the damages attributable to highway noise. These studies found varying degrees of damages and significances. In general small, but significant, damages were attributable to highway noise.

Gamble (1974) and Anderson and Wise (1977) both studied the Towson corridor, which is included in the current study. Anderson and Wise also studied a portion of the I-95 corridor, which is also included in the current study. The results of these two studies in the Towson area reflect a $141 and $129 cost per decibel respectively. This equates to 0.43 to 0.47% per decibel. These results are consistent with the results found in other studies. While the current study does not explicitly model noise, the results are compatible with noise findings of these previous studies.

Nelson (1982) summarizes the results of nine early studies. He reports the average damage from noise to be in the neighborhood of 0.4% per decibel. More recent studies have found similar results. Becker and Lavee (2003) study the damages from noise in a study of Israeli housing. They find that high noise areas receive a 1.2% reduction in property value in urban areas and a 2.2% reduction in property value in rural areas. Huang and Palmquist (2001) found that a 2.5 decibel reduction in noise yielded a 1.4% increase in property value. A discrete analysis of houses 1000 feet from the highway by Bailey (1977) shows that this distance increases property values by 7.5%. While the figures seem to be very different, the 7.5% figure is not incompatible with those of the other studies.

It can easily be seen that these figures are confusing to a lay reader of the statistical study. The current study removes the issue of measuring impacts per decibel in an effort to make the results more general and to ease the interpretation for lay readers of the report.

Becker and Lavee also look at scenic views for property values. They find that a view of the sea added 2.4% to the property value and a view of open space (nature) added 2.0% to the property value. This is the only study that explicitly modeled the view as a determinant of property value. There was no variable to capture the view of the highway as a potential negative for property value.

There is also some literature on the desirability of transportation infrastructure. Haider and Miller (2000) find a positive correlation between property values and distance from transportation infrastructure. They find that property values increase close to access points for the infrastructure (subway stations as an example). The impact of being near an access point is to raise property values by approximately 1.6%. Taylor (1995) finds that property owners might desire a higher level of highway expenditure in Connecticut. Modeling the use of government funds across various spending categories and using housing prices as an indicator of the preferences of citizens, Taylor shows that there is a demand for highway expenditures in excess of current levels in the Hartford, Connecticut market. Both of these studies underline the importance of transportation infrastructure to regional economic performance.

These studies point out the fundamental problem in highway construction. Regional considerations dictate that highways are a net good and that they are in high, often unmet, demand. Local considerations show that highways have negative impacts on the adjacent properties. The compensation of these property owners is an important part of federal and local highway department policy. Previous studies have not sufficiently addressed the question of the impact of this externality on property owners to allow right of way issues to be addressed uniformly. This study provides a more general and consistent baseline for addressing the impact of the externality of highway presence on property values.

III. DATA AND METHODOLOGY

The study was conducted with data previously gathered for a FHWA study that coordinated with the Maryland State Highway Administration. The data are representative of homes sold in proximity of highways from 1995 to 2002. Table 1 contains summary statistics for the data.

TABLE 1 - Summary Statistics					
Variable	N	Mean	Std Dev	Minimum	Maximum
List Price	4750	132,090	63,751.86	900	685,000
Settlement Price	4750	129,677.9	63,440.21	10,200	799,900
No.of Bedrooms	4750	3.180632	0.761107	1	9
No. of Full Baths	4750	1.702526	0.691779	1	13
No.of Half Baths	4750	0.678105	0.672979	0	13
No. of Levels	4750	2.182316	0.741643	1	5
No. of Fireplaces	4750	0.417957	0.590732	0	6
Lot Square Feet	4750	14,211.5	31,348.06	500	522,720
Age	4629	29.23094	23.73089	-1	178
Days on Listing	4750	81.21179	90.43855	1	702
Square Feet	4750	1,459.33	574.9638	500	9,750
1994	4750	0.000421	0.020517	0	1
1995	4750	0.061474	0.240222	0	1
1996	4750	0.085053	0.278989	0	1
1997	4750	0.124	0.329616	0	1
1998	4750	0.138737	0.345708	0	1
1999	4750	0.164	0.370315	0	1
2000	4750	0.160421	0.367035	0	1
2001	4750	0.196421	0.397332	0	1
2002	4750	0.069053	0.25357	0	1
January	4750	0.069474	0.254285	0	1
February	4750	0.086737	0.281479	0	1
March	4750	0.101684	0.302264	0	1
April	4750	0.102737	0.303647	0	1
May	4750	0.093474	0.291126	0	1
June	4750	0.096632	0.295487	0	1
July	4750	0.089684	0.285759	0	1
August	4750	0.083368	0.276467	0	1
September	4750	0.06779	0.251411	0	1
October	4750	0.076211	0.265363	0	1
November	4750	0.069474	0.254285	0	1
December	4750	0.062737	0.242515	0	1
Anne Arundel County	4750	0.088842	0.284546	0	1

TABLE 1 - Summary Statistics					
Variable	N	Mean	Std Dev	Minimum	Maximum
Baltimore County	4750	0.134947	0.341703	0	1
Baltimore City	4750	0.424632	0.494339	0	1
Calvert County	4750	0.032	0.176019	0	1
Cecil County	4750	0.006947	0.08307	0	1
Charles County	4750	0.014526	0.119659	0	1
Frederick County	4750	0.035158	0.184198	0	1
Harford County	4750	0.099158	0.298905	0	1
Howard County	4750	0.042105	0.20085	0	1
Prince George's County	4750	0.1	0.300032	0	1
Saint Mary's County	4750	0.014947	0.121355	0	1
Washington County	4750	0.005053	0.07091	0	1
Basement	4750	0.724	0.447064	0	1
Distance from Highway	4750	578.4964	637.864	10	10,280.36
Driving Distance from Highway	4750	1.602728	1.364188	0.06	18.2
Adjacent to Highway	4750	0.055368	0.228722	0	1
Noise Barriers	4750	0.104211	0.305566	0	1
Can SEE Highway	4750	0.057263	0.232369	0	1

A quick summary of the important items from this table is given here. The average list price was about \$132,000 while the average sales price was about \$129,500. The "average house" had just over three bedrooms, about one and two-thirds full baths and two-thirds of a half bath, just over twolevels and just under ½ a fireplace. The average house had a lot size of about 14,000 square feet and about 1,400 square feet of living space. In addition the average house was about 30 years old and stayed on the listing service for just under three months. Almost 20% of the sample sold in 2001 and other years represented between 6 and 16% (discarding 1994). March and April represent just over 10% of the sales each and December represents just over 6% of the sales. All other months lie between these figures. Baltimore County represents 42% of the sample while Baltimore City represents 13%. All other counties represent a smaller percentage of the sample than these two. The average house was a bit over 500 feet from the highway and was located 1.6 miles from the highway ramp. About 5.5% of the homes in the sample were adjacent to the highway and about 10.4% were located in an area shielded by noise barriers. Approximately 5.7% of the properties had an unobstructed view of the highway.

The data were restricted to lie within certain boundaries to assure that the data were not skewed by outliers or misrepresented data on the Multiple Listing Service (MLS). These values are given in the maximum and minimum columns above. Values outside these ranges were assumed to be outliers or errors that could skew the data analysis.

The base correlations between the variables and the price of the properties are presented in Appendix B. For each of the variables, the relationship with property value is expressed graphically. Most of the variables have the relationship expected with even a cursory knowledge of property values.

The methodology employed in this study will be to model the value of the property on the explanatory variables obtained and to interpret the results from the regressions. There will be some other statistical tools utilized but the basic analysis will be regression modeling of the property value on the explanatory variables.

There are two different types of relationships explored: linear and log. For each of these relationships there are four models of varying degrees of discreteness (explained below). There is no reason to believe that the relationship between the explanatory variables and the property value is either log or linear. Most economic relationships seem to be more log oriented, but no theory rules out the linear case. Thus both are presented throughout the report.

The first model is described here and the additions to the model used to create the following three estimations are left for the results section. The first is a simple relationship between the property value and the explanatory variables. The regression is of the form:

$$V_{it} = \alpha + \beta X_{it} + \varepsilon_{it}$$

where V_{it} is the value of property i in period t, α is the constant term, β is the vector of parameter estimates, X_{it} is the vector of explanatory variables and ε_{it} is the error term for property i in period t. The vector of explanatory variables used in the regression is detailed below with a description of each variable. Ordinary Least Squares (OLS) techniques are used to examine the data. While some temporal error problems may exist, the lack of repeated observations of the same property precludes normal means of correcting this. This is important only for inference and not for the level of the variables themselves. This will be discussed further in the results section.

Bedrooms – is the number of bedrooms listed on the MLS form by the listing agent.
Bathrooms – is the number of full bathrooms listed on the MLS form by the listing agent.
Half Baths – is the number of half bathrooms listed on the MLS form by the listing agent.
Levels – is the number of levels listed on the MLS form by the listing agent.
ListTime – is the number of days the property was listed on the MLS before selling.
Fireplace – is the number of fireplaces listed on the MLS form by the listing agent.
Age – is the age of the home as listed by the agent on the MLS form.
Squarefeet – is the square footage of the home as listed on the MLS form by the listing agent.
Lotsqft – is the square footage of the property as listed on the MLS form by the listing agent.
Distance – is the number of feet from the center of the property to the right of way as depicted in ##.
Distance2 – is the square of the demeaned distance variable.
Drive – is the number of miles from the address of the property to the onramp of the highway as found in Yahoo Maps.
Drive2 – is the square of the demeaned drive variable.
Basement – is a dummy variable that is 1 if the listing agent declared the home to have a basement and 0 otherwise.
Adjacent – is a dummy variable that is 1 if the property is adjacent to the highway right of way and 0 otherwise.
See – is a dummy variable that is 1 if there is a view of the highway from the property and 0 otherwise.

Noise – is a dummy variable that is 1 if there are noise barriers between the property and the highway and 0 otherwise.

In the log regressions, all of the non-dummy variables are taken in log form (including the sales price). The form of the regression remains the same and the estimation methodology remains OLS. A correction is necessary to the Bathroom variables in the log regressions since there are often no half bathrooms and this is troublesome. A NumBath variable is created with the following formula:

$$NumBath = Bathrooms + .5 * HalfBaths$$

This variable is used in place of Bathrooms and HalfBaths in the log regressions. In addition, all variables that take on the value 0 are replaced with .001 before taking the log. This is a rare occurance and the impact of this action is discussed in the results section.

IV. RESULTS

The results are presented for each of the eight models in increasing level of detail and, presumably, accuracy. Each subsection contains both the linear and log regression results for the model.

IV.A. Model 1

The first model presented contains the variables listed in the last section. There is no control for location or date of sale. The results of the linear regression are presented in Table 2.

The goodness of fit measures show that this model does a fairly good job of describing property values in aggregate. The F statistic shows that the model is relevant at well above the 99% level and the R^2 statistic shows that almost two-thirds of the variance in property values is explained by this model. While the fit is fairly strong, there are many reasons to believe that this model is not the most appropriate and this will be discussed in detail after the presentation of the other models. All of the variables have the expected sign and the magnitudes are not all that surprising. The parameter estimates will be quickly summarized here. All estimates except those for HalfBaths, Levels, See the highway and the distance variables are significant at the 95% or 99% level.

According to this estimation an extra bedroom raises the value of the property by almost $12,000 while an extra full bathroom raises the property value by about $10,500. A half bathroom raises the value of the property by about $575. An extra level in the house adds almost no value at all. For every extra day that the property remains on the listing without selling the property decreases in value by about $42 (or $1300 per month). A fireplace raises the property value by about $18,500. A house goes down in value about $450 per year or $4,500 per ten years as it ages. A square foot of living space increases the property value by about $48. So, an extra 100 square feet raises the property value by about $4,800. Every square foot of the lot adds $0.37. So, an extra 1000 square feet of lot raises the property value by $365. The presence of a basement raises the property value by about $3,250.

TABLE 2 - Regression Results for Linear Model 1[1]		
Number of Observations		4628
Measure of Fit		Value
F		496.33**
R^2		.6466
Adjusted R^2		.6453
Variable	**Parameter Estimate**	**Standard Error**
Intercept	127,505**	1,127.35895
Bedrooms	11,800**	906.32377
Bathrooms	10,683**	993.99263
HalfBaths	579.58061	927.79838
Levels	1.61967	830.77846
ListTime	-42.69763**	6.15883
Fireplace	18,586**	1,064.25909
Age	-451.46472**	26.88881
Squarefeet	47.90756**	1.32243
LotSqft	0.36537**	.01917
Basement	3,259.14651*	1,326.6625
Adjacent	-8,899.43561**	2,740.54176
See	-3,858.03964	2,594.31049
Noise	7,046.59096**	1,965.25532
Distance	0.75556	1.27355
Drive	182.43595	582.61096
Distance2	-0.00033641	.00038884
Drive2	86.67409	58.51481

The highway proximity variables have the basic values that might be expected. Being adjacent to the highway right of way lowers the property value by almost $9,000. Being able to see the highway lowers the value by almost $4,000. The presence of noise barriers raises the property value by about $7,000. The variables for distance from the highway reveal an interesting relationship if it remains true with further specifications. The linear distance from the highway right of way has a positive influence on property values: The further from the highway the higher the property value. As Table 3 shows, the increase in value peaks at around 1000 feet from the right of way. The decreasing relationship after this distance may be an artifact of this model. More will be said later on this non-linear relationship.

[1] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

Table 3 - Impact of Distance from Right of Way on Property Value			
Distance	Value Increase	Distance	Value Increase
0	$0.00	400	$248.40
50	$36.94	450	$271.88
100	$72.19	500	$293.68
150	$105.76	750	$377.44
200	$137.66	1000	$419.15
250	$167.86	1500	$376.42
300	$196.39	2000	$165.48
350	$223.24	2500	-$213.66

Table 4 shows the same relationship for driving distance. This relationship is non-linear but monotonically increasing. There seems to be a large premium for homes located a long distance from highways. Homes more than 5 miles from the highway have values from $3,000 to $30,000 greater than those located close to highway onramps. More will be said once location variables are added to the regression.

Table 4 - Impact of Driving Distance from Highway on Property Value			
Driving Distance	Value Increase	Driving Distance	Value Increase
0.1	$19.11	4	$2,116.53
0.5	$112.89	5	$3,079.03
1	$269.11	7.5	$6,243.69
1.5	$468.67	10	$10,491.77
2	$711.57	12.5	$15,823.28
2.5	$997.80	15	$22,238.21
3	$1,327.37	17.5	$29,736.57

Model 1 is also estimated for a log form. The same variables are included with the exception of the bathrooms variable explained above. The log regression results are presented in Table 5.

Again the measures of fit are quite good. In fact, they are slightly better than in the linear model. Most of the variables of interest have highly significant coefficients. The number of bedrooms, number of bathrooms, number of levels, number of fireplaces, square feet of the house, square feet of the lot, presence of a basement and noise barriers all raise the property values. The number of days listed before selling, age of the home, being adjacent to the right of way and being able to see the highway all lower the value of the property. All of the distance variables have negative values. This is the exact opposite of the linear model. While the log model seems to have better fit, judgment on the true direction of the distance impact will need to be reserved until later models.

TABLE 5 - Regression Results for Log Model 1[2]		
Number of Observations	4508	
Measure of Fit	Value	
F	590.67**	
R^2	.6778	
Adjusted R^2	. 6767	
Variable	**Parameter Estimate**	**Standard Error**
Intercept	11.66637**	0.00900
Bedrooms	0.21117**	0.02102
Bathrooms	0.20417**	0.01410
Levels	0.04860**	0.01197
ListTime	-0.03533**	0.00318
Fireplace	0.01430**	0.00101
Age	-0.12591**	0.00517
Square Feet	0.28875**	0.01737
LotSqft	0.16198**	0.00446
Basement	0.01824†	0.00964
Adjacent	-0.07961**	0.01988
See	-0.05985*	0.01884
Noise	0.09005**	0.01406
Distance	-0.00877*	0.00438
Drive	-0.00631	0.00559
Distance2	-0.00925**	0.00280
Drive2	-0.00816†	0.00433

In order to see the level of impact these variables have, a conversion back to property values is required. Table 6 presents this conversion for all of the logged variables.

This table converts the values in the log regression into percent and dollar values. The dummy variables are shown separately at the bottom because they are already in percent form in the regression. The table shows the percent and dollar change in the value of the average property from a change in each variable. This is done at the mean (columns five and six) and at an alternative level (columns nine and ten).

For almost all of the variables, the impact of increasing their value decreases as the size of the home increases. This is standard in economics as the law of diminishing returns is expected to operate. There is no reason to believe that this is not the case with property values and this is the reason that log regressions are often preferred.

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[2] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

Table 6 - Dollar Value Impacts from Log Regression Results									
Variable	Estimate	Mean	New Level	Percent Change	Value Change	Alternate Level	New Alternate Level	Percent Change	Value Change
Bedrooms	0.21117	3.18	4	4.84%	$5,643.06	5	6	3.85%	$4,488.59
Bathrooms	0.20417	2.04	3	7.86%	$9,161.52	4	5	4.56%	$5,311.49
Levels	0.0486	2.18	3	1.55%	$1,803.07	3	4	1.40%	$1,630.01
ListTime	-0.03533	81.21	180	-2.81%	-$3,278.24	180	270	-1.43%	-$1,670.08
Fireplace	0.0143	0.001	1	9.88%	$11,516.30	3	4	0.41%	$479.61
Age	-0.12591	29.23	60	-9.05%	-$10,556.01	90	120	-3.62%	-$4,222.92
Square Feet	0.28875	1459.33	1560	1.93%	$2,245.65	2,400	2,500	1.18%	$1,374.22
LotSqft	0.16198	14211.5	15200	1.09%	$1,269.86	7,000	8,000	2.16%	$2,521.65
Distance	-0.00877	578.50	675	-0.14%	-$157.74	1,000	1,100	-0.08%	-$97.45
Distance2	-0.00925	334658.1	455625	-0.31%	-$355.91	12	13	-0.18%	-205.57
Drive	-0.00631	1.603	2.6	-0.29%	-$332.75	1,000,000	1,210,000	-0.05%	-$58.88
Drive2	-0.00816	2.569	6.76	-0.79%	-$920.51	144	169	-0.13%	-$152.29
Distance Tot					-$490.50				-$303.02
Drive Tot					-$1,276.42				-$211.18
Basement	0.01824	0.724	1(from 0)	1.82%	$2,126.50				
Adjacent	-0.07961	0.0554	1(from 0)	-7.96%	-$9,281.28				
See	-0.05985	0.104	1(from 0)	-5.99%	-$6,977.57				
Noise	0.09005	0.057	1(from 0)	9.01%	$10,498.42				

The value of an extra bedroom is almost 5% at the mean (3 bedrooms) and almost 4% if there are already 5 bedrooms. This translates to values of about $5,500 and $4,500 respectively. An extra bathroom is worth about 8% ($9,000) for the average house and 4.5% ($5,300) if there are already 4 bathrooms in the house. A house with 3 levels is worth about 1.5% ($1,800) more than the same house with 2 levels but a house with 4 levels is worth only about 1.4% ($1,700) more than a house with 3 levels. A house that takes 6 months to sell is worth 2.8% ($3,300) less than one that sells in 3 months. A house that remains on the market 9 months is worth 1.4% ($1,700) than a house that takes 6 months to sell.

The value of adding the first fireplace is approximately 10% ($11,500) while the value of adding the fourth fireplace is about .4% ($500). A home that is 60 years old is worth about 9% ($10,500) less than one that is 30 years old. A home that is 120 years old is worth 3.6% ($4,200) less than a home that is 90 years old. The presence of a basement is worth about 1.8% ($2125) on the average home. The square footage variables show a strong relation with property values. A house with 1560 square feet is worth 1.9% ($2,250) more than a house with the average 1460 square feet. A house with 2,500 square feet is worth 1.2% ($1,400) more than a house with 2,400 square feet. A house with 15,200 square feet of lot space is worth 1% ($1,275) more than a house with a 14,200 square foot lot. For a house that has a lot more like the average urban lot, an increase from 7,000 to 8,000 square foot lot size increases the value of the home by 2.2% ($2,500).

The distance variables, which are all negative in this estimation, are summed up for discussion. A house that is located 675 feet from the right of way instead of the average of 578 is worth .4% ($500) less. A house that is located 1,100 feet from the right of way is worth .25% ($300) more than a house located 1,000 feet from the right of way. For driving distance, a house that is 2.6 miles from the highway is worth 1.1% ($1,300) less than a house that is 1.6 miles from the highway. A house that is 13 miles from the highway is worth .2% ($200) less than a house that is 12 miles from the highway. The diminishing returns are very obvious in this variable.

The highway variables are all of the expected sign and are similar in level to the linear regression. Being adjacent to the highway decreases the property value by 8% ($9,250 on the average home). Being able to see the highway decreases the property value by 6% ($7,000 on the average home). Having noise barriers raises the property value by 9% ($10,500 on the average home).

It is important to note that all of these relationships are percentages. The impact of all of these variables on a $250,000 home are double what it is on a $125,000 home when regarded in dollar values. In the conclusions section, a detailed examination of which regression type fits better and how this impacts the values is presented.

IV.B. Model 2

In Model 2, controls are added for the date the house was sold. Obviously, real estate markets are not uniform over time. There are high price and low price periods in the market, as in any other commodity or equity market. Model 2 is identical to Model 1 except that these controls are added. The controls are added in the form of fixed effects for the month of sale and the year of sale. This means that a series of dummy variables are added for the months and years. The month of December and the year 1998 are dropped to allow estimation and these become the base time periods to which the coefficients are compared. This model is estimated for both the linear and log models. Table 7 contains the results from the linear regression estimation of Model 2.

TABLE 7 - Regression Results for Linear Model 2[3]		
Number of Observations	4628	
Measure of Fit	Value	
F	234.79**	
R^2	.6480	
Adjusted R^2	.6452	
Variable	**Parameter Estimate**	**Standard Error**
Intercept	130,858**	2,817.42329
Bedrooms	11,828**	909.40288
Bathrooms	10,690**	996.32428
HalfBaths	574.48571	927.33766
Levels	-1.48243	832.69706
ListTime	-42.37055**	6.17147
Fireplace	18,632**	1,067.98302
Age	-451.74510**	26.99697
Squarefeet	47.82412**	1.32502
LotSqft	0.36613**	0.01922
Basement	3,233.1214*	1,329.18751
Adjacent	-8,860.37811**	2,748.72487
See	-3,964.44481	2,599.87307
Noise	7,026.25103**	1,970.70021
Distance	0.72474	1.27671
Drive	255.00371	584.30986
Distance2	-0.00034019	0.00038938
Drive2	76.43581	59.51294
1994	10,965	27,423
1995	1,271.24511	2,708.06302
1996	3,672.10347	2,424.13573
1997	-904.72194	2,170.98133
1999	355.79510	2,028.36571
2000	677.58059	2,041.55946
2001	-439.39990	1,951.97447
2002	2,516.97634	2,706.29783
January	-4,491.56023	3,107.28292
February	-3,732.35770	2,977.81657
March	-2,190.84019	2,865.69185
April	-6,744.68905*	2,856.70177
May	-3,493.42748	2,896.90983

[3] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

TABLE 7 - Regression Results for Linear Model 2[3]		
Variable	**Parameter Estimate**	**Standard Error**
June	-7,049.48932*	2,861.38724
July	-2,791.38127	2,904.83378
August	-5,376.74130†	2,950.43066
September	-2,897.65896	3,086.92263
October	-3,730.25829	3,021.10211
November	-1,394.15435	3,076.80337

The first notable result from Table 7 is that the fit did not improve with the addition of these new variables. Controlling for time did not seem to make a difference in the amount of variance explained. This is partially a function of the relatively flat real estate market in the state of Maryland during this period. In periods with more drastic changes to housing values, the year dummy variables would likely improve the fit of the estimation dramatically. The largest change from the first estimation is that most of the variables have lowered the value of their impact on property value.

All of the variables have nearly an identical impact as in Model 1. Only the new variables will be discussed here. The impact of the year variables shows the difference in property value that can be explained by the year it was sold after all other variables are controlled for. If the data were a series of sales of the same homes, this would be of great interest and would have a strong correlation to the strength of the housing market in that year. With the current data, with not many repeat sales of the same property, the year dummies have less significance as far as their interpretation. None of these variables are significant at even the 90% level. The value for 1994 is an outlier because there were only two homes in the data from that year. There is a general trend upward in the coefficients for the years (recall that the value of 1998 would be 0 as it is the base year). Since none of the coefficients are significant care must be taken in interpreting the lack of a steep increase in housing prices over time. More will be said of this later after fully controlling for all aspects of property value.

The month variables show a somewhat surprising trend. The value for sales in December (0) is the highest observed. The lowest coefficients are those for April, June and August. These three months values are also significant at the 90% or 95% level. This seems to be in contrast to the perception that there are higher prices for homes over the summer when the market is “hot”. The appendix has a figure that shows raw data for property sales by month. The lack of a trend in the data shows up there also. More will be said of this below after controlling for some other factors.

Table 8 shows the results for the log estimation of Model 2.

TABLE 8 - Regression Results for Log Model 2[4]		
Number of Observations	4508	
Measure of Fit	Value	
F	270.13**	
R^2	.6788	
Adjusted R^2	.6763	
Variable	**Parameter Estimate**	**Standard Error**
Intercept	11.66629**	.02060
Bedrooms	.21093**	.02108
Bathrooms	.20379**	.01414
Levels	.04847**	.01201
ListTime	-.03530**	.00319
Fireplace	.01433**	.00101
Age	-.12603**	.00520
Squarefeet	.28905**	.01742
LotSqft	.16212**	.00447
Basement	.01840†	.00967
Adjacent	-.08085**	.01993
See	-.06058	.01889
Noise	.09018	.01411
Distance	-.00895*	.00440
Drive	-.00608	.00562
Distance2	-.00923**	.00281
Drive2	-.00866*	.00436
1994	.20268	.19041
1995	-.00502	.01929
1996	.02547	.01736
1997	.00208	.01554
1999	.01801	.01453
2000	-.00505	.01464
2001	-.00497	.01399
2002	.00837	.01949
January	.00209	.02244
February	.00462	.02143
March	.00197	.02062
April	-.01651	.02053
May	.00577	.02084

[4] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

TABLE 8 - Regression Results for Log Model 2[4]		
Variable	**Parameter Estimate**	**Standard Error**
June	-.02247	.02056
July	.00602	.02090
August	-0.1169	.02119
September	-.00862	.02222
October	-.00217	.02161
November	.00293	.02208

As in the linear estimation for Model 2, the fit is no better after adding the time variables. This is a bit surprising, as it was in the linear model, but after other factors are added as control variables more can be said on this. The variables have nearly identical impacts as in Model 1 with the addition of the time dummy variables. Table 9 translates these results into percent and dollar values.

Table 9 - Dollar Value Impacts from Log Regression Results									
Variable	Estimate	Mean	New Level	Percent Change	Value Change	Alternate Level	New Alternate Level	Percent Change	Value Change
Bedrooms	0.21093	3.18	4	4.83%	$5,636.64	5	6	3.85%	$4,483.49
Bathrooms	0.20379	2.04	3	7.84%	$9,144.47	4	5	4.55%	$5,301.60
Levels	0.04847	2.18	3	1.54%	$1,798.24	3	4	1.39%	$1,625.65
ListTime	-0.0353	81.21	180	-2.81%	-$3,275.45	180	270	-1.43%	-$1,668.66
Fireplace	0.01433	0.001	1	9.90%	$11,540.46	3	4	0.41%	$480.62
Age	-0.12603	29.23	60	-9.06%	-$10,566.07	90	120	-3.63%	-$4,226.95
Square Feet	0.28905	1459.33	1560	1.93%	$2,247.99	2400	2500	1.18%	$1,375.65
LotSqft	0.16212	14211.5	15200	1.09%	$1,270.95	7000	8000	2.16%	$2,523.83
Distance	-0.00895	578.50	675	-0.14%	-160.98	1,000	1,100	-0.085%	-99.45
Distance2	-0.00923	334658.1	455625	-0.28%	-332.03	12	13	-0.18%	-205.12
Drive	-0.00608	1.603	2.6	-0.29%	-342.94	1,000,000	1,210,000	-0.049%	-56.74
Drive2	-0.00866	2.569	6.76	-0.84%	-976.92	144	169	-0.14%	-161.63
Distance Tot					-493.01				-304.57
Drive Tot					-1,319.85				-218.36
Variable	**Estimate**	**New Level**	**Percent Change**	**Value Change**	**Variable**	**Estimate**	**New Level**	**Percent Change**	**Value Change**
Basement	0.0184	1(from 0)	1.84%	$2,145.15	January	0.00209	1(from 0)	0.21%	$243.66
Adjacent	-0.08085	1(from 0)	-8.09%	-$9,425.84	February	0.00462	1(from 0)	0.46%	$538.62
See	-0.06058	1(from 0)	-6.06%	-$7,062.68	March	0.00197	1(from 0)	0.20%	$229.67
Noise	0.09018	1(from 0)	9.02%	$10,513.57	April	-0.01651	1(from 0)	-1.65%	-$1,924.81
1994	0.20268	1(from 0)	20.27%	$23,629.31	May	0.00577	1(from 0)	0.58%	$672.69
1995	-0.00502	1(from 0)	-0.50%	-$585.25	June	-0.02247	1(from 0)	-2.25%	-$2,619.65
1996	0.02547	1(from 0)	2.55%	$2,969.40	July	0.00602	1(from 0)	0.60%	$701.84
1997	0.00208	1(from 0)	0.21%	$242.50	August	-0.1169	1(from 0)	-11.69%	-$13,628.71
1999	0.01801	1(from 0)	1.80%	$2,099.68	September	-0.00862	1(from 0)	-0.86%	-$1,004.96
2000	-0.00505	1(from 0)	-0.51%	-$588.75	October	-0.00217	1(from 0)	-0.22%	-$252.99
2001	-0.00497	1(from 0)	-0.50%	-$579.42	November	0.00293	1(from 0)	0.29%	$341.59
2002	0.00837	1(from 0)	0.84%	$975.81					

The variables from Model 1 all have nearly identical impacts as in that model. The year variables have roughly the same pattern that was observed in the linear estimation of this model. Again, 1994 is an outlier and should be ignored since only two homes were sold that year. The lack of a pattern in the year dummy values continues and remains a bit surprising. The month variables also show almost no pattern. Unlike the linear model, there are five months with values lower than December and six with values greater than December. The highest value is for the month of July, $700 more than that of December. The lowest value is for August with a value $13,000 lower than December. More will be said of this after other variables are added as controls.

IV.C. Model 3

The third model adds a variable for the county in which the property was located. In lieu of fully identifying location, as in the following model, the dummy variables serve as a first approximation to location. This intermediate step is performed to allow comparison with a full control of location. After Model 4, and the individual estimations, it will be possible to choose between the various means of controlling for location to determine the appropriate trade-off between specificity and generally usable results. As in Model 2, December and 1998 are the base years. Harford County is the county dropped from the estimation and thus Harford County becomes the base for these observations.

Table 10 contains the results from the linear estimation of Model 3.

The increase in fit is very slight from adding these variables. From this measure, it appears that the addition of the county variables did not fully account for location. More will be said of this after other means of controlling for location are presented. Again, the results for the variables are nearly identical to the first two estimations. Further comment on the results for these variables will be left for after the final estimations. The county variables are discussed briefly here.

Harford County was chosen as the base since it was a county that had a reasonable number of observations and had an average property value close to the average for the sample. The values of all the other counties are relative to Harford County. Only about one-third of the values were significant. Only two counties, Calvert and Howard, had coefficients above Harford County. Howard County had the highest coefficient at about $9,000 higher than Harford County. The county with the lowest value was Washington County with a value about $16,000 lower than Harford County.

TABLE 10 - Regression Results for Linear Model 3[5]		
Number of Observations	4628	
Measure of Fit	Value	
F	181.52**	
R^2	.6506	
Adjusted R^2	.6470	
Variable	**Parameter Estimate**	**Standard Error**
Intercept	133,062**	3,343.491
Bedrooms	11,725**	910.2707
Bathrooms	10,651**	996.4178
HalfBaths	873.50115	937.7463
Levels	-71.75105	839.5055
ListTime	-41.23708**	6.18122
Fireplace	18,392**	1,069.721
Age	-457.262**	27.33181
Squarefeet	47.89941**	1.32985
LotSqft	0.36193**	0.01942
Basement	3,570.1719*	1,392.104
Adjacent	-8,608.152**	2,787.903
See	-4,144.784	2,609.822
Noise	7,717.7575**	1,989.048
Distance	0.49198	1.28648
Drive	305.06441	591.1357
Distance2	-0.000275	0.00039
Drive2	63.03289	59.84303
1994	11,018	27,355
1995	654.52829	2,720.019
1996	3,270.269	2,431.865
1997	-1,074.849	2,169.655
1999	229.47792	2,026.295
2000	339.65152	2,040.895
2001	-605.4927	1,956.716
2002	2,472.7397	2,716.707
January	-4,831.818	3,106.417
February	-4,081.967	2,977.686
March	-2,213.2	2,867.1
April	-6,700.266*	2,853.131
May	-3,916.494	2,895.642

[5] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

TABLE 10 - Regression Results for Linear Model 3[5]		
Variable	**Parameter Estimate**	**Standard Error**
June	-6,795.329*	2,858.426
July	-2,829.831	2,902.549
August	-5,350.443†	2,946.92
September	-3,105.813	3,082.981
October	-3,745.85	3,017.808
November	-1,207.009	3,071.536
Anne Arundel County	-723.5747	2,641.035
Baltimore County	-2,684.534	2,413.899
Baltimore City	-2,696.473	2,023.879
Calvert County	1,871.4769	3,605.496
Cecil County	-13,307†	6,853.101
Charles County	-7,886.685	5,077.624
Frederick County	-7,977.478*	3,535.056
Howard County	8,990.859**	3,282.766
Prince George's County	-4,863.456†	2,626.844
Saint Mary's County	-6,201.727	5,186.632
Washington County	-15,885	8,465.35

The results of the regression for the log model are presented in Table 11.

TABLE 11 - Regression Results for Log Model 3[6]		
Number of Observations	4628	
Measure of Fit	Value	
F	209.04**	
R^2	.6830	
Adjusted R^2	.6798	
Variable	**Parameter Estimate**	**Standard Error**
Intercept	11.65813**	0.0248
Bedrooms	0.21119**	0.021
Bathrooms	0.20252**	0.0141
Levels	0.05467**	0.0121
ListTime	-0.03357**	0.0032
Fireplace	0.01423**	0.001
Age	-0.12785**	0.0053
Squarefeet	0.28134**	0.0175
LotSqft	0.16294**	0.0045
Basement	0.01235	0.0101
Adjacent	-0.07851**	0.0201
See	-0.05616**	0.0189
Noise	0.09223**	0.0142
Distance	-0.00872*	0.0044
Drive	-0.00278	0.0057
Distance2	-0.00888**	0.0028
Drive2	-0.00777†	0.0045
1994	0.19986	0.1894
1995	-0.00807	0.0193
1996	0.02117	0.0174
1997	0.00169	0.0155
1999	0.01738	0.0145
2000	-0.00596	0.0146
2001	-0.00647	0.014
2002	0.00348	0.0195
January	0.00351	0.0224
February	0.00682	0.0214
March	0.00726	0.0206
April	-0.01361	0.0205
May	0.00608	0.0208
June	-0.01707	0.0205

[6] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

TABLE 11 - Regression Results for Log Model 3[6]		
Variable	**Parameter Estimate**	**Standard Error**
July	0.00899	0.0208
August	-0.00921	0.0211
September	-0.00703	0.0221
October	0.000725	0.0215
November	0.00758	0.022
Anne Arundel County	-0.01303	0.019
Baltimore County	0.01199	0.0177
Baltimore City	0.01109	0.0149
Calvert County	0.06216*	0.026
Cecil County	-0.11415*	0.0487
Charles County	-0.00573	0.0362
Frederick County	-0.05499*	0.0257
Howard County	0.11152**	0.0235
Prince George's County	0.00554	0.0191
Saint Mary's County	0.03867	0.0368
Washington County	-0.12662*	0.0599

The measures of fit, like the linear model, show a slight improvement over the first two models. Table 12 presents these results in percentage and dollar value form.

Table 12 - Dollar Value Impacts from Log Regression Results									
Variable	Estimate	Mean	New Level	Percent Change	Value Change	Alternate Level	New Alternate Level	Percent Change	Value Change
Bedrooms	0.21119	3.18	4	4.84%	$5,643.59	5	6	3.85%	$4,489.02
Bathrooms	0.20252	2.04	3	7.79%	$9,087.48	4	5	4.52%	$5,268.57
Levels	0.05467	2.18	3	1.74%	$2,028.26	3	4	1.57%	$1,833.59
ListTime	-0.03357	81.21	180	-2.67%	-$3,114.93	180	270	-1.36%	-$1,586.88
Fireplace	0.01423	0.001	1	9.83%	$11,459.93	3	4	0.41%	$477.26
Age	-0.12785	29.23	60	-9.19%	-$10,718.66	90	120	-3.68%	-$4,287.99
Squarefeet	0.28134	1459.33	1560	1.88%	$2,188.02	2400	2500	1.15%	$1,338.95
LotSqft	0.16294	14211.5	15200	1.10%	$1,277.38	7000	8000	2.18%	$2,536.60
Distance	-0.00872	578.50	675	-0.13%	-156.84	1,000	1,100	-0.083%	-96.89
Distance2	-0.00888	334658.1	455625	-0.27%	-319.44	12	13	-0.17%	-197.34
Drive	-0.00278	1.603	2.6	-0.13%	-156.8	1,000,000	1,210,000	-0.022%	-25.94
Drive2	-0.00777	2.569	6.76	-0.75%	-786.52	144	169	-0.12%	-145.01
Distance Tot					-$476.29				-$294.24
Drive Tot					-$1,033.32				-$170.96
Variable	**Estimate**	**New Level**	**Percent Change**	**Value Change**	**Variable**	**Estimate**	**New Level**	**Percent Change**	**Value Change**
Basement	0.01235	1(from 0)	1.24%	$1,439.82	June	-0.01707	1(from 0)	-2.25%	-$2,619.65
Adjacent	-0.07851	1(from 0)	-7.85%	-$9,153.03	July	0.00899	1(from 0)	0.60%	$701.84
See	-0.05616	1(from 0)	-5.62%	-$6,547.37	August	-0.00921	1(from 0)	-11.69%	-$13,628.71
Noise	0.09223	1(from 0)	9.22%	$10,752.57	September	-0.00703	1(from 0)	-0.86%	-$1,004.96
1994	0.19986	1(from 0)	19.99%	$23,300.54	October	0.000725	1(from 0)	-0.22%	-$252.99
1995	-0.00807	1(from 0)	-0.00807	-$940.84	November	0.00758	1(from 0)	0.29%	$341.59
1996	0.02117	1(from 0)	2.12%	$2,468.09	Anne Arundel County	-0.01303	1(from 0)	-1.71%	-$1,990.09
1997	0.00169	1(from 0)	0.17%	$197.03	Baltimore County	0.01199	1(from 0)	0.90%	$1,048.09
1999	0.01738	1(from 0)	1.74%	$2,026.24	Baltimore City	0.01109	1(from 0)	-0.92%	-$1,073.74
2000	-0.00596	1(from 0)	-0.60%	-$694.84	Calvert County	0.06216	1(from 0)	-0.70%	-$819.59
2001	-0.00647	1(from 0)	-0.65%	-$754.30	Cecil County	-0.11415	1(from 0)	0.073%	$84.52
2002	0.00348	1(from 0)	0.35%	$405.71	Charles County	-0.00573	1(from 0)	0.76%	$883.71
January	0.00351	1(from 0)	0.35%	$409.21	Frederick County	-0.05499	1(from 0)	-1.30%	-$1,519.09
February	0.00682	1(from 0)	0.68%	$795.11	Howard County	0.11152	1(from 0)	1.20%	$1,397.85
March	0.00726	1(from 0)	0.73%	$846.40	Prince George’s County	0.00554	1(from 0)	1.11%	$1,292.92
April	-0.01361	1(from 0)	-1.36%	-$1,586.71	Saint Mary’s County	0.03867	1(from 0)	6.22%	$7,246.88
May	0.00608	1(from 0)	0.61%	$708.83	Washington County	-0.12662	1(from 0)	-11.42%	-$13,308.10

As in the linear estimation almost no changes occurred in the values from the estimation of Model 2. More will be said of the incremental changes in the estimations after all control variables are added. The results for the values of the county variables are slightly modified from the linear estimation of the model. Again, Harford County has a value of 0 as it is the base county for this estimation. All but two of the counties have values within $2,000 of the base. Only Saint Mary's County, with a value of $7,250 above the base, and Washington County , with a value $13,000 below the base, are outside this range. This lack of significance in the property values across counties is part of the reason that the estimation barely changes from Model 2. The next model fully addresses the issue of location and allows us to examine the location impacts more specifically.

IV.D. Model 4

This model fully accounts for the location of the property by including the advertised subdivision as a location variable. Since not all properties are listed in an advertised subdivision, and because some advertised subdivisions have very few properties listed in the sample, there must be a further screening of the data to run this model. In order to limit the chance of gaining pure property value precision at the expense of parameter estimate precision, subdivisions with only a few properties in the sample must be deleted. For this model, only subdivisions with at least 10 observations are kept. There are 127 subdivisions with 3,077 observations that remain in the sample after implementing this requirement. Table 13 contains the summary statistics for this sample.

As can be seen, by comparing to Table 10, there are only minor changes to the average values of the data. The new data looks quite similar to the full sample as far as means and standard deviations are concerned.

The estimation changes only in the addition of the 126 subdivision dummy variables to control for location. As with any addition of variables this specific, a loss of specificity for the other variables is expected. It is impossible to tell whether this loss of significance and importance is part of the "true" relationship or a figment of over specification of the model. This will be discussed in the following section.

TABLE 13 - Summary Statistics for Sub-Sample					
Variable	N	Mean	Std Dev	Minimum	Maximum
List Price	3077	121,990	50,611.9	900	495,000
Settlement Price	3077	119,869	50,931.5	10,200	799,900
No.of Bedrooms	3077	3.11115	3.91569	1	9
No. of Full Baths	3077	1.66526	2.3988	1	13
No.of Half Baths	3077	0.71856	1.33721	0	4
No. of Levels	3077	2.1872	2.92489	1	4
No. of Fireplaces	3077	0.36178	0.95654	0	4
Lot Square Feet	3077	10,075.6	38,243.3	500	522,720
Age	2983	27.9038	52.0765	0	152
Days on Listing	3077	80.3539	170.973	1	702
Square Feet	3077	1,392.85	1,960.72	500	9,750
yr94	3077	0.00032	0.01803	0	1
yr95	3077	0.05785	0.23349	0	1
yr96	3077	0.08157	0.27376	0	1
yr97	3077	0.13195	0.33849	0	1
yr98	3077	0.13747	0.3444	0	1
yr99	3077	0.16672	0.37279	0	1
yr00	3077	0.15372	0.36074	0	1
yr01	3077	0.19955	0.39972	0	1
yr02	3077	0.07085	0.25661	0	1
m1	3077	0.0754	0.26408	0	1
m2	3077	0.09197	0.28903	0	1
m3	3077	0.10172	0.30233	0	1
m4	3077	0.10172	0.30233	0	1
m5	3077	0.0897	0.28579	0	1
m6	3077	0.09587	0.29446	0	1
m7	3077	0.08677	0.28155	0	1
m8	3077	0.08255	0.27524	0	1
m9	3077	0.07052	0.25607	0	1
m10	3077	0.07475	0.26303	0	1
m11	3077	0.07052	0.25607	0	1
m12	3077	0.0585	0.23472	0	1
D1	3077	0.09652	0.29535	0	1
D2	3077	0.15892	0.36566	0	1
D3	3077	0.42184	0.49393	0	1
D4	3077	0.03705	0.18891	0	1
D5	3077	0.00975	0.09827	0	1
D6	3077	0.01755	0.13133	0	1
D7	3077	0.03672	0.18811	0	1
D8	3077	0.04972	0.21741	0	1

TABLE 13 - Summary Statistics for Sub-Sample					
Variable	N	Mean	Std Dev	Minimum	Maximum
D9	3077	0.04322	0.20339	0	1
D10	3077	0.10465	0.30615	0	1
D11	3077	0.01787	0.13252	0	1
D12	3077	0.00357	0.05969	0	1
B1	3077	0.70003	0.45832	0	1
Distance from Highway	3077	567.36	1,235.69	10	10,280
Driving Distance from Highway	3077	1.544	2.9321	0.1	18.2
A1	3077	0.0585	0.23472	0	1
N1	3077	0.10855	0.31112	0	1
E1	3077	0.04777	0.21332	0	1

Table 14 contains the results for the linear estimation of this model. The Abingdon subdivision in Harford County is the base. Therefore the base observation is now a property in the Abingdon subdivision of Harford County in December of 1998.

TABLE 14 - Regression Results for Linear Model 4[7]		
Number of Observations	2982	
Measure of Fit	Value	
F	46.68**	
R^2	.7419	
Adjusted R^2	.7260	
Variable	**Parameter Estimate**	**Standard Error**
Intercept	119,435**	5,083.281
Bedrooms	9,138.569**	932.5057
Bathrooms	7,794.855**	939.5999
HalfBaths	2,246.603*	939.171
Levels	1,524.34†	902.2203
ListTime	-15.3383**	5.75652
Fireplace	10,402**	1,108.27
Age	-122.186	38.719
Squarefeet	26.23714**	1.47648
LotSqft	0.38869**	0.02636
Basement	3,610.07†	1,844.315
Adjacent	-1,490.65	3,222.855
See	-1,850.28	2,863.742
Noise	1,628.075	2,944.657
Distance	-0.57443	1.47038
Drive	189.922	1,052.671
Distance2	-0.00007024	0.000346
Drive2	117.902	287.1055
1994	-1,965.4	28,436
1995	-3,583.66	2,525.407
1996	-5,094.54*	2,244.153
1997	-2,173.24	1,954.146
1999	-1,061.33	1,839.453
2000	-3,333.46†	1,883.209
2001	-2,962.78†	1,779.542
2002	-1,271.88	2,471.142
January	-3,845.85	2,816.777
February	-5,903.89*	2,736.479
March	-1,483.07	2,657.519
April	-3,399.64	2,658.32
May	-1,691.6	2,722.872

[7] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

TABLE 14 - Regression Results for Linear Model 4[7]		
Variable	**Parameter Estimate**	**Standard Error**
June	-3,336.88	2,660.246
July	-3,432.67	2,717.672
August	-4,705.26†	2,738.35
September	-4,489.57	2,822.299
October	-4,071.36	2,807.822
November	-1,481.22	2,832.631
Anne Arundel County	3,573.662	3,989.412
Baltimore County	10,516**	3,844.417
Baltimore City	8,760.344*	3,582.498
Calvert County	6,501.971	4,590.045
Cecil County	1,118.179	6,675.156
Charles County	725.151	5,427.484
Frederick County	949.0252	5,220.684
Howard County	11,789**	4,477.014
Prince George's County	2,266.335	3,942.073
Saint Mary's County	2,038.712	5,576.691
Washington County	1,625.159	11,190

Unlike the previous additions to the base model, in this model there are significant changes to the fit and the results. The largest change is in the significance of many of the variables. Many of the coefficients are moved toward zero from the values in earlier models, thus reducing their impacts and in some cases making them less significant. A full description of the changes in the key variables is included in Table 15.

It is clear that the values have changed in the last estimation. The intercept has come down about $13,000 but this is mostly a result of using Abingdon subdivision as the base subdivision within Harford County. The value of an additional bathroom has come down about $2,000, which is 15% of the original estimate and 1.5% of the base property value. This variable still remains very significant. The value of a bathroom has come down about $3,000, which is 25% of the original estimate and 2.5% of the base property value. Again this variable still remains very significant. The value of a half bath has risen about $1,500. In each of the estimations where location was controlled, the value of a half bath rises. In the final estimation this variable actually changes from being not significant to being significant. The number of levels in the house follows the same pattern as half baths. This variable moved from basically 0 to about $1,500 and it is not significant.

Table 15 - Comparison of Linear Estimates				
Variable	**Model 1 Parameter Estimate**	**Model 2 Parameter Estimate**	**Model 3 Parameter Estimate**	**Model 4 Parameter Estimate**
Intercept	127,505**	130,858**	133,062**	119,435**
Bedrooms	11,800**	11,828**	11,725**	9,138.569**
Bathrooms	10,683**	10,690**	10,651**	7,794.855**
HalfBaths	579.58061	574.48571	873.50115	2,246.603*
Levels	1.61967	-1.48243	-71.75105	1,524.34†
ListTime	-42.69763**	-42.37055**	-41.23708**	-15.3383**
Fireplace	18,586**	18,632**	18,392**	10,402**
Age	-451.46472**	-451.74510**	-457.262**	-122.186
Squarefeet	47.90756**	47.82412**	47.89941**	26.23714**
LotSqft	0.36537**	0.36613**	0.36193**	0.38869**
Basement	3,259.14651*	3,233.1214*	3,570.1719*	3,610.07†
Adjacent	-8,899.43561**	-8,860.37811**	-8,608.152**	-1,490.65
See	-3,858.03964	-3,964.44481	-4,144.784	-1,850.28
Noise	7,046.59096**	7,026.25103**	7,717.7575**	1,628.075
Distance	0.75556	0.72474	0.49198	-0.57443
Drive	182.43595	255.00371	305.06441	189.922
Distance2	-0.00033641	-0.00034019	-0.000275	-0.00007024
Drive2	86.67409	76.43581	63.03289	117.902

The number of days the property remains on the list became much less of a factor in the value of the home. The impact of this variable is about $15 per day ($450 per month), which is nearly a 65% reduction in its impact. The value of a fireplace fell about $8,000, which represents about 40% of the original value and 6.5% of the base property value. Though the value of this impact has decreased dramatically, it remains highly significant. The impact of the age of the home fell considerably as well. This variable fell from about $450 per year to about $125 per year and is not significant in the final regression.

The dollar value of a square foot of living space fell from almost $50 to just over $25 in this final regression. This variable remains highly significant, but its impact is greatly reduced on the property value. The value and significance of lot square feet did not change much at all. The value of a basement also changed very little. Both of these variables remained at approximately the same level and retained their significance.

The highway proximity variables lost nearly all of their significance in this estimation. Being adjacent to the highway went from -$8,500 to -$1,500 and became statistically insignificant. Being able to see the highway went from -$4,000 to -$1,850 and lost significance as well. The impact of noise barrier went from $7,000 to $1,600 and also lost its significance. The distance from the highway variables were very imprecisely measured and had little impact on the value of the home in this estimation. More will be said of this after examining the log regression and the individual sub-division regressions. From this estimation it appears that the inclusion of the sub-division variables dominated the value of the property estimation. If this were true in all estimations, it would appear that highway proximity is secondary to the sub-division location of the home in determining property value.

Table 16 contains the results of the log regression of this model.

TABLE 16 - Regression Results for Log Model 4[8]		
Number of Observations		2931
Measure of Fit		Value
F		57.24**
R^2		.7811
Adjusted R^2		.7675
Variable	**Parameter Estimate**	**Standard Error**
Intercept	11.65996**	0.04027
Bedrooms	0.1922**	0.02314
Bathrooms	0.15853**	0.01501
Levels	0.04827**	0.0141
ListTime	-0.0148**	0.00331
Fireplace	0.00797**	0.00107
Age	-0.06013**	0.00871
Squarefeet	0.19893**	0.0207
LotSqft	0.15568**	0.00702
Basement	0.02286	0.01458
Adjacent	-0.00299	0.02553
See	-0.04303†	0.02267
Noise	-0.00276	0.02294
Distance	0.0113*	0.00564
Drive	0.00312	0.01078
Distance2	-0.00164	0.00325
Drive2	0.00121	0.00762
1994	-0.04165	0.21823
1995	-0.02818	0.01949
1996	-0.02722	0.01736
1997	-0.00455	0.01518
1999	-0.00203	0.01426
2000	-0.03055*	0.01458
2001	-0.02373†	0.01383
2002	-0.01709	0.01927
January	-0.02677	0.02197

[8] Values that are marked with a † are significant at the 90% level, values marked with a * are significant at the 95% level and values marked with a ** are significant at the 99% level.

TABLE 16 - Regression Results for Log Model 4[8]		
February	-0.02372	0.02133
March	-0.01046	0.02066
April	-0.00626	0.02067
May	0.00547	0.02115
June	-0.01162	0.02066
July	-0.01323	0.0211
August	-0.01925	0.02125
September	-0.02527	0.02204
October	-0.02602	0.02178
November	-0.00067549	0.02192
Anne Arundel County	-0.01057	0.03122
Baltimore County	0.037	0.03035
Baltimore City	0.02549	0.02841
Calvert County	0.00246	0.03604
Cecil County	-0.0125	0.05202
Charles County	-0.03718	0.0424
Frederick County	-0.023	0.04091
Howard County	0.05621	0.0351
Prince George's County	-0.01884	0.031
Saint Mary's County	-0.00309	0.04335
Washington County	0.02761	0.08874

These estimates are converted to percentages and values in Table 17.

Table 17 - Dollar Value Impacts from Log Regression Results									
Variable	Estimate	Mean	New Level	Percent Change	Value Change	Alternate Level	New Alternate Level	Percent Change	Value Change
Bedrooms	0.1922	3.18	4	4.41%	$5,136.12	5	6	3.50%	$4,085.37
Bathrooms	0.15853	2.04	3	6.10%	$7,113.56	4	5	3.54%	$4,124.16
Levels	0.04827	2.18	3	1.54%	$1,790.82	3	4	1.39%	$1,618.94
ListTime	-0.0148	81.21	180	-1.18%	-$1,373.28	180	270	-0.60%	-$699.61
Fireplace	0.00797	0.001	1	5.51%	$6,418.53	3	4	0.23%	$267.31
Age	-0.06013	29.23	60	-4.32%	-$5,041.16	90	120	-1.73%	-$2,016.71
Squarefeet	0.19893	1459.33	1560	1.33%	$1,547.11	2400	2500	0.81%	$946.75
LotSqft	0.15568	14211.5	15200	1.05%	$1,220.47	7000	8000	2.08%	$2,423.57
Distance	0.0113	578.50	675	0.17%	$203.25	1000	1100	0.11%	$125.56
Distance2	-0.00164	334658.1	455625	-0.05%	-$59.00	1000000	1210000	-0.031%	-$36.45
Drive	0.00312	1.603	2.6	0.15%	$175.98	12	13	0.025%	$29.11
Drive2	0.00121	2.569	6.76	-0.051%	-$59.00	1000000	1210000	-0.031%	-$36.45
Distance Tot					$144.25				$89.12
Drive Tot					$312.48				$51.70
Variable	Estimate	New Level	Percent Change	Value Change	Variable	Estimate	New Level	Percent Change	Value Change
Basement	0.02286	1(from 0)	2.29%	$2,665.12	June	-0.01162	1(from 0)	-1.16%	-$1,354.72
Adjacent	-0.00299	1(from 0)	-0.30%	-$348.59	July	-0.01323	1(from 0)	-1.32%	-$1,542.42
See	-0.04303	1(from 0)	-4.30%	-$5,016.62	August	-0.01925	1(from 0)	-1.93%	-$2,244.26
Noise	-0.00276	1(from 0)	-0.28%	-$321.77	September	-0.02527	1(from 0)	-2.53%	-$2,946.10
1994	-0.04165	1(from 0)	-4.17%	-$4,855.74	October	-0.02602	1(from 0)	-2.60%	-$3,033.54
1995	-0.02818	1(from 0)	-2.82%	-$3,285.35	November	-0.000676	1(from 0)	-0.068%	-$78.81
1996	-0.02722	1(from 0)	-2.72%	-$3,173.42	Anne Arundel County	-0.01057	1(from 0)	-1.06%	-$1,232.30
1997	-0.00455	1(from 0)	-0.46%	-$530.46	Baltimore County	0.037	1(from 0)	3.70%	$4,313.65
1999	-0.00203	1(from 0)	-0.20%	-$236.67	Baltimore City	0.02549	1(from 0)	2.55%	$2,971.75
2000	-0.03055	1(from 0)	-3.06%	-$3,561.65	Calvert County	0.00246	1(from 0)	0.25%	$286.80
2001	-0.02373	1(from 0)	-2.37%	-$2,766.55	Cecil County	-0.0125	1(from 0)	-1.25%	-$1,457.31
2002	-0.01709	1(from 0)	-1.71%	-$1,992.43	Charles County	-0.03718	1(from 0)	-3.72%	-$4,334.63
January	-0.02677	1(from 0)	-2.68%	-$3,120.96	Frederick County	-0.023	1(from 0)	-2.30%	-$2,681.46
February	-0.02372	1(from 0)	-2.37%	-$2,765.38	Howard County	0.05621	1(from 0)	5.62%	$6,553.24
March	-0.01046	1(from 0)	-1.05%	-$1,219.47	Prince George's County	-0.01884	1(from 0)	-1.89%	-$2,196.46
April	-0.00626	1(from 0)	-0.63%	-$729.82	Saint Mary's County	-0.00309	1(from 0)	-0.31%	-$360.25
May	0.00547	1(from 0)	0.55%	$637.72	Washington County	0.02761	1(from 0)	2.76%	$3,218.91

The changes in the log estimation of model 4 are not quite as dramatic as those for the linear estimation, but they still indicate quite a change from the first three models. Table 18 shows the progression of the value change at the mean for each of the key variables over the four models.

Table 18 - Comparison of Log Estimate Value Chages				
Variable	**Model 1 Parameter Estimate**	**Model 2 Parameter Estimate**	**Model 3 Parameter Estimate**	**Model 4 Parameter Estimate**
Bedrooms	$5,643.06	$5,636.64	$5,643.59	$5,136.12
Bathrooms	$9,161.52	$9,144.47	$9,087.48	$7,113.56
Levels	$1,803.07	$1,798.24	$2,028.26	$1,790.82
ListTime	-$3,278.24	-$3,275.45	-$3,114.93	-$1,373.28
Fireplace	$11,516.30	$11,540.46	$11,459.93	$6,418.53
Age	-$10,556.01	-$10,566.07	-$10,718.66	-$5,041.16
Squarefeet	$2,245.65	$2,247.99	$2,188.02	$1,547.11
LotSqft	$1,269.86	$1,270.95	$1,277.38	$1,220.47
Basement	$2,126.50	$2,145.15	$1,439.82	$2,665.12
Adjacent	-$9,281.28	-$9,425.84	-$9,153.03	-$348.59
See	-$6,977.57	-$7,062.68	-$6,547.37	-$5,016.62
Noise	$10,498.42	$10,513.57	$10,752.57	-$321.77
Distance	-$157.74	-$160.98	-$156.84	$125.56
Drive	-$332.75	-$342.94	-$156.80	$29.11
Distance2	-$355.91	-$332.03	-$319.44	-$36.45
Drive2	-$920.51	-$976.92	-$786.52	-$36.45

As can be seen from just a cursory look at Table 18, the estimates for the log equation are much more stable than those for the linear equation. The value of a bedroom and a bathroom are both slightly lower than in the previous three models but remain highly positive and significant. The value of an extra level in the property also remains nearly the same. The penalty for a property that is listed six months instead of three falls from around $3,000 for the first three models to around $1,400 in this fourth model. The value of a fireplace also falls from around $11,500 to about $6,500. The penalty for a 60-year-old house, contrasted with a 30-year-old house, also falls in half from $10,500 to $5,000. All three of these variables still remain significant in the estimation however.

The addition of 100 square feet to a house raises the value about $1,500 instead of the $2,200 in the previous three models. The value of an extra 1000 square feet of lot remains about the same at $1,250. The value of a basement seems to have risen slightly from around $2,000 to about $2,600 in this last estimation. This is much more stability than was found in the linear estimation. More will be said below about which estimation is reliable and what this means for the values.

The highway proximity variables are changed in what seems to be a surprising way. The penalty for a property immediately adjacent to the right of way decreases from over $9,000 to almost 0.

The benefit to noise barriers drops similarly. The penalty for being able to see the highway falls, but only slightly from around $7,000 to about $5,000.

The distance variables are also reduced in impact. An extra 100 feet from the right of way increases the property by about $100 and an extra mile from the highway reduces the value of the home by $7. These figures are much reduced, though now of the expected sign, from the other three estimations.

The log equation has had consistently higher measures of fit, and handles the addition of location to the model much better than the linear equation. More will be said concerning the validity of the various estimations in Section V below. The next estimations are those run separately for each of the sub-division.

IV.E. Individual Sub-Division Estimations

The following set of tables show the results from the individual sub-division estimations that include all of the variables from the other regressions. These regressions suffer from small sample biases that are so large as to make the results almost unusable. This will be addressed with another set of regressions. The tables contain the average value of the coefficient from all of the regressions, the number of positive coefficients, the number of negative coefficients and the number of coefficients that are exactly zero. This points to a large problem since a coefficient of exactly zero results from lack of ability to actually estimate the coefficient. The number of times this occurs is quite large and points to the dilemma of trying these estimations with so many variables.

In the large sub-samples (at least 50 sales) the behavior of the variables is slightly better, but still there are many zero values (which point to an inability to estimate at least some of the coefficients). Also, the variance in the signs of the coefficients remains high. Through all of these estimations, being adjacent to the highway has a positive impact and noise barriers have a negative impact. A new set of estimations is attempted in order to better fit the data. The variables employed will be a subset of the original. The new regression variables are listed and the reason for dropping the others is given.

The variables kept in the new regression are:
Bedrooms, Bathrooms, HalfBaths (in the linear form), Fireplace, Age, Squarefeet, LotSqft, Adjacent, See and Noise.

The year and month dummies are dropped because they weren't very significant and they add 18 variables to the estimation. Levels, Listtime and Basement are dropped because they had little or no impact on the values in any of the regressions and were quite insignificant in these individual sub-division estimations. The distance variables are dropped because they were never highly significant and they were very unreliable in the sub-division estimations. The tables are created again from these new regressions.

Table 19 - Individual Linear Estimates for Sub-Division with at least 10 Observations (n=134)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	5468.88	.6044776	.3805970	.0149254
Bathrooms	6854.46	.7164179	.2164179	.0671642
HalfBaths	-1473.19	.6268657	.3358209	.0373134
Fireplace	6456.79	.6194030	.2686567	.1119403
Age	1045.31	.6268657	.3731343	0
Squarefeet	-14.2646024	.6940299	.2835821	.0223881
LotSqft	3.7756001	.6492537	.3134328	.0373134
Adjacent	-2697.07	.0970149	.0970149	.8059701
See	279.9033838	.0970149	.1044776	.7985075
Noise	730.6180691	.0746269	.0671642	.8582090

Table 20 - Individual Log Estimates for Sub-Division with at least 10 Observations (n=134)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	.1435169	.6492537	.3283582	.0223881
Bathrooms	.1418323	.7313433	.2611940	.0074627
Fireplace	.0069004	.6343284	.2537313	.1119403
Age	.2661471	.6641791	.3358209	0
Squarefeet	.1455228	.6567164	.3208955	.0223881
LotSqft	.0755692	.6716419	.2910448	.0373134
Adjacent	.0043719	.1044776	.0820896	.8134328
See	-.0190696	.1044776	.0895522	.8059701
Noise	.0130664	.0746269	.0671642	.8582090

Table 21 - Individual Linear Estimates for Sub-Division with at least 15 Observations (n=77)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	4026.50	.6753247	.3246753	0
Bathrooms	10015.23	.8051948	.1688312	.0259740
HalfBaths	3997.01	.662337	.3116883	.0259740
Fireplace	5512.61	.7012987	.2207792	.0779221
Age	396.8100799	.5714286	.4285714	0
Squarefeet	17.2997001	.7142857	.2727273	.0129870
LotSqft	1.6956216	.6883117	.2597403	.0519481
Adjacent	-369.5108021	.1428571	.1298701	.7272727
See	-15.5559351	.1168831	.1298701	.7532468
Noise	-62.6847876	.0779221	.1038961	.8181818

Table 22 - Individual Log Estimates for Sub-Division with at least 15 Observations (n=77)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	.1124263	.7272727	.2727273	0
Bathrooms	.1315352	.7792208	.2207792	0
Fireplace	.0073645	.7012987	.2077922	.0909091
Age	.1227144	.5844156	.4155844	0
Squarefeet	.2666474	.6493506	.3376623	.0129870
LotSqft	.0934933	.7012987	.2467532	.0519481
Adjacent	.0068108	.1558442	.1038961	.7402597
See	-.0165803	.1298701	.1038961	.7662338
Noise	.0072687	.0779221	.1038961	.8181818

Table 23 - Individual Linear Estimates for Sub-Division with at least 25 Observations (n=36)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	5117.91	.7222222	.2777778	0
Bathrooms	9169.53	.8611111	.1111111	.0277778
HalfBaths	2978.77	.7222222	.2777778	0
Fireplace	3658.29	.7222222	.2222222	.0555556
Age	212.7290463	.5555556	.4444444	0
Squarefeet	23.7201377	.8333333	.1666667	0
LotSqft	1.9098353	.6944444	.2777778	.0277778
Adjacent	1256.24	.2222222	.1388889	.6388889
See	-426.1381988	.1388889	.2222222	.6388889
Noise	-1522.05	.1111111	.2222222	.6666667

Table 24 - Individual Log Estimates for Sub-Division with at least 25 Observations (n=36)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	.1348228	.6944444	.3055556	0
Bathrooms	.1356695	.8333333	.1666667	0
Fireplace	.0042282	.7222222	.2222222	.0555556
Age	-.0599308	.5277778	.4722222	0
Squarefeet	.2500496	.8333333	.1666667	0
LotSqft	.0923252	.7500000	.2222222	.0277778
Adjacent	.0081611	.2222222	.1388889	.6388889
See	-.0188690	.1666667	.1944444	.6388889
Noise	.0061589	.1111111	.2222222	.6666667

Table 25 - Individual Linear Estimates for Sub-Division with at least 50 Observations (n=10)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	6285.00	9	1	0
Bathrooms	8535.47	8	1	1
HalfBaths	-560.8835970	7	3	0
Fireplace	9224.71	8	1	1
Age	-548.6568680	4	6	0
Squarefeet	5.2623940	7	3	0
LotSqft	3.5329756	9	0	1
Adjacent	5552.24	3	1	6
See	-6073.12	2	5	3
Noise	472.9088337	1	3	6

Table 26 - Individual Log Estimates for Sub-Division with at least 50 Observations (n=10)				
Variable	Average Value	Number > 0	Number < 0	Number = 0
Bedrooms	.2006817	8	2	0
Bathrooms	.0640479	7	3	0
Fireplace	.0096764	8	1	1
Age	-.0471491	5	5	0
Squarefeet	.0968620	6	4	0
LotSqft	.1613431	9	0	1
Adjacent	.0446629	3	1	6
See	-.0603266	4	3	3
Noise	.0081054	1	3	6

As can be seen from these tables, the coefficients behave much better in these estimations but still have a great deal of variance caused by the small sample bias. These estimations will be used merely to help decide on the validity of the coefficients from the more general regressions run above.

V. Comparison of Results and Regression Conclusions

As mentioned above, there are strengths and weaknesses to each of the models and methodologies employed at the various stages of this study. In this section these will be examined and discussed to allow for valid conclusions to be drawn. This will first be done for each method and model and then for each variable.

V.A. The Models and Equation Forms

When comparing the four models, there are obvious strengths in the later models. The first model contains variables that impact property values but controls for no impacts from date or location of sale. The second model controls for date of sale but has no controls for location of sale. The third model adds a regional location variable (county) while the fourth model adds a specific location variable (sub-division). The last estimations, sub-division specific regressions, allows the greatest flexibility in estimation by letting each sub-division have its own coefficients.

Each additional category that is controlled in the regression increases the explanatory power of the model. This is clear from the goodness of fit measures. However, this comes at the expense of having a large number of regressors, which can lead to multi-colinearity problems that can bias estimates. This became most clear in the individual sub-division estimates. It is clear that the individual sub-division estimates can only be used as peripheral contributing evidence and not read as viable regression results in and of themselves. This is because most of them suffered from severe multi-colinearity problems.

There were some fairly broad changes in the results from Model 3 to Model 4. It is difficult to tell how much of these changes were a result of over parameterization and how much of them were a result of better explanatory power from the addition of the sub-division variables. Both of these models will be given high weight when comparing results to determine the actual impact of the variables. A very large study of this problem would be required to determine the true relationship once location is fully controlled in the estimation process. Barring the ability to do this, questions will remain as to which results are more valid. The basic results between the two are very similar and the differences, while important, do not show either to be completely invalid.

The comparison between the linear and the log regressions is more easily handled. At each step of the process, the goodness of fit measure was higher for the log regression than for the linear regression. This implies that the impact of these variables is more of a percentage relationship than a flat value relationship. This is intuitive and matches much economic data in its results. Therefore, while linear relationships will still be explored, the log relationships will be considered more important in determining the impact of various variables on the property value. If one estimation had to be chosen as the "best" it would be Model 3 log or Model 4 log depending on how one felt about the issue of over-parameterization in Model 4. With this in mind, each variable will be examined for its impact.

V.B Rooms and Features of the House

The first set of variables examined will be the number of various rooms in the house. The number of bedrooms is unambiguously positive and significant in its impact on property value. The value of this parameter varies from about $12,000 in the first three linear models, to a low of about $5,000 in the final log model. Using the better-fit log estimation, it appears that the value of the fourth bedroom in a house is worth about $5,000 to $6,000. Due to the diminishing returns, the sixth bedroom appears to be worth about $4,000 - $4,500.

The number of Bathrooms in the house is also unambiguously positive and significant in its impact on property value. The value for this parameter varied between $7,000 and $10,000 on the average property. Using the more appropriate log regressions, the value of the third full bathroom is between $7,000 and $9,000. The value of the fifth bathroom is between $4,000 and $5,000. The value of a half bathroom (only applicable in the linear case) is between $500 and $2,250.

The impact of an extra level in a house is ambiguous. In the first three linear regressions, the value of the parameter was essentially zero. In the final model the value was about $1,500 and was significant. In all four of the log models the value was not significant, but was between $1,700 and $2,000. In a case where the parameters are not significant it is impossible to place a value on an extra level. If we assign a bit of weight to the significance in the final linear model, we can hedge and state that a level might be worth about $1,500. Statistically, we need to reserve judgment until we have better data (a more complete study could reveal either a value close to zero or confirm a value closer to those obtained in this study but with significance). While it might seem strange to have a three story home with the same value as a two story home, this is not all that difficult to justify. Recall that these are identical homes: same square footage, same lot size, same number of bedrooms etc. The only difference is that one is two large floors and the other is three smaller floors. In this context it is easier to see how this variable might have a value of zero.

The number of days the property listed before selling is unambiguously negative and significant in its impact on property value. The value of this parameter varies between about $3,500 per quarter for the first three models to about $1,350 for the last model. There is the strong possibility that this variable is endogenous. In other words, a choice made by the seller might influence the value of this variable. If this is true, it is possible that the variable either overstates or understates the true impact of a property not selling quickly. The two cases are easily made. If those selling low valued properties (in poor condition for example) are more likely to overvalue their properties, then the value obtained for this parameter overstates the loss from not selling quickly (as it represents a property in poor condition rather than the actual waiting to sell). If those selling high valued properties (perfect condition for example) are more likely to overvalue their properties, then the value obtained for this parameter understates the loss from not selling quickly (as the penalty for not selling quickly is at least partially offset by the higher valued property).

The impact of a fireplace is unambiguously positive and significant in determining the value of a property. The value of this parameter varies from around $18,500 (in the first three linear models) to around $6,500 (in the log version of model 4). Using the more reliable log estimates the value of the first fireplace is between $6,500 and $11,500. The value of a fourth fireplace is between $250 and $500. The diminishing returns to quantity is clearly evident, and intuitive, in this case.

The impact of the age of the home is unambiguously negative and significant in determining the value of a property. The value of this parameter follows similar patterns to those above. For both the linear and log forms of the first three models the value of the parameter is quite stable. A sixty-year-old home is worth $13,500 less than a thirty-year-old home according to the linear estimates and $10,500 less according to the log estimates. In the final model these values fall to $3,500 and $5,000 respectively. Using the more reliable log estimates, the value of a home falls about $5,000 to $10,000 when the age of the home moves from 30 to 60 years.

The value of extra square footage in the house is unambiguously positive in its impact on property value. The value of 100 extra square feet (for the average house) varies from almost

$5,000 in the first three linear estimations to about $1,500 in the final log estimation. Using the more reliable log estimations, an extra 100 square feet is worth between $1,500 and $2,200 at the average (around 1500 square feet). At 2500 square feet, the same addition of 100 square feet is worth $950 to $1,350.

The value of extra square footage in the lot is similar to that in the house. The value of an extra 1,000 square feet of lot, for the average lot of 14,000 square feet, is worth about $350 according to the linear regressions and about $1,250 according to the log regressions. At the size of a more normal urban lot (7,000 square feet) the value of another 1,000 square feet is more like $2,500 according to the log models.

The value of the house having a basement is also strongly positive and significant in determining the property value. According to the linear regressions the value of a basement is approximately $3,500 and according to the log regressions the value is between $1,500 and $2,650. This is one of the few variables whose impact seemed to increase moving from Model 3 to Model 4. Since this is a dummy variable, the actual impact is in percentage terms. The additional value brought by the presence of a basement seems to be between 1.2% and 2.3%

V.C Highway Proximity Variables

Many of the highway proximity variables changed from being highly significant to being fairly insignificant once the sub-division variables were included. The next subsection deals with this specifically. The individual variables are covered here.

The impact of a property being adjacent to the highway registers between almost $9,000 (in the first three models for both linear and log regressions) to being basically zero in the final log regression. Depending on the interpretation of the additional subdivision variables, this value lies between zero and -$9,000. The value of this is again a percentage and was –0.2% in the fourth model and –8% in the third model. More will be said about this directly below.

The impact of being able to see the highway remains quite strong even once sub-division variables are added to the estimation. In the first three log models this impact is -$6,500 to -$7,000. In the first three linear regressions it is about -$4,000. In the final log regression it is about -$5,000 and in the final linear regression it is about negative $1,500. Using the more reliable log regressions, the impact is about -$5,000 to -$6,500. In percentage terms the impact seems to be between -4.3% and -5.6%. The more stable values for this impact measure will be discussed immediately below.

The impact of noise barriers was similar to that of being adjacent to the right of way as far as the variance in estimates is concerned. In the first three log models the value of noise barriers was about $10,000 while it was about $7,500 in the first three linear models. The value falls to nearly zero in the fourth models. In percentage terms the value of noise barriers was about 9.3% in Model 3 and basically 0 in Model 4.

The distance variables were not significant in most of the models and had varying impacts depending on the model. In the linear models the driving distance to the highway always added value to the property and the linear distance from the highway added value over the first three models and was negative in the fourth. None of these values was very large nor were any significant. In the log models, the first three models had negative values for both distances, albeit not significant. Due to the insignificance in these three models we conclude that the distance had little or no effect in these three models. In the fourth model, the driving distance to the highway still was insignificant and was very close to zero numerically. However, the linear distance from the right of way had a positive and significant impact. In this case, a change from 575 feet to 675 feet increased the property value by about $150 and an increase from 1000 to 1100 feet increased the value almost $100. Maybe more significantly, increasing the distance from the right of way from 50 to 1000 feet raised the property value by 3.4% or about $4,000 for the average property. This was the only distance figure that was significant in any regression.

V.D. Sub-Division Impact and Homogeneity of Neighborhoods

When the sub-division variables were added a large number of the impacts were lowered toward zero and lost significance. The reasons for this are explored here and a comparison of the two best models is made. This entire discussion is based on the log estimations of Model 3 and Model 4.

The addition of the sub-division variables is done to control for the most important component of real estate value: location. The fact that better explanatory power comes at the expense of some significance in the variables is a trade-off that is clearly worthwhile if trying to pinpoint the value of a home. The only concern arises in a study such as this where the goal is to pinpoint the impact of the highway proximity values. In general, it is better to measure the value of the property as closely as possible even in this situation.

The reason that the sub-division variables had the effect they did on the other variables is important to understand. In essence, once the location of the home was fully described with the sub-division variables, much of the variance in other variables was removed. This is because within a sub-division homes are often very similar. The impact of some other descriptive variables can be improperly measured when location is not considered.

An example is illustrative of this point. If one sub-division contains mostly 5 bedroom houses and they sell for around $300,000 while another sub-division contains mostly 3 bedroom houses and they sell for around $200,000 a basic regression might find the value of a bedroom to be $50,000. However, adding two bedrooms to a house in the lower priced sub-division would not truly increase the value of the property to $300,000. Much of the difference in value is the location of the two sub-division. Once this is accounted for in the estimation, the value of a bedroom is significantly reduced. This is likely the case with nearly all the variables in the regressions.

Leaving the highway proximity variables for a bit later, it appears that the number of bathrooms, list time, number of fireplaces, age of the house, and the number of square feet were all over-valued in the estimations that did not have location variables included. The implication of this is that these variables tend to be highly correlated with the sub-division the property is located in and that their average values move in the direction of the parameter's sign. In other words, houses in the same sub-division tend to have similar numbers of bathrooms and more desirable sub-division locations tend to have houses with more bathrooms, fireplaces and square feet than less desirable sub-division locations. Also, houses in the more desirable sub-divisions sold more quickly and were newer than those in less desirable sub-divisions.

For these variables, the change in impact is clearly explained and is actually desirable. For all of these variables, the values obtained for model 4 are in line with what appraisal systems use in determining property values. Next the highway variables will be explained.

The highway proximity variables have the same pattern across the models. Again, the sub-division variables pick up most of the variance in these factors since most homes in sub-divisions have similar highway proximity values. The loss of monotonicity is caused by the fact that there are both highly desirable sub-divisions and less desirable sub-divisions located near highways.

The results of Model 4 imply that being adjacent to a highway is not a penalty in and of itself. This seems surprising until one considers that a sub-division that has properties directly adjacent to the right of way normally has all of its properties close to that right of way. This result implies that for a sub-division that lies close to a right of way, the property that is actually adjacent to the right of way suffers little damage from its immediate location.

Model 4 points out an interesting relationship for being able to see the highway. This is the one proximity variable that did not change very much. This implies that within sub-divisions that lie close to highways, those that have a view of the highway are reduced in value across all sub-division types.

Noise barriers follow the pattern of adjacency. But again, this could be a lack of variation in sub-divisions. It is likely that if there are noise barriers along a right of way for one house of a sub-division, they are present for all houses in the sub-division. This would explain why there is no impact from their presence in this model. So, this implies that there might still be an impact on the order found in the first three models (about 8% - 9%) but that this impact is absorbed in the sub-divisions variables. This is not true about adjacency because the impact can only be shared (absorbed in the location variable) if the condition is shared by all (or most) of the properties in the sub-division.

VI. CONCLUSIONS

This study examined real estate values in Maryland to determine the impact of highway proximity and noise abatement projects on property values. Many key findings are summarized and discussed here. Other findings are tempered by the need for further data or research and those are also pointed out.

The data are from most of the major highways in Maryland over about a five-year period. Most of the property sales within one-half mile of highways during this period are included in the data. The results are, therefore, limited to describing properties of the type in the sample. Using these conclusions outside of the sample, while potentially constructive, is not appropriate without further work and more data collection. For the purposes of this study, expanding the sample to properties not near highways was not productive as this was a study of highway proximity and noise abatement.

The eight models presented in the report allow us to compare various means of estimating the impact of the included variables on property values. It appears that the log form of the models works better in every case. This is intuitive as most properties are impacted in a percentage form instead of a value form. In other words, the addition of a basement adds $2,500 to a $120,000 property but might increase a $250,000 by as much as $5,000. While the percentages might not be constant over all values: they appear relatively stable over the values present in the sample. The other impact of the fact that log models fit the data more precisely is that there are diminishing returns to the property values.

This is also intuitive and plays a critical role in determining property values. An example of this is the number of square feet in the house. Table 26 shows the diminishing returns to this variable.

Table 27 - Example of Diminishing Returns to Square Footage		
Original Square Footage	Percentage Increase in Property Value with 100 Square Foot Increase	Value Increase in Property Value
500	3.62692%	$4,228.42
1000	1.89601%	$2,210.44
1500	1.28386%	$1,496.78
2000	0.97058%	$1,131.55
2500	0.78022%	$909.61
3000	0.65229%	$760.47
3500	0.56040%	$653.34
4000	0.49121%	$572.67

This table clearly shows diminishing returns as the house gets larger. The value of 100 square feet to a 500 square foot house is $4,228.42 while the value of 100 square feet to a 4000 square foot house is around $572.67. This diminishing returns property of the log estimation is the reason for the better fit and thus describes the data quite well.

In looking at the models, Model 4 clearly demonstrates the best fit due to its inclusion of location variables. This comes at the cost of some variables (particularly adjacency and noise barriers) losing significance. In general, the results of Model 4 are preferred with the caveat that some of the proximity variables' impacts are now being spread across all homes in the sub-division.

In agreement with nearly all appraisal intuition, the number of bedrooms, number of bathrooms, number of levels, number of fireplaces, square feet of the house, square feet of the lot and presence of a basement all raise the value of the property. The impact of a bedroom, bathroom and fireplace are all about of the same order (value). Also in agreement with nearly all appraisal intuition, the length of time it takes the property to sell and the age of the house lower property values.

The highway proximity variables are of great interest in this study and provide a wealth of results. When location is not fully controlled in the estimation, it appears that a property immediately adjacent to a highway is reduced in value by approximately 8%. Once the location is fully controlled in the estimation, Model 4, it falls to nearly zero (-0.3% and not significant). It is possible that some of this impact is being absorbed by the location variables but this is not likely to be the full explanation. It is not the case that sub-divisions with properties adjacent to the right of way are comprised solely, or even mostly, of properties of this type. Sub-divisions that contain properties adjacent to the highway also contain properties not adjacent. In fact, the properties on the other side of the street would not be adjacent. Thus, it appears that the adjacency might not be a strong indicator property value since it has little impact. There remains a small chance that the location parameters caused some multi-colinearity (over parameterization) that leads to a bias toward insignificance in this variable. Though this is unlikely, a larger sample would allow further study of this variable.

The visual disutility of the highway is a strong indicator of property value and remains so even when location is fully controlled for in Model 4. A property with a clear view of the highway suffers approximately a 4.5% to 5.5% reduction in value over a similar property with no view of the highway. This visual utility is not controlled for in previous studies and seems to incorporate much of the disutility found for highway proximity of a property.

The presence of noise barriers was found to be a strong indicator of property value in the early estimations but not in the last model. In Model 3, the presence of noise barriers for a property near a right of way seems to raise value by about 9%. In Model 4 this falls to nearly zero (-0.3% and insignificant). Unlike the adjacency variable, it is possible that the impacts found in the earlier models might still be present. It is likely that many sub-divisions that have noise barriers for one property have them for all properties, or nearly all. When this is the case the impact of the noise barriers on property values will be absorbed by the location variable. It is impossible to differentiate how much of the location variables' values come from noise barriers and how much comes from other sources.

The distance from the highway variables were, surprisingly, not very important in determining property values. The driving distance to the highway onramp was not significant in all estimations. In addition to being not significant, in the final regression the impact was very close to zero numerically. The distance from the right of way was slightly more significant but still contributed very little to the property value. In Model 4, this variable was positive and significant but trivial in numeric value. It appears that distance from a highway is a secondary contributor to property value and is not highly significant in its contribution.

All of the results of this report, with a few exceptions, are solid and conclusive with the data used. The few variables that require further consideration would benefit from a larger study of property values. Such a study could focus on two separate data needs. First, if a general appraisal tool was needed, properties further from the highway should be included. Second, if more precision was required concerning the highway proximity variables, more sales from adjacent properties need to be included. The inclusion of more recent years compounds the time of sale issue, but this is not of great concern if the sample size is large enough.

References

Allen, G. R. *Relationships Between Highway Noises, Noise Mitigation, and Residential Property Values*. FHWA/VA-81/1. Charlottesville, Va. Virginia Highways and Transportation Council, 1980.

Anderson, R. J., and D. E. Wise. The Effects of Highway Noise, and Accessibility on Residential Property Values. Report DOT-FH-11-8841. Springfield, Va. National Technical Information Service, 1977.

Anonymous. 1992 Infrastructure Award Winner. *The American City and County*, Vol. 107, Issue 13, Dec. 1992, pp. 32-34.

Anonymous. Houston Neighborhoods Program Gets Top Honors. *The American City and County, Vol.* 3, Issue 13, Dec. 1996, pp. 40-41.

Bailey, M. J. Report on Pilot Study: *Highway Noise and Accessibility on Residential Property Values.* Unpublished paper. University of Maryland, 1977.

Becker, N., and D. Lavee. The Benefits and Costs of Noise Reduction. *Journal of Environmental Planning and Management*, Vol. 46, No. 1, January 2003, pp. 97-111.

Buffington, J. L., and M.T. Wildenthal. Estimated Impact of Widening U.S. Highway 80 (Marshall Avenue) in Longview, Texas. In *Transportation Research Record 1450*, TRB, National Research Council, Washington, D.C., 1994, pp. 59-64.

Gamble, H. B. *The Influence of Highway Environmental Effects on Residential Property Values*. University Park, Pa.: Institute for Research on Land and Water Resources, 1974.

Haider, M., and E. J. Miller. Effects of Transportation Infrastructure and Location on Residential Real Estate Values: Application of Spatial Autoregressive Techniques. In *Transportation Research Record 1722*, TRB, National Research Council, Washington, D.C., 2000, pp.1-8.

Hall, F. L., B. E. Breston, and S. M. Taylor. Effects of Highway Noise on Residential Property Values. In *Transportation Research Record 686*, TRB, National Research Council, Washington, D.C., 1978, pp. 38-43.

Huang, J., and R.B. Palmquist. Environmental Conditions, Reservation Prices, and Time on the Market for Housing. *Journal of Real Estate Finance and Economics*, Vol. 22, Issue 2-3, March-May 2001, pp. 203-219.

Langley, C. J. Adverse Impacts of the Washington Beltway on Residential Property Values. *Land Economics*, Vol. 52, 1976, pp. 54-65.

Nelson, J. P. *Economic Analysis of Transportation Noise Abatement*. Cambridge, Mass.: Ballinger, 1978.

Nelson, J. P. Highway Noise and Property Values: A Survey of Recent Evidence. *Journal of Transport Economics and Policy*, Vol. 16, Issue 2, May 1982, pp. 117-138.

Palmquist, R. B. *Impact of Highway Improvements of Property Values in Washington*. Report WA-RD-37.1. Springfield, Va.: National Technical Information Service, 1980.

Palmquist, R. D. Measuring Environmental Effects on Property Values Without Hedonic Regressions. *Journal of Urban Economics,* 1981.

Reed, R. A Reexamination of the Impact of Highway Proximity on Residential Property Values. Working Paper, Morgan State University, 2003.

Vaughan, R. J., and L. Huckins. *The Economics of Expressway Noise Pollution Abatement*. Santa Monica, Ca.: The Rand Corporation, 1975.

Porter, T.R. The Home Market Must Be Bad if Bolton Isn't Booming. *Across the Board*, Vol. 8, Issue 23, Nov. 10, 1989, pp. 24-26.

Reed, R. The Impact of Highway Proximity on Real Property Values. Federal Highway Administration Technical Report, 2004, 64 pages.

Talhelm, D. R., and A.H. Frobom, Jr. The Community Options Model: Using Artificial Intelligence for Transportation Planning and Community Decision Making. Presented at 6th Transportation Research Board Conference, Washington, D.C.,1997.

Taylor, L.L. Allocative Inefficiency and Local Government. *Journal of Urban Economics*, Vol. 37, Issue 2, March 1995, pp. 201-211.

Vadali, S. R., and C. Sohn. Using A Geographic Information System to Track Changes in Spatially Segregated Location Premiums: Alternative Method for Assessing Residential Lnad Use Impact of Transportation Projects. In *Transportation Research Record 1768*, TRB, National Research Council, Washington, D.C. 2001, pp. 180-192.

Appendix

This section contains a series of tables and figures that highlight results from the data that pertain to general property values rather than the impact of highways on property values. This section will not be of interest to all readers. The tables and figures in this section are presented on the uncorrected data (intentionally so that reference can be made to these in the text).

The first series of tables and figures show the relationship between the characteristics of the house and property value. Figure 1shows the relationship between sales price and the number of bedrooms in the house.

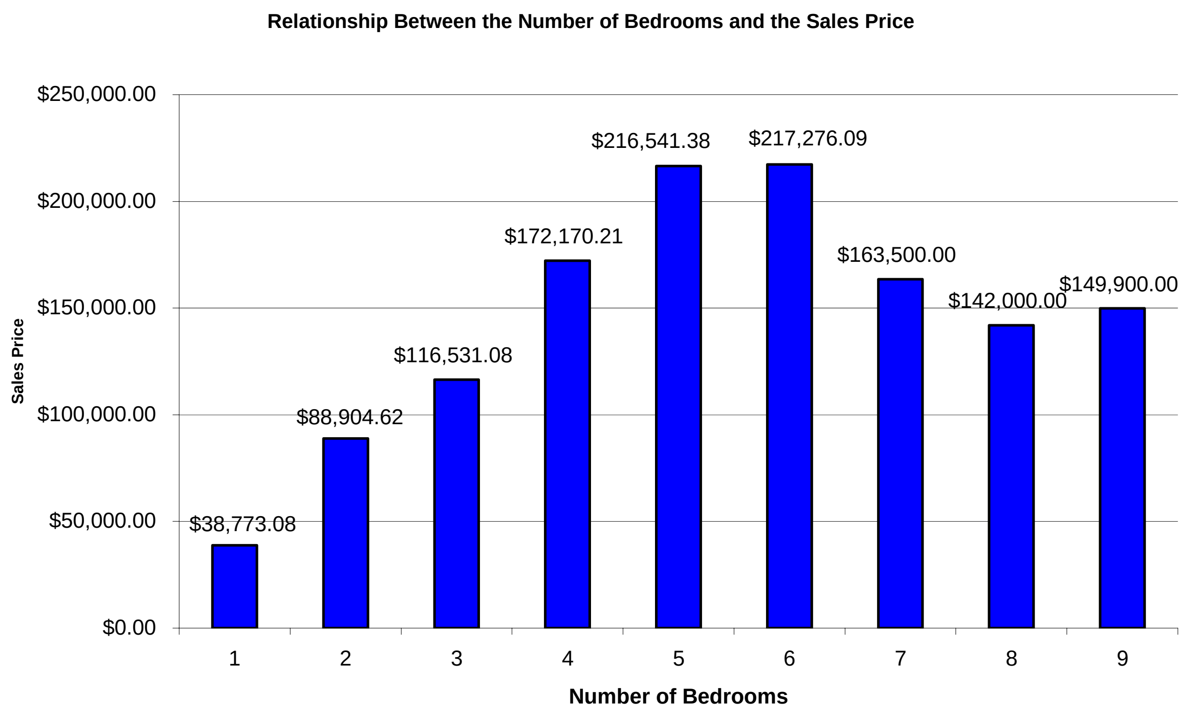

Figure 1

Obviously, the expected relationship exists between the number of bedrooms and the sales price at least through six bedrooms. It should be noted that only four homes out of the sample had more than six bedrooms and so these observations should be somewhat discounted as outliers (or misprints in the MLS data). Figure 2 shows the relationship between the sales price and the number of full bathrooms in the house.

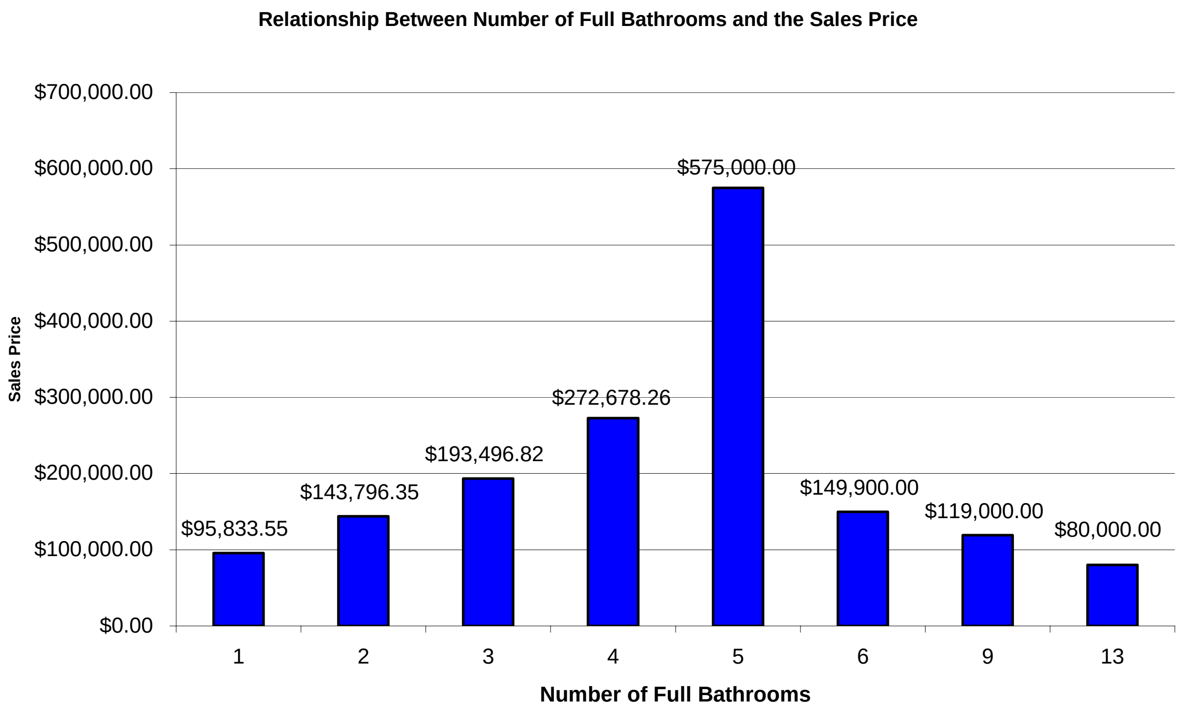

Figure 2

Again, the obvious relationship holds for the first five bathrooms in the house. Also, like the number of bedrooms, there are only four observations with more than four bathrooms in the house. Therefore the four observations concerning more than this number of bathrooms are suspect. Almost certainly the homes with six, nine and thirteen bathrooms are bad data points. Figure 3 shows the relationship between the number of half bathrooms in the house and property value.

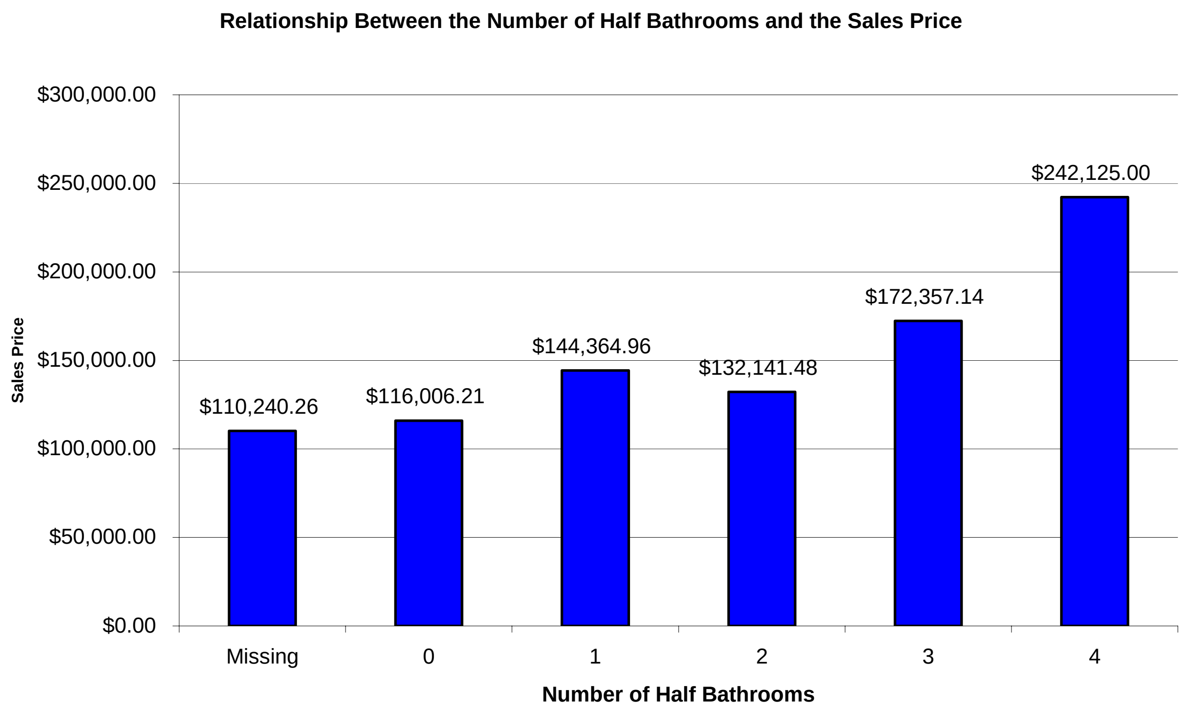

Figure 3

The relationship is roughly what would be expected. While not monotonic, the sales price does increase as the number of half bathrooms increases. There are 1,668 observations for which there is no entry on the MLS data for the number of half bathrooms. For purposes of this study these are treated as if there is no half bathroom in that house. While not a perfect result, this salvages over 1/3 of the data. In addition, since the number of bathrooms is a selling point for a house, it makes sense that the realtor would include them if they were present in the house. It also appears, from the average value, that the houses that had a missing value for this variable had a very similar value to those that had a zero for this variable. Figure 4 shows the relationship between the constructed bathrooms variable (full baths plus ½ half baths) and the sales price.

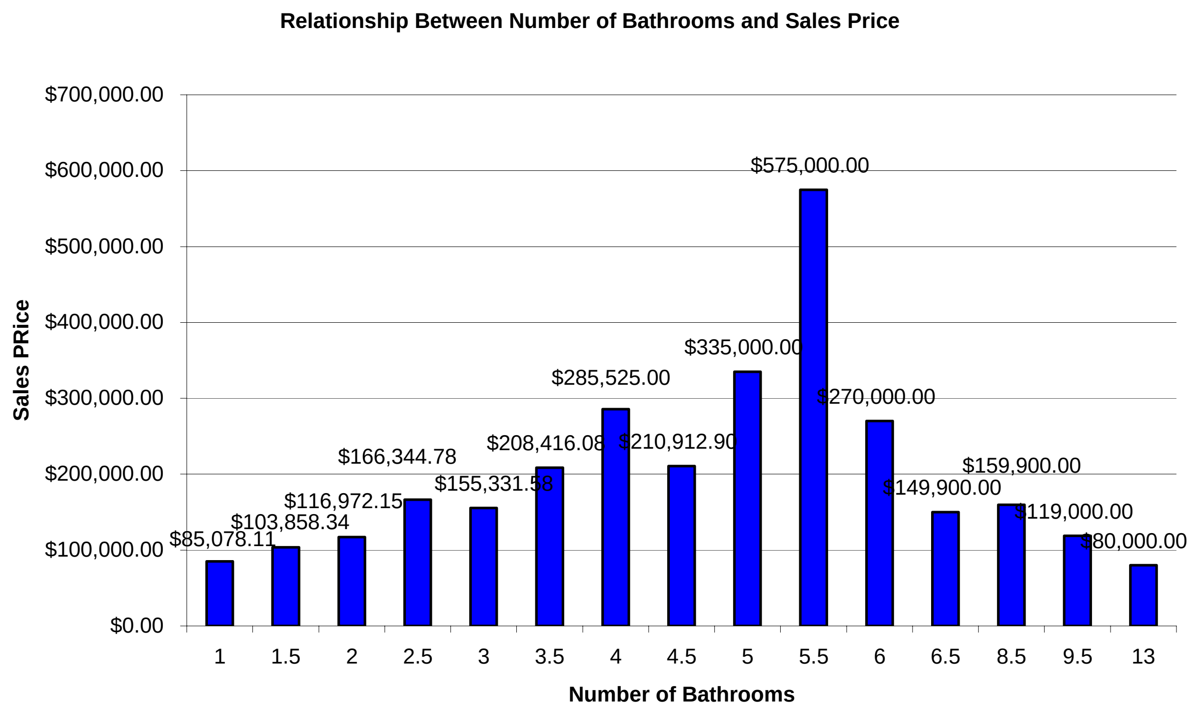

Figure 4

Clearly the relationship is similar to those of the two other bathroom variables. The number of bathrooms seems to increase the value of the property through about 5 bathrooms or so. After this there are a very small number of observations (there are only nine observations with more than five bathrooms) so the declining sales price should not be taken as a true relationship. Figure 5 shows the relationship for the number of levels in the house.

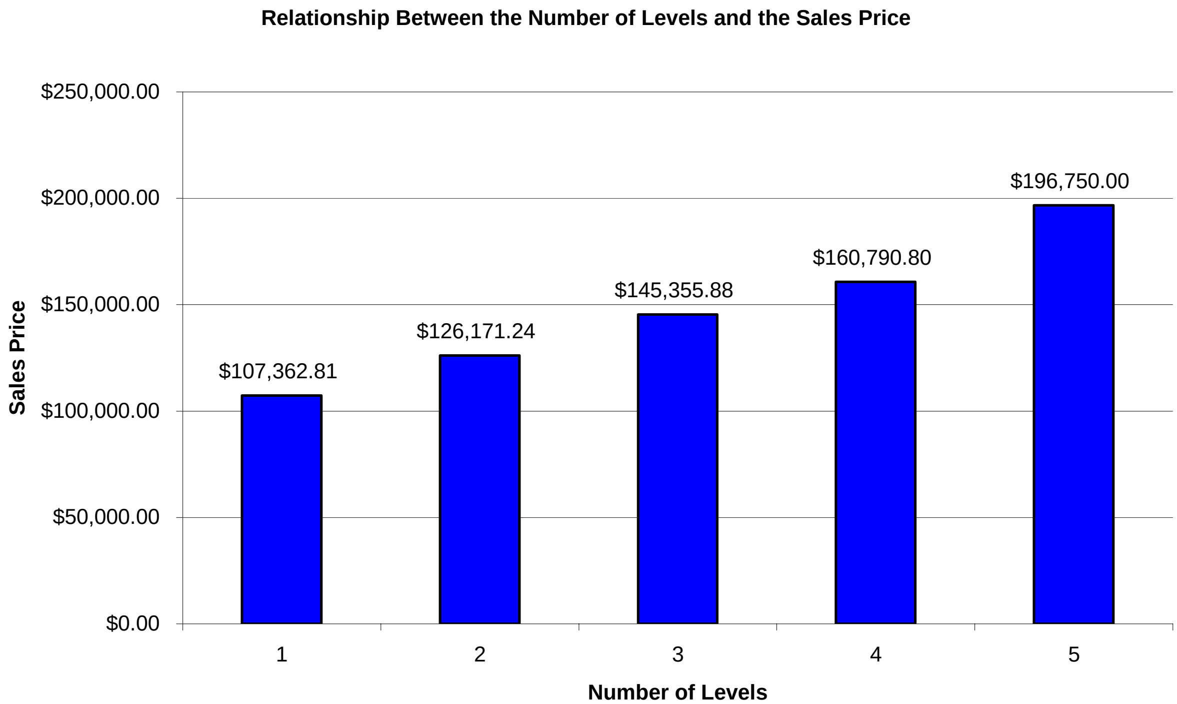

Figure 5

Again, the relationship appears to be the expected one. The average sales price is increasing in the number of levels in the house. There were four houses in the sample with five levels. Figure 6 shows the relationship for the presence of a basement.

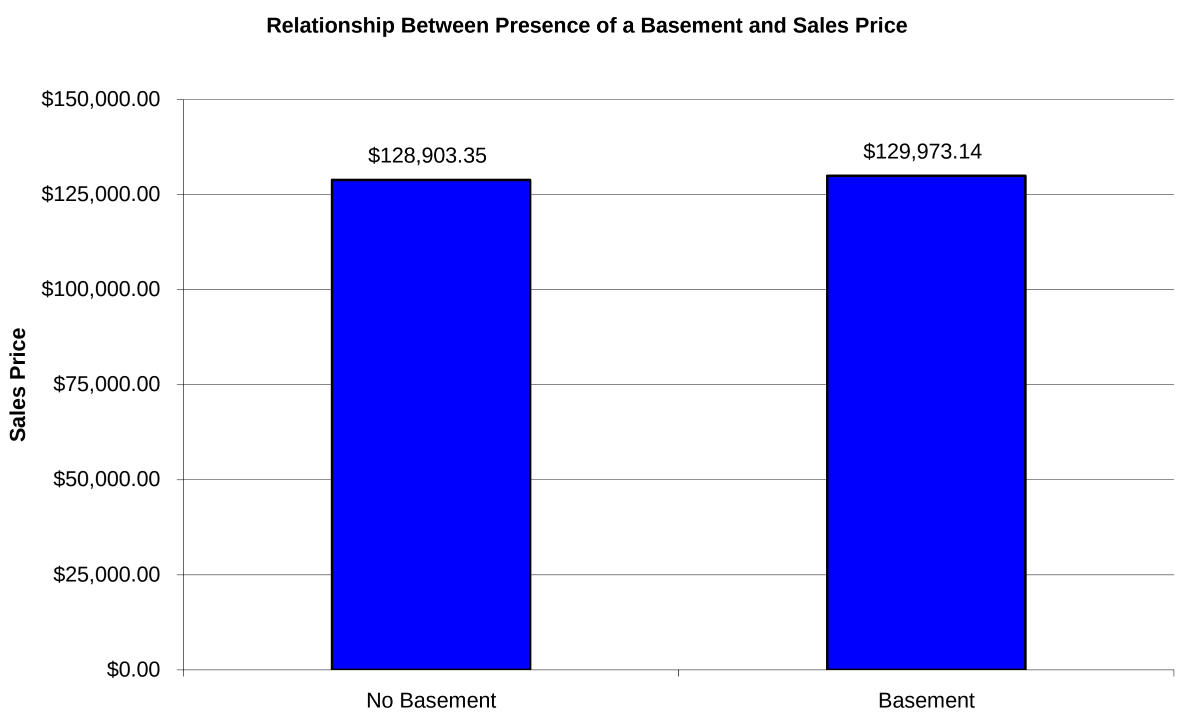

Figure 6

There is a very small, but significant, difference in the sales price for a house with or without a basement. This difference, of just over $1,000, is very consistent in the data and perpetuates into the regressions. Figure 7 shows the relationship for the number of fireplaces.

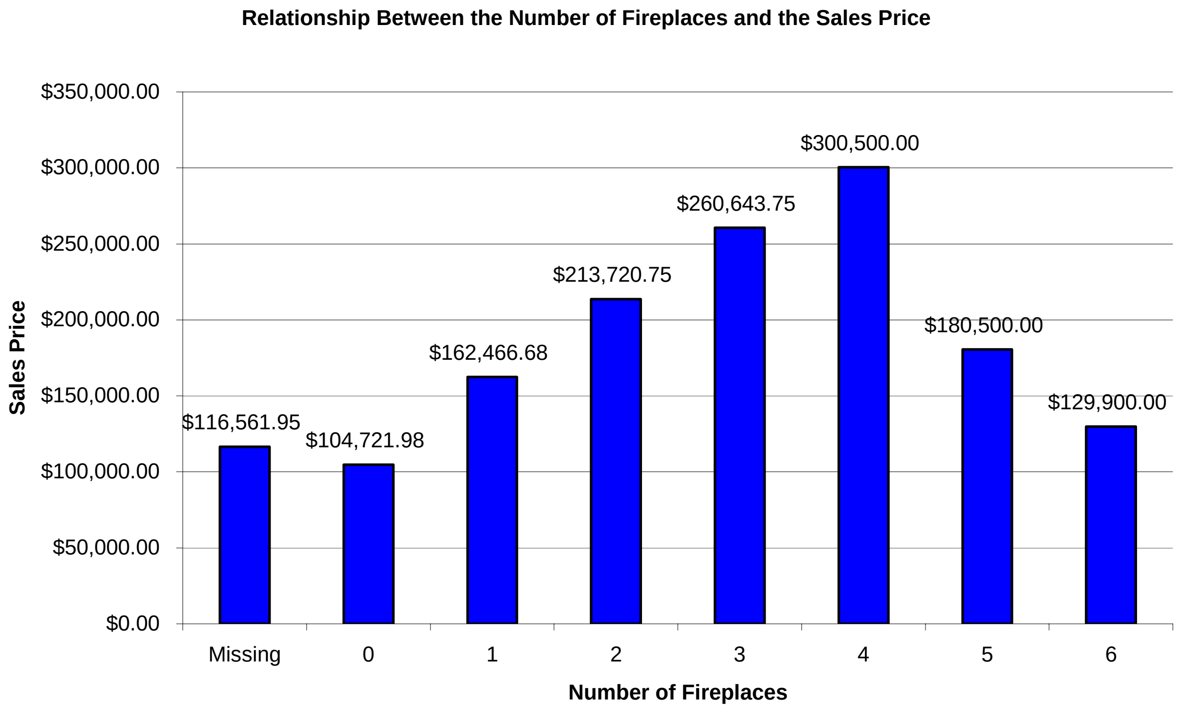

Figure 7

Again, the obvious pattern emerges. There are only five houses with more than three fireplaces and these observations are either outliers or errors in the data. Similar to half bathrooms, the observations without a value are treated as having zero fireplaces. There are 496 of these observations in the data. The average sales price seems to support this decision, as well as the logic that this is a positive sales point for the property and omission is likely to equal the lack of presence. Figure 8 shows the relationship between the size of the home (in square feet) and the sales price.

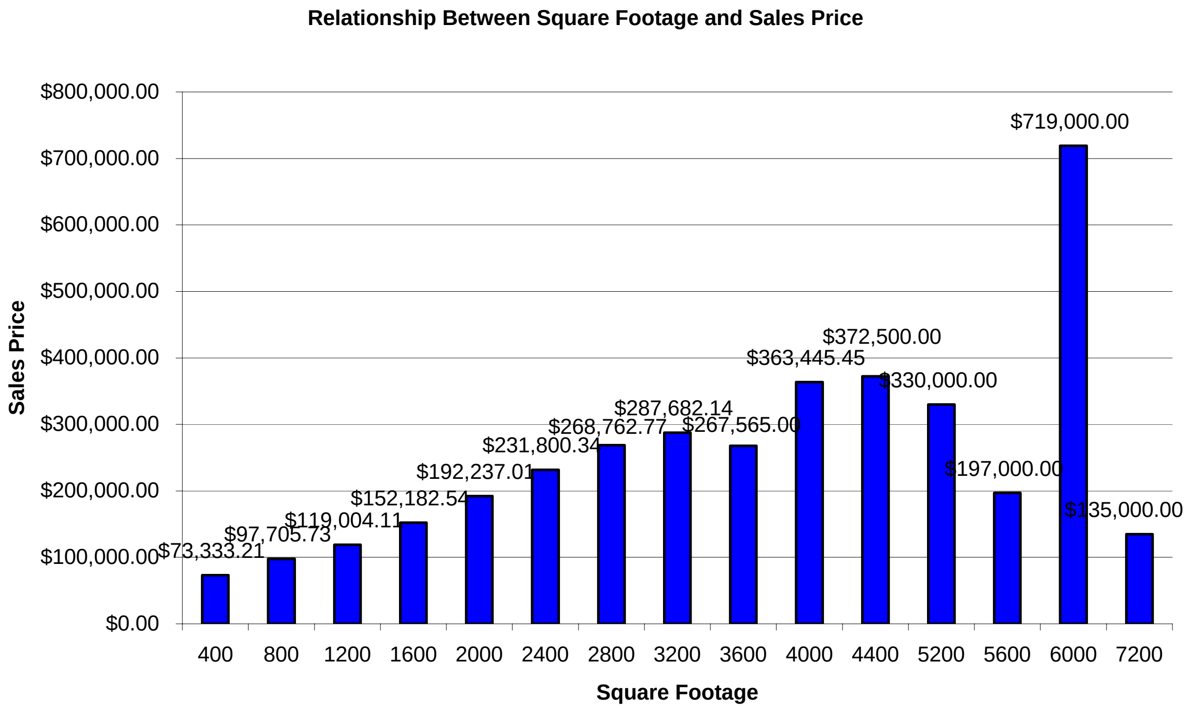

Figure 8

The size of the house clearly influences the price positively. This relationship is nearly monotonic, and quite evident, through about 4,400 square feet. After this, the small number of observations. There are only four homes in the sample with square footage in excess of 4,400. Figure 9 shows this relationship for type of house.

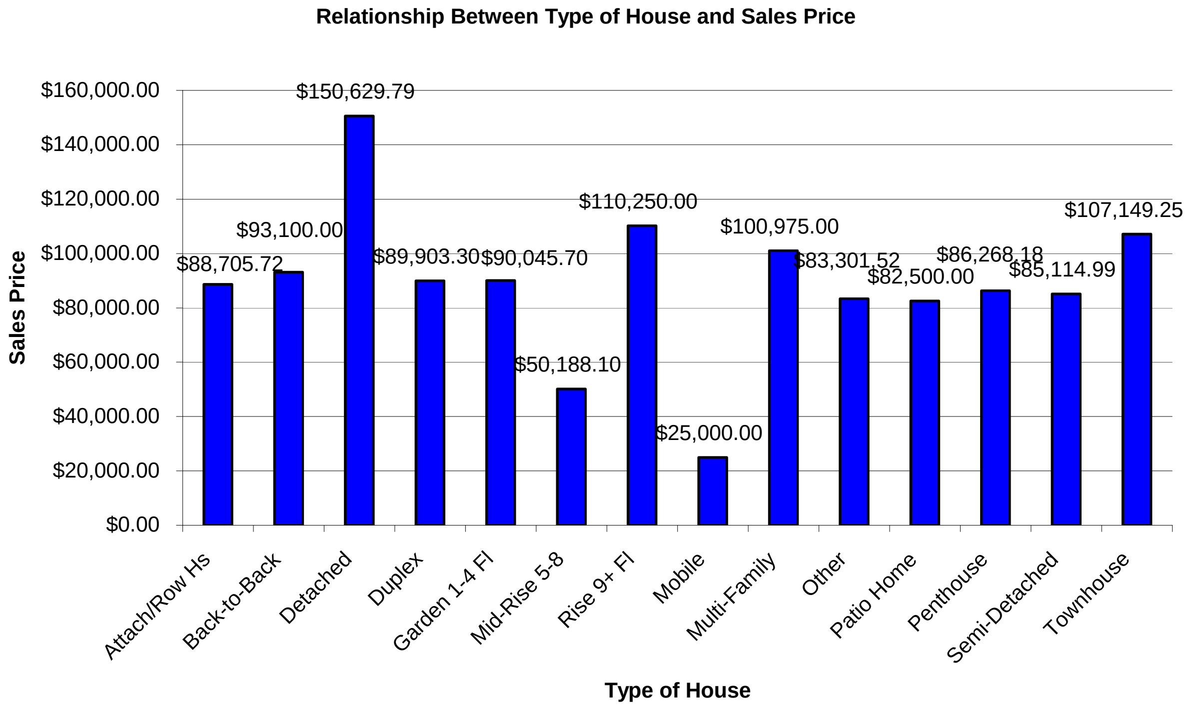

Figure 9

The relationship here is not very strong and is presented merely for those interested in this relationship. It should be noted that 2,909 observations were of detached homes. Figure 10 shows the relationship by style of home.

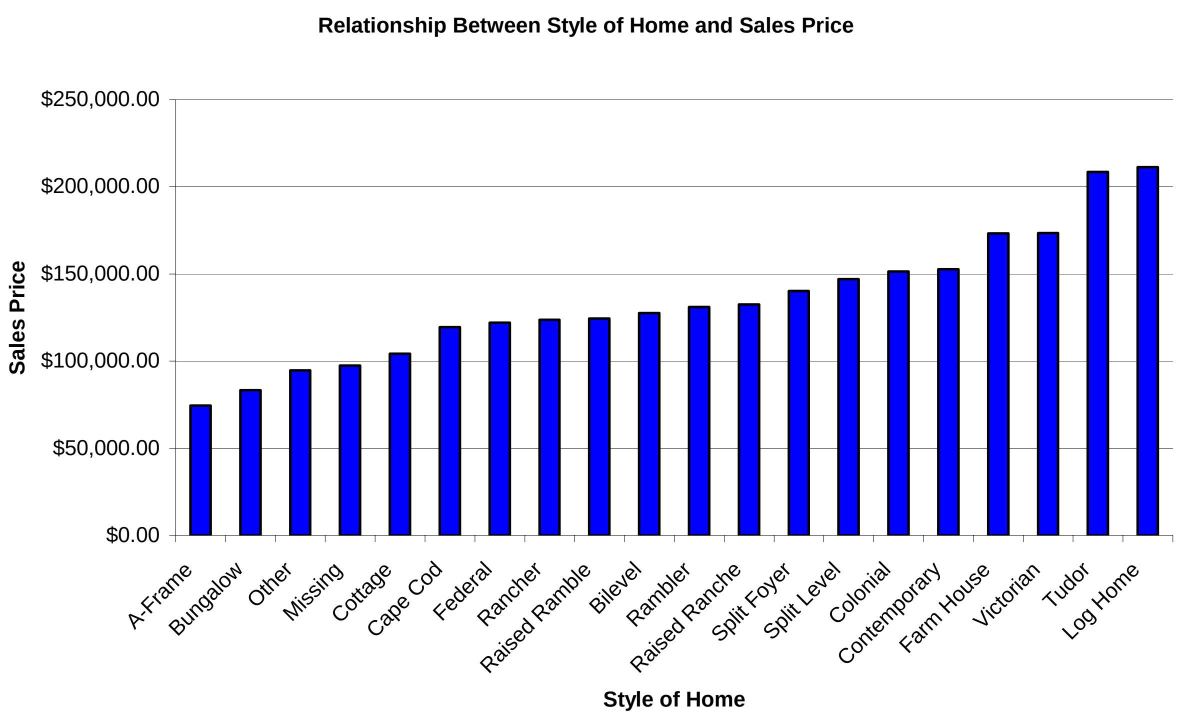

Figure 10

Again, the relationship here is not very strong. Over half of the observations were of the top three styles: Colonial, Other and Rancher. Figure 11 shows this relationship for the age of the house.

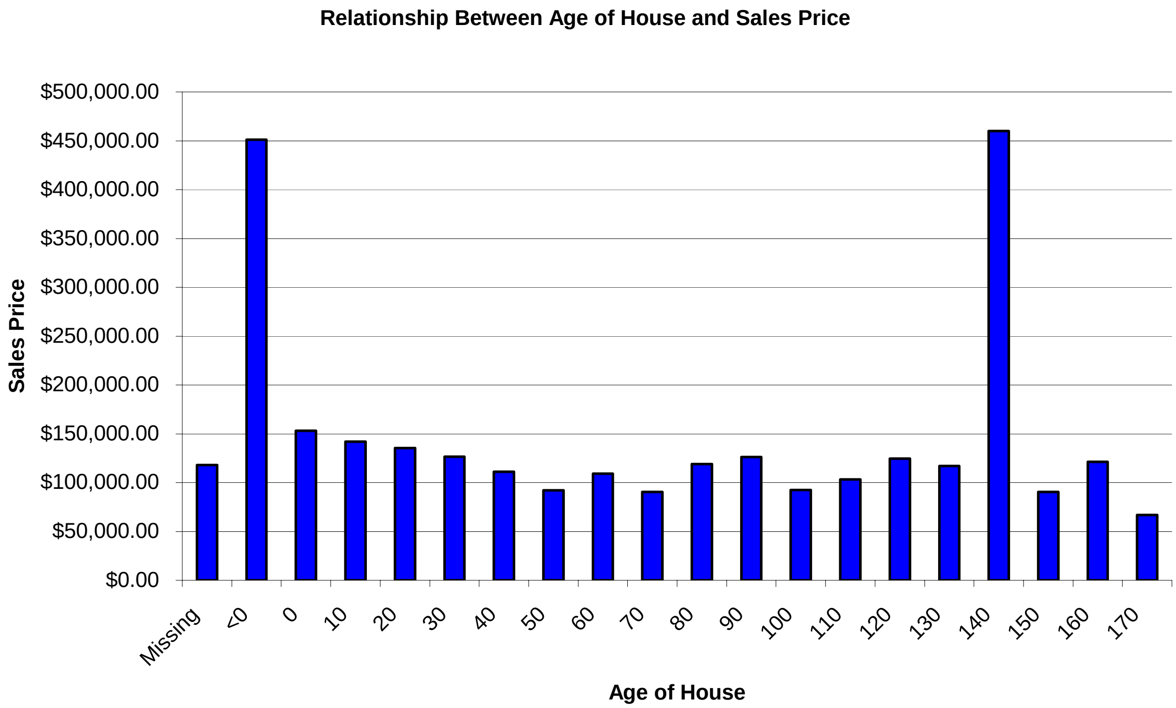

Figure 11

Note that the values seem to decrease until around 50-70 years old and then level off. The very high value at 140-150 years was for a single house. Figure 12 shows the relationship by the year sold.

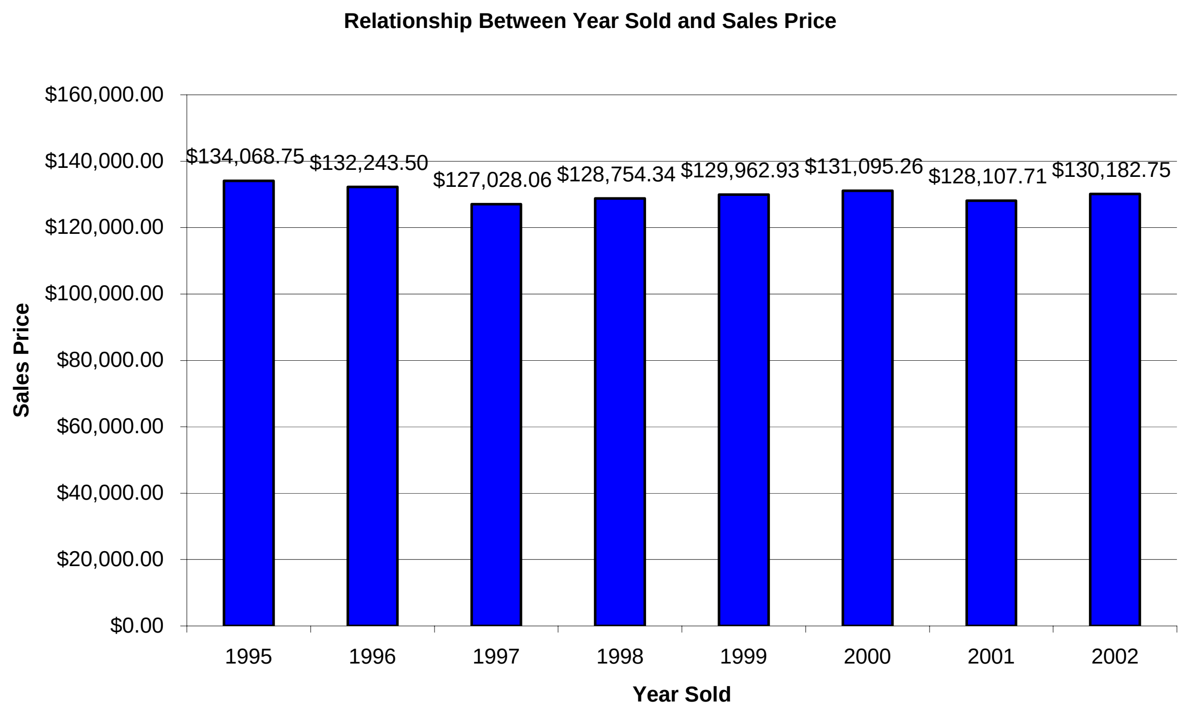

Figure 12

The relationship is slightly decreasing for the first two years and then increasing from that point on (with a slight dip in 2001). In 2002 there were only sales in the first five months and so this might have suppressed this value to some degree. Figure 13 shows the relationship by month sold.

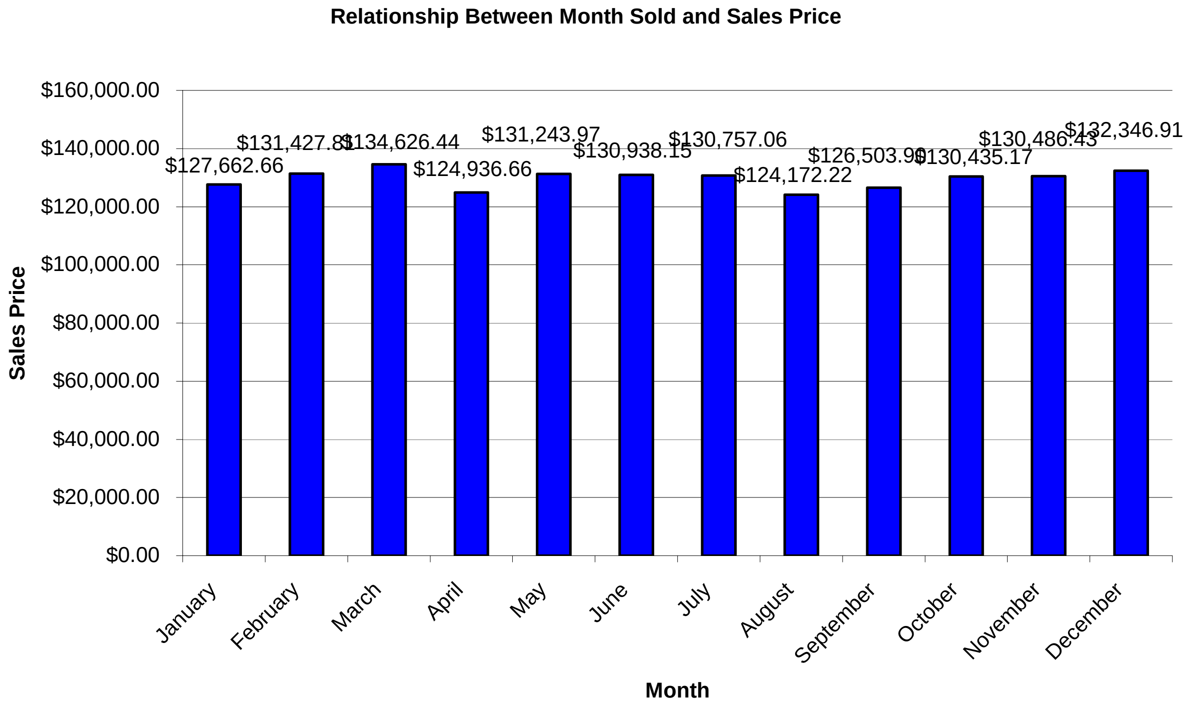

Figure 13

The relationship here does not appear very strong. While summer months tend to have higher sales prices, this does not show up in this figure. The need to control for other factors is quite evident from this figure. Figure 14 shows the relationship by county.

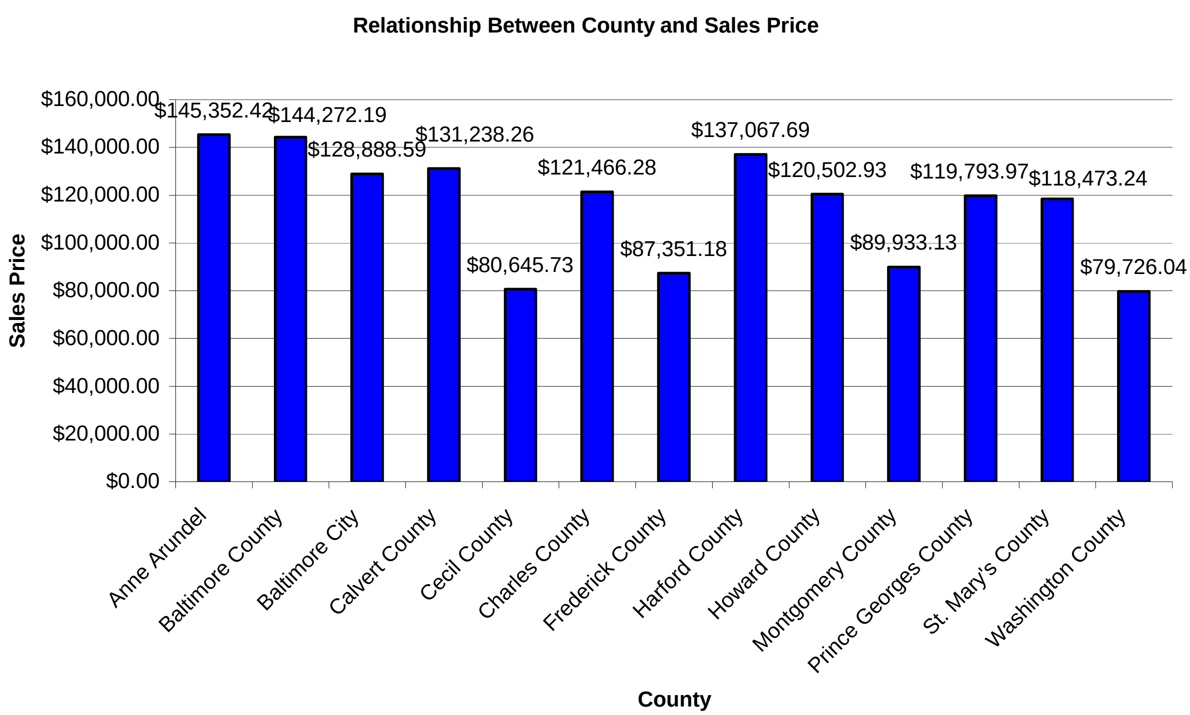

Figure 14

The more urban counties have higher sales price in general with the rural counties having lower values. Montgomery County is a deceptive value in this case as there were only eight homes from this county in the sample. Figure 15 shows the relationship by the highway that was closest to the property.

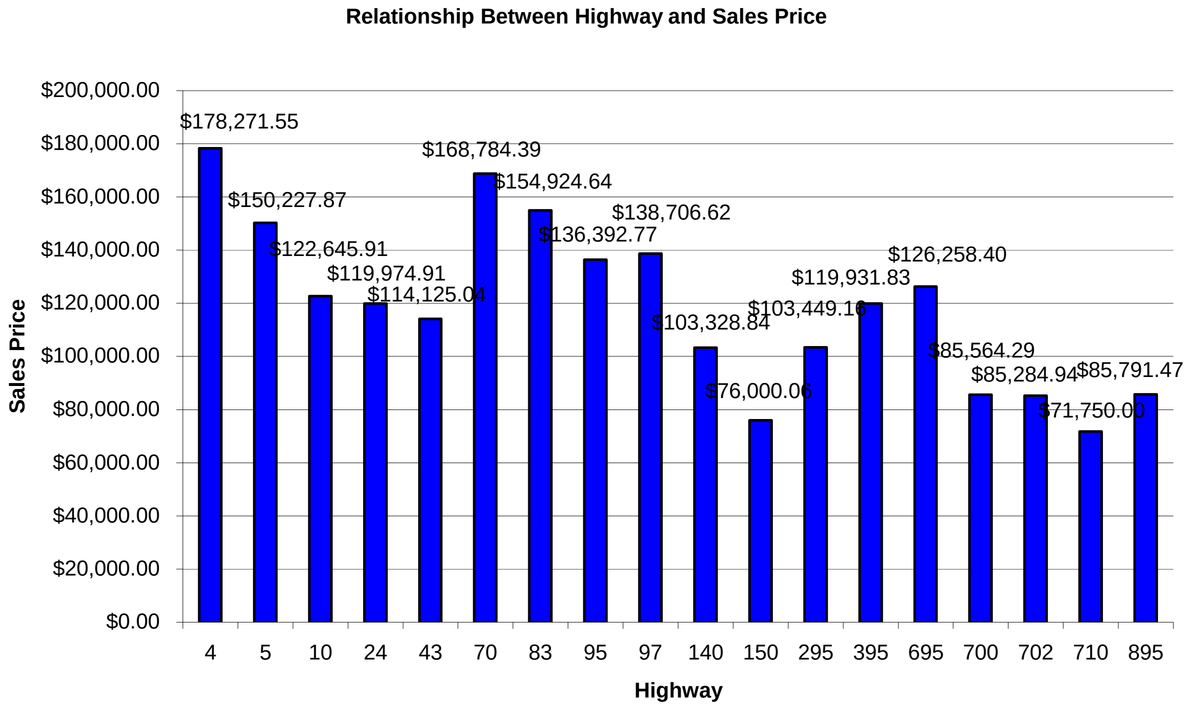

Figure 15

There is no clear pattern, nor any reason to suspect one, in these data. Figure 16 shows the relationship for distance from the highway.

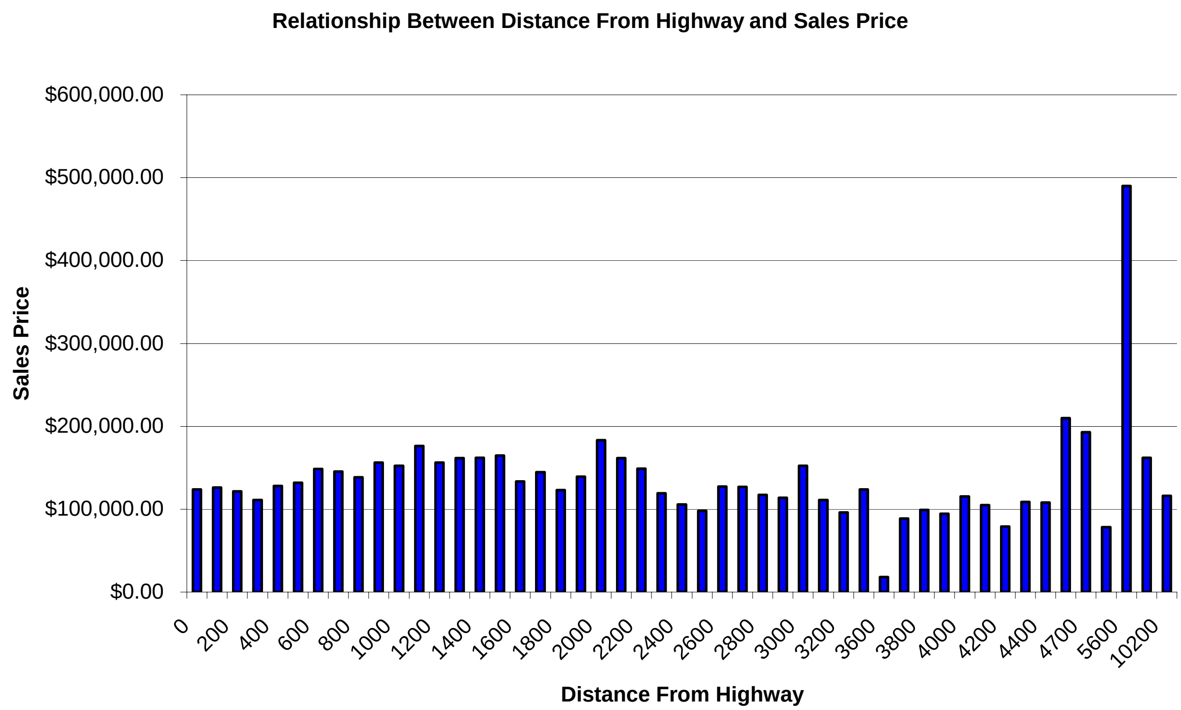

Figure 16

Note how this relationship is increasing through about 1200 feet and then fairly flat thereafter. This seems to confirm that most of the negative utility from the highway is experienced within 1000 feet of the highway. Figure 17 shows the relationship by driving distance from the highway entrance/exit.

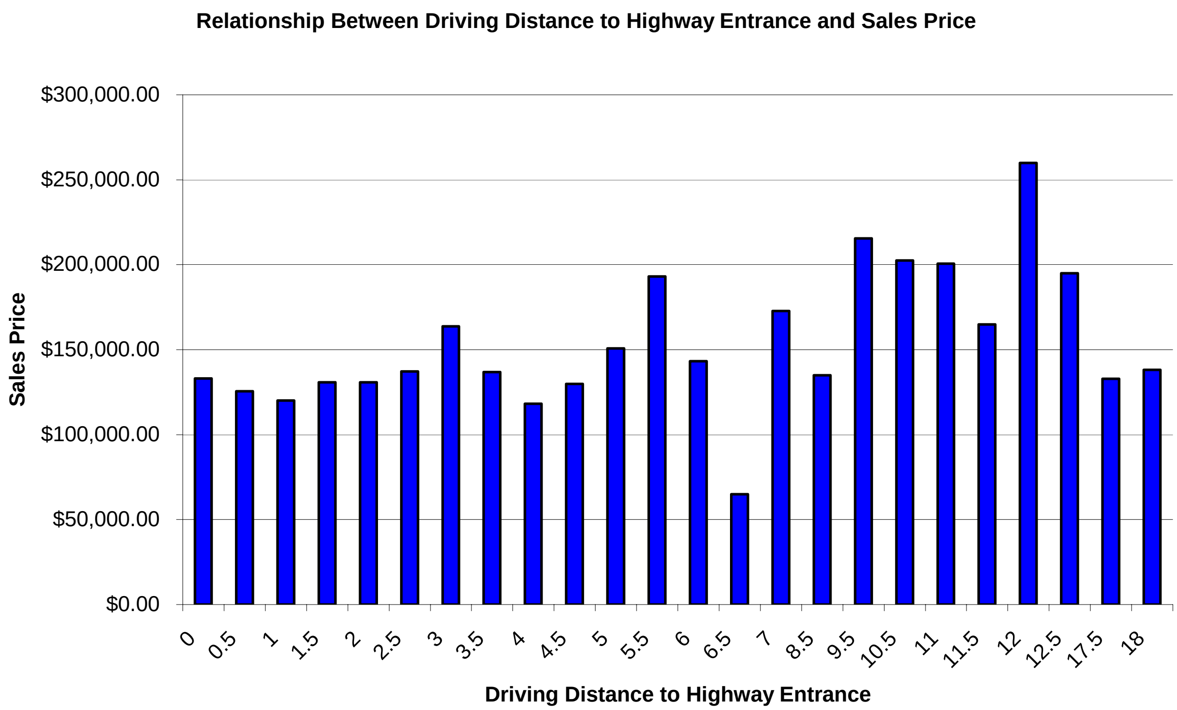

Figure 17

The relationship here is generally increasing as the home is further from the highway entrance. This is a bit in conflict with the consensus opinion, which states that proximity to a highway entrance is a positive influence on housing price. Figure 18 shows the relationship by adjacency to the highway.

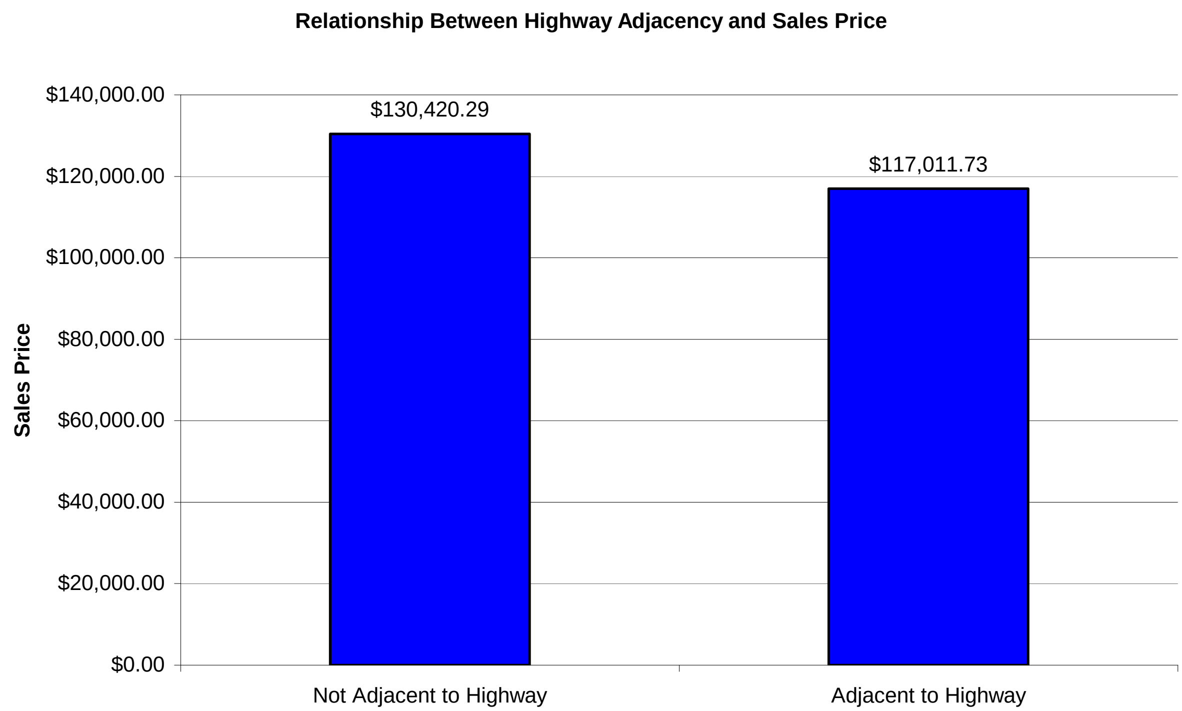

Figure 18

Here we see a very strong relationship of the predicted direction. Properties adjacent to the highway are valued about $13,000 less than those not adjacent to the highway in this sample. Figure 19 shows the relationship by the visual relationship to the highway.

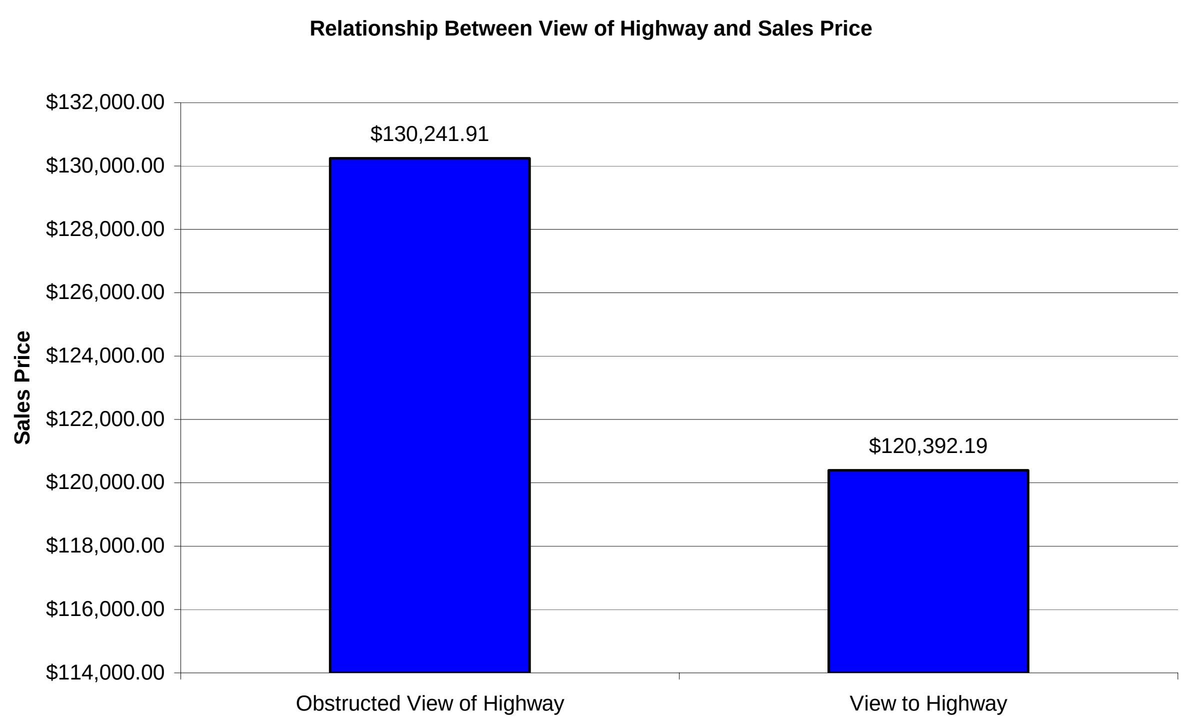

Figure 19

Clearly, having an obstructed view of the highway raises the property value. Here we see a $10,000 difference in property value between those properties with an obstructed view of the highway and those with a clear view of the highway. Table 20 shows the relationship with the presence of noise barriers.

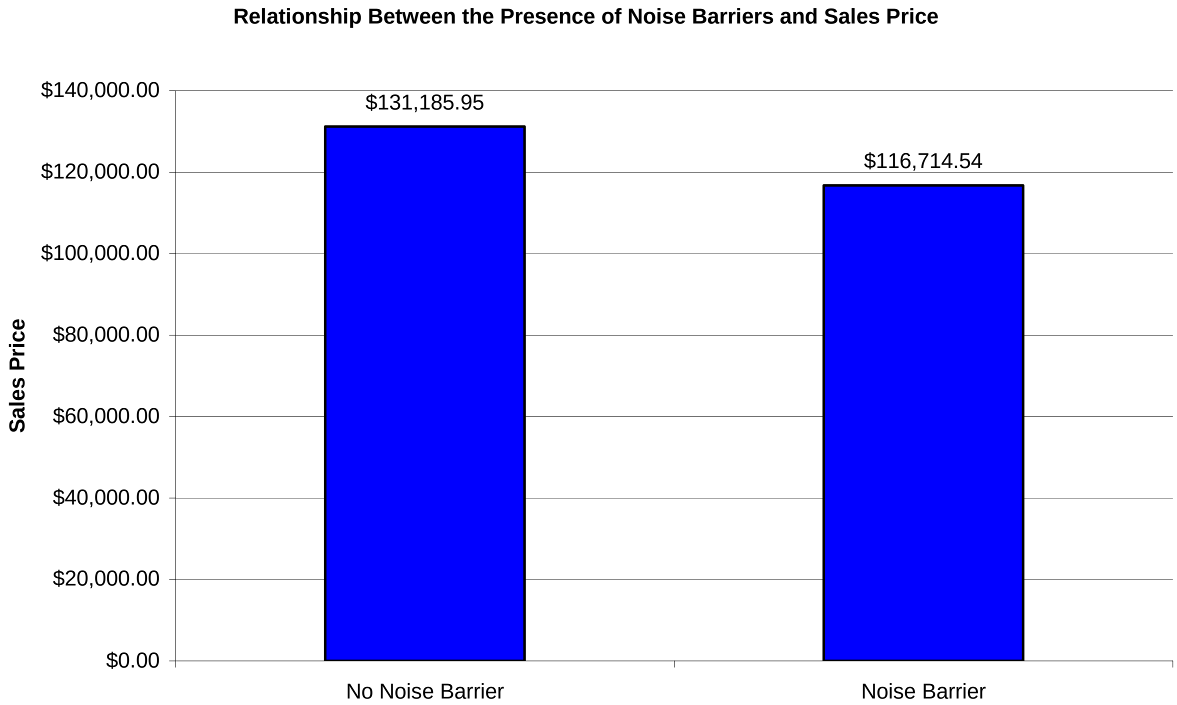

Figure 20

The straight correlation between the presence of noise barriers and the value of the property in this sample is counterintuitive. Those homes with noise barriers have a value approximately $15,000 less than those without noise barriers. Again, the need to control for other factors is extremely important and highlighted by this figure.