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Ceyhun Ozgur
Valparaiso University

Zachariah Hughes
Valparaiso University

Grace Rogers
Valparaiso University

Sufia Parveen
Valparaiso University

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Multiple Linear Regression Applications in Real Estate Pricing

Ceyhun Ozgur, Ph.D., CPIM[1], Zachariah Hughes[2], Grace Rogers[3], Sufia Parveen[4]

[1]*Professor, Valparaiso University College of Business Information & Decision Sciences Urschel Hall 223 – Valparaiso University Valparaiso, IN 46383*
[2]*Undergraduate Research Assistant Valparaiso University Finance – College of Business Economics – College of Arts and Sciences*
[3]*Undergraduate Research Assistant Valparaiso University Actuarial Science - College of Arts and Sciences Business Analytics - College of Business*
[4]*Graduate Research Assistant Valparaiso University M.S. in Analytics and Modeling*

ABSTRACT: *In this paper, we attempt to predict the price of a real estate individual homes sold in North West Indiana based on the individual homes sold in 2014. The data/information is collected from realtor.com. The purpose of this paper is to predict the price of individual homes sold based on multiple regression model and also utilize SAS forecasting model and software. We also determine the factors influencing housing prices and to what extent they affect the price. Independent variables such square footage, number of bathrooms, and whether there is a finished basement,. and whether there is brick front or not and the type of home: Colonial, Cotemporary or Tudor. How much does each type of home (Colonial, Contemporary, Tudor) add to the price of the real estate.*

I. INTRODUCTION

This paper is about 480 houses selected as a representative sample of all real estate sold in the State Indiana in 2014. The information used in this paper was taken from realtor.com. The purpose of this paper is to develop a relatively good regression equation for predicting the price of these houses. It is known that there are many factors to influence housing price, but we do not know for certain what factors will influence the price of the houses and to what extent these factors will impact the price. As a buyer, one can judge whether the price of a house of interest is rational or not. As a seller, one would be able to select a rational price according to the equation helping to optimize potential sales and correctly forecast demand.

According to one of the similar papers by Anpalaki J. Ragavan(2008), independent variables were categorized as two types: a) continuous independent variables (e.g: number of bedrooms, number of bathrooms, size of the property), and b) indicator independent variables that provide supporting information about the unit in the form of an item or facility that is either present (1) or not present (0) in the unit (e.g: built in dishwasher (DW), refrigerator (fridge), laundry facilities (WD)). There were 6 continuous independent variables namely, i) number of bedrooms (BED), ii) number of bathrooms (BATH), iii) square footage or size (SIZE), iv) sale price (PRICE), v) age of the property (AGE), and v) size of the yard (LOT).

According to Leslie A. Christensen, a linear model has the form $Y = b0 + b1X + \varepsilon$. The constant b0 is called the intercept and the coefficient b1 is the parameter estimate for the variable X. The ε is the error term. ε is the residual that cannot be explained by the variables in the model. Most of the assumptions and diagnostics of linear regression focus on the assumptions of ε. The following assumptions must hold when building a linear regression model.

1. The dependent variable must be continuous. If we are trying to predict a categorical variable, linear regression is not the correct method. We can investigate discrim, logistic, or some other categorical procedure.
2. The data we are modeling meets the "iid" criterion. That means the error terms, ε, are: a) independent from one another and b) identically distributed. If assumption 2a does not hold, we need to investigate time series or some other type of method. If assumption 2b does not hold, we need to investigate methods that do not assume normality such as non-parametric procedures.
3. The error term is normally distributed with a mean of zero and a standard deviation of σ 2, $N(0,\sigma\ 2\ )$. Although not an actual assumption of linear regression, it is good practice to ensure the data we are modeling came from a random sample or some other sampling frame that will be valid for the conclusions we wish to make based on our model.

Following the above procedures in this paper, the response variable selected is the “price” of these houses and the price is a numeric variable. At the same time, there are 12 variables used as the potential predictors and they are: Size (in square feet), Region (Urban, Suburban or Rural) Type (Condominium, Townhouse or SFH), Yard (in square feet), Bedrooms (number of), Bathrooms (number of), Garage (Attached, Detached or No), Floors, (number of), HOA (Homeowner Association in dollars), Tax (in percentage), Basement (Yes or No), Age (in years). The variables region, type, garage and basement are specifically numeric variables and are measured by digits, while the remainder are character variables. These character variables can be changed to numeric variables for the purpose of performing regression analysis. In this study, there are 480 houses and they are observational subjects.

To assess the validity of the regression assumptions, residual plots are used. Appropriate transformations of the dependent or independent variable can be done by making changes to the model until they are improved upon from previous problems. Estimated regression equation is then reported. Any outliers or influential values are being noted. If we find any influential values, we remove them from the dataset and a new report of estimated regression equation is made without the influential values. Finally comparison of the new estimated regression equation to the original one is done. We have used the Sherwin Rosen (1974) paper on hedonic pricing and implicit markets as the foundation of this paper regarding pricing in real estate. We also used the paper by Lipsey and Rosenbluth (1971). Both of these papers, showed that the Real Estate market is competitively priced.

II. PRELIMINARY DATA EXPLORATION

For quantitative predictors, scatterplot and correlation can be used to assess; for categorical predictors, boxplots can be used to assess. At the same time, the method of correlation can be used to find if there are some high correlated potential predictors.

2.1The Basic Data

The UNIVARIATE Procedure
Variable: price

Moments

N	480	Sum Weights	480
Mean	344294.431	Sum Observations	165261327
Std Deviation	132190.301	Variance	1.74743E10
Skewness	2.15460366	Kurtosis	6.59518407
Uncorrected SS	6.52687E13	Corrected SS	8.37018E12
Coeff Variation	38.394551	Std Error Mean	6033.63415

Basic Statistical Measures

Location		Variability	
Mean	344294.4	Std Deviation	132190
Median	320063.0	Variance	1.74743E10
Mode	218438.0	Range	1059817
		Interquartile Range	124553

Table 2: Tests for Location

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	57.06253	Pr > |t|	<.0001
Sign	M	240	Pr >= |M|	<.0001
Signed Rank	S	57720	Pr >= |S|	<.0001

Quantiles (Definition 5)

Quantile	Estimate
100% Max	1148962
99%	827428
95%	619739

The UNIVARIATE Procedure
Variable: price

Quantiles (Definition 5)

Quantile	Estimate
90%	463489
75% Q3	383822
50% Median	320063
25% Q1	259269
10%	223378
5%	206030
1%	175380
0% Min	89145

Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
89145	478	827428	408
109822	19	894994	250
141289	479	934652	83
172778	310	941304	71
175380	23	1148962	471

From this result, we can get some basic data about the response variable (the price of these houses). Specially, Mean=344294.4 Median=320063.0 Standard deviation=132190

2.2: Correlation between variables

Table 3: Correlation between variables

The CORR Procedure

price size Region_h Type_h yards bedrooms bathrooms garage_h floors age hoa

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
price	480	344294	132190	165261327	89145	1148962
size	480	2206	583.09745	1058861	958.00000	3860
Region_h	480	2.31875	0.72566	1113	1.00000	3.00000
Type_h	480	2.10417	0.88220	1010	1.00000	3.00000
yards	480	4536	4162	2177466	0	36870
bedrooms	480	3.63958	0.79225	1747	1.00000	6.00000
bathrooms	480	2.33021	0.81018	1119	1.00000	4.00000
garage_h	480	1.77500	0.69249	852.00000	1.00000	3.00000
floors	480	1.67708	0.73241	805.00000	1.00000	3.00000
basement_h	480	1.53125	0.49954	735.00000	1.00000	2.00000
age	480	37.38125	30.11915	17943	0	162.00000
hoa	480	1639	938.43569	786598	0	5400

This procedure gives information about the 12 variables with their simple statistics and Pearson's correlation coefficient.

Correlation of these variables 15:24 Saturday, December 6, 2008 8

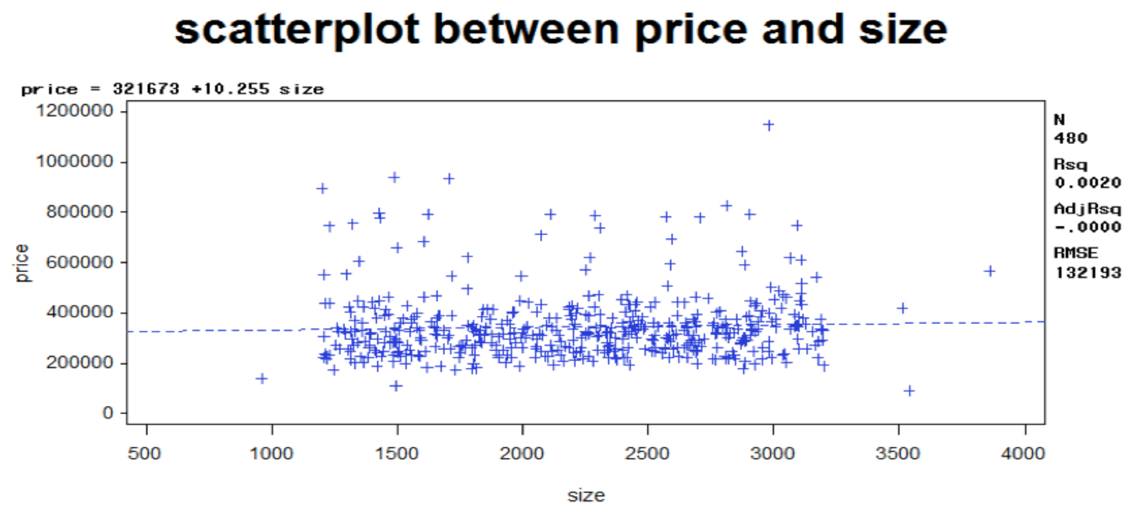
The CORR Procedure

Pearson Correlation Coefficients, N = 480
Prob > |r| under H0: Rho=0

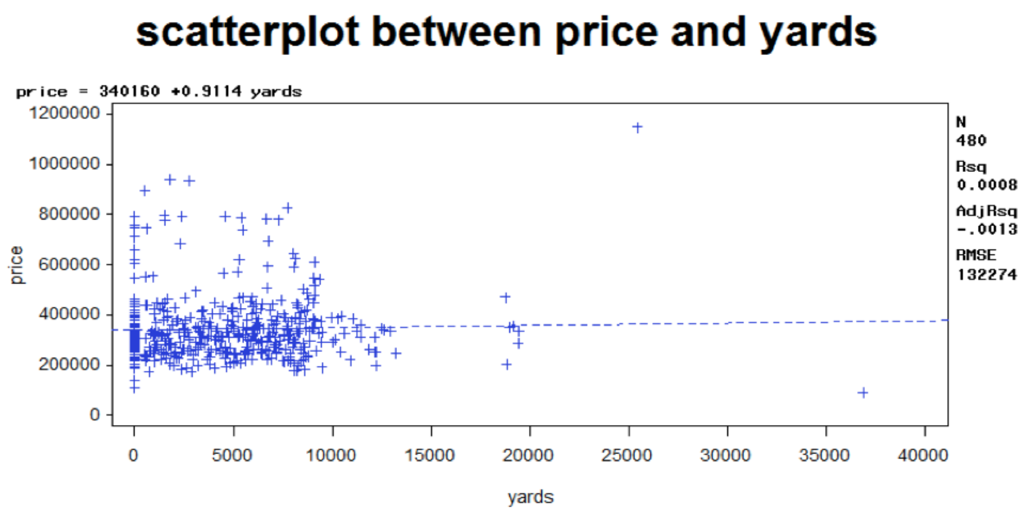
	price	size	Region_h	Type_h	yards	bedrooms	bathrooms	garage_h	floors	basement_h	age	hoa
price	1.00000	0.04523 0.3227	-0.05172 0.2581	-0.02994 0.5128	0.02870 0.5305	-0.05749 0.2087	0.01755 0.7014	0.02788 0.5422	0.04369 0.3395	-0.01907 0.6769	-0.00313 0.9455	0.16628 0.000
size	0.04523 0.3227	1.00000	-0.12408 0.0065	0.02315 0.6129	0.58639 <.0001	0.39558 <.0001	0.45765 <.0001	-0.08438 0.0647	0.82208 <.0001	0.63344 <.0001	-0.06647 0.1459	0.79567 <.0001
Region_h	-0.05172 0.2581	-0.12408 0.0065	1.00000	0.09152 0.0451	-0.28663 <.0001	-0.12294 0.0070	-0.09951 0.0293	0.00177 0.9692	-0.08089 0.0766	-0.06497 0.1553	-0.05152 0.2600	-0.00968 0.8324
Type_h	-0.02994 0.5128	0.02315 0.6129	0.09152 0.0451	1.00000	0.17897 <.0001	0.05682 0.2140	0.02480 0.5879	0.33917 <.0001	0.01340 0.7697	-0.00740 0.8715	-0.08077 0.0771	-0.05504 0.2044
yards	0.02870 0.5305	0.58639 <.0001	-0.28663 <.0001	0.17897 <.0001	1.00000	0.24608 <.0001	0.24769 <.0001	-0.16584 0.0003	0.71384 <.0001	0.16551 0.0002	-0.08908 0.0511	0.21202 <.0001
bedrooms	-0.05749 0.2087	0.39558 <.0001	-0.12294 0.0070	0.05682 0.2140	0.24608 <.0001	1.00000	0.40372 <.0001	-0.02635 0.5647	0.25954 <.0001	0.21051 <.0001	0.01058 0.8171	0.29499 <.0001
bathrooms	0.01755 0.7014	0.45765 <.0001	-0.09951 0.0293	0.02480 0.5879	0.24769 <.0001	0.40372 <.0001	1.00000	-0.04591 0.3155	0.35423 <.0001	0.36519 <.0001	-0.02917 0.5238	0.38469 <.0001
garage_h	0.02788 0.5422	-0.08438 0.0647	0.00177 0.9692	0.33917 <.0001	-0.16584 0.0003	-0.02635 0.5647	-0.04591 0.3155	1.00000	-0.18060 <.0001	0.09882 0.0304	0.01743 0.7032	-0.00015 0.9973
floors	0.04369 0.3395	0.82208 <.0001	-0.08089 0.0766	0.01340 0.7697	0.71384 <.0001	0.25954 <.0001	0.35423 <.0001	-0.18060 <.0001	1.00000	0.44133 <.0001	-0.05242 0.2517	0.60004 <.0001
basement_h	-0.01907 0.6769	0.63344 <.0001	-0.06497 0.1553	-0.00740 0.8715	0.16551 0.0002	0.21051 <.0001	0.36519 <.0001	0.09882 0.0304	0.44133 <.0001	1.00000	-0.01460 0.7497	0.66471 <.0001
age	-0.00313 0.9455	-0.06647 0.1459	-0.05152 0.2600	-0.08077 0.0771	-0.08908 0.0511	0.01058 0.8171	-0.02917 0.5238	0.01743 0.7032	-0.05242 0.2517	-0.01460 0.7497	1.00000	-0.04466 0.3289

2.3: Scattered plots
Graph 1: Scatter plot between Price and hoa

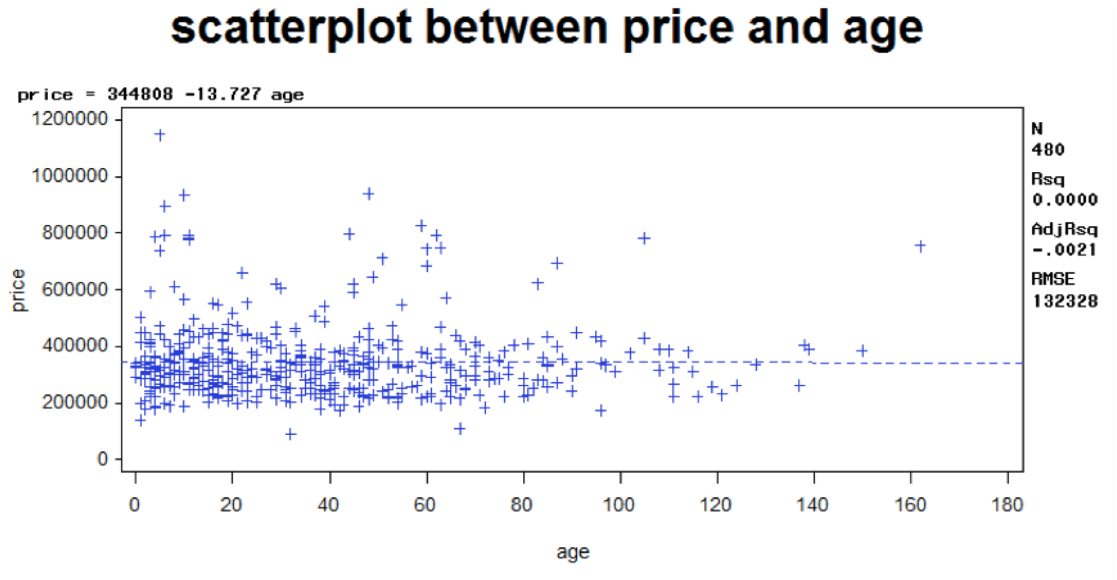
Graph 2: Scatter plot between Price and size:



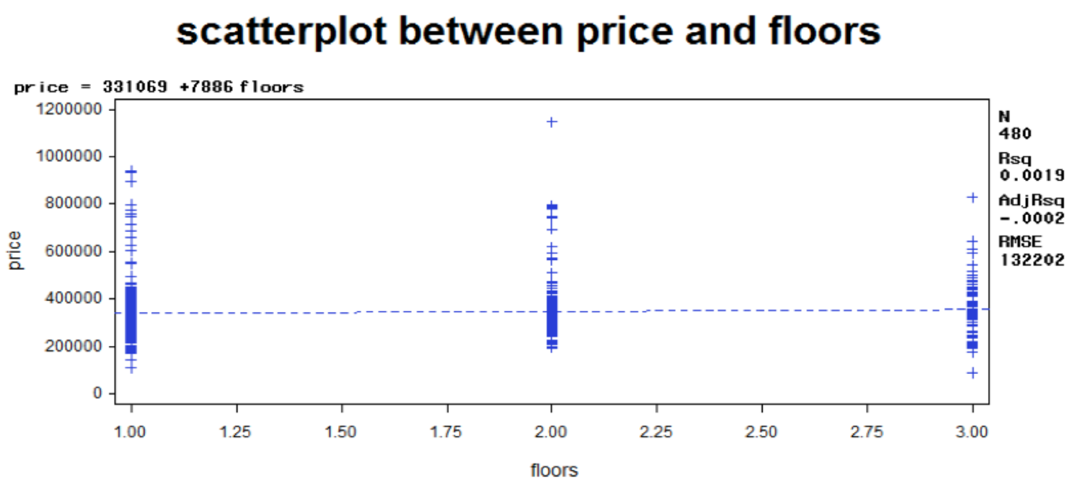
Graph 3: Scatter plot between Price and yards:



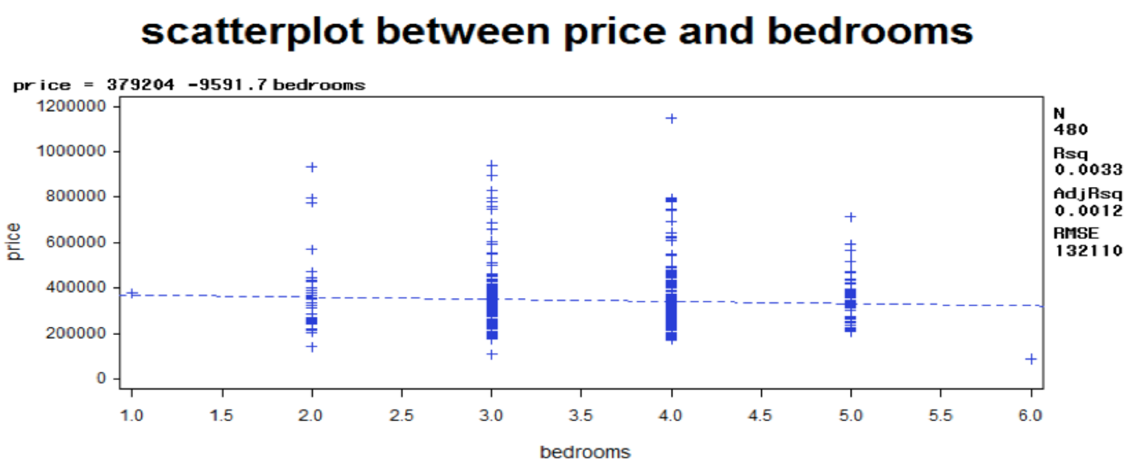
Graph 4: Scatter plot between Price and age:



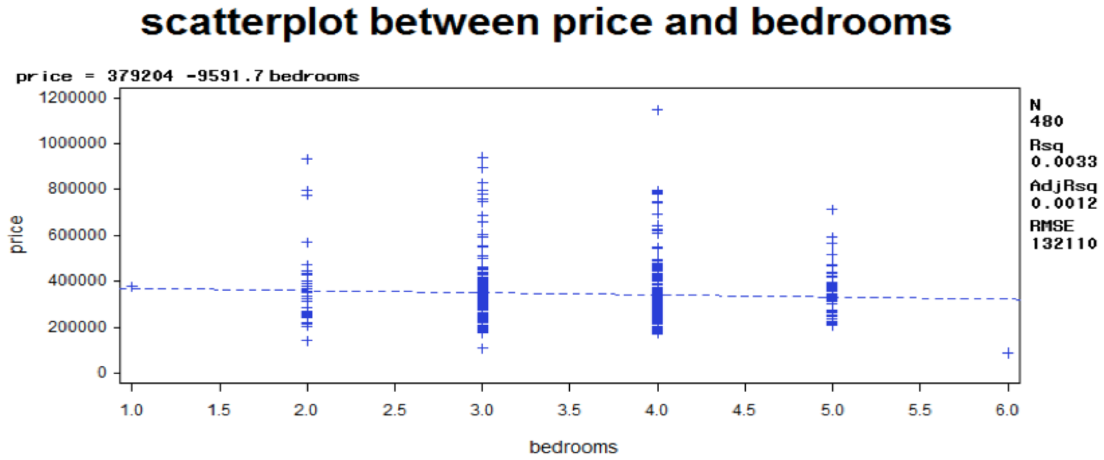
Graph 5: Scatter plot between Price and floors:



Graph 6: Scatter plot between Price and bedrooms:



Graph 7: Scatter plot between Price and bathrooms:



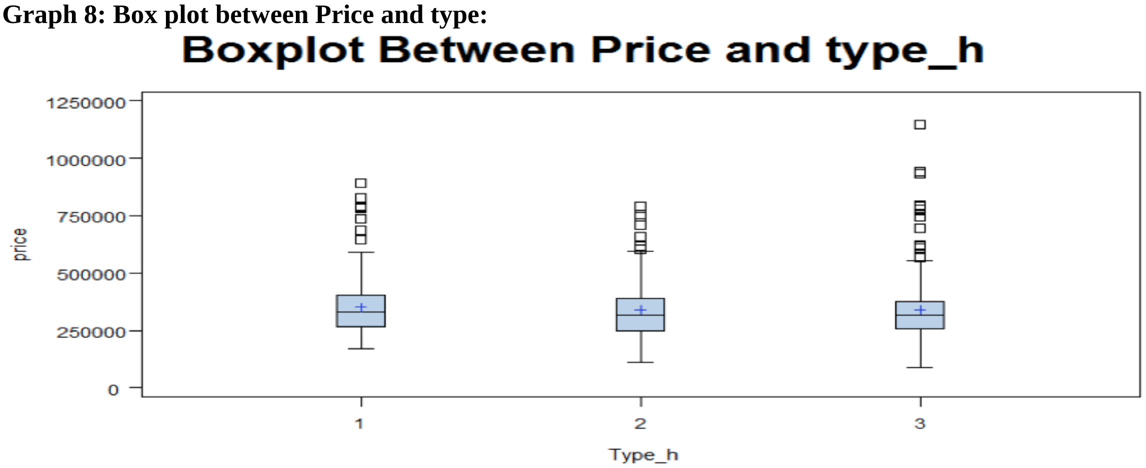
By observing the correlation between the variables and the scatterplots the following conclusion was drawn. The correlation coefficient between price and HOA is 0.16628 and the scatterplot shows they have positive relationship. From the second scatterplot, we can find that the price and size have positive relationship; the price increases as the size increases. In detail, the correlation coefficient between price and size is 0.04523. From the third scatterplot it has been observed that price and yards have positive relationship just like it has with size. The correlation coefficient between price and yards is 0.028, indicating that the correlation is significant. The correlation coefficient between price and age is -0.00313, indicating that the correlation between price and age is not significant and the scatterplot between them shows a negative relationship, that is, as the age of the house increases the price obviously decreases.

The correlation coefficient between price and floors is 0.04369 and the scatterplot shows there is a significant positive correlation between them. The correlation coefficient between price and bedrooms is -0.05749 and the scatterplot shows as the number of bedrooms increases the price gradually decreases which is a negative correlation. Finally, the correlation coefficient between price and bathrooms is 0.01755 and the scatterplot indicates there is a positive correlation meaning, as the number of bathrooms increases the price increases initially but later decreases with an increase in number of bathrooms.

There also exist relationships among the other potential predictors through the table. For example the correlation coefficient between size and yards is found to be 0.58639 and the correlation coefficient between garage_h and type_h is 0.33917, these two absolute values of correlation coefficient are both greater than 0.3 and less than 0.8, so they have moderate correlation. Other absolute values of correlation coefficients, which were found to be less than 0.3, were found to have low correlation relationships.

2.4: Box plots

Graph 8: Box plot between Price and type:

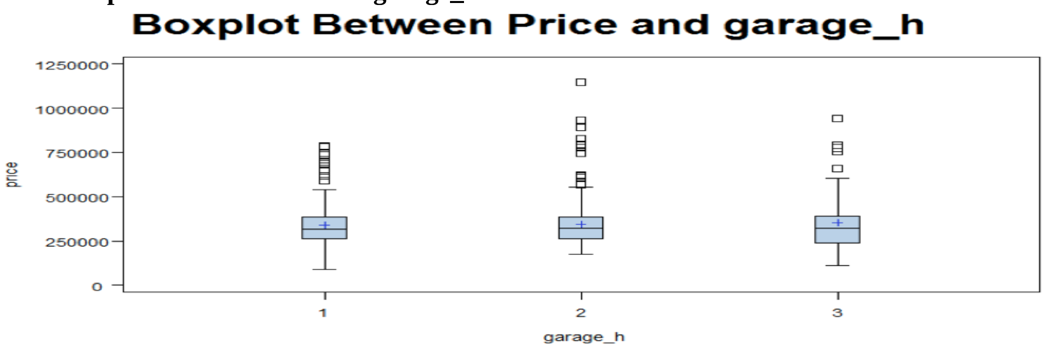


From the box-plot above, it can be observed that when price range is between 20,000 to 60,000, the type of the house available is townhouse, when it is between 15,000 to 65,000 the house type is SFH and when the price range is between 10,000 to 55,000 the house type available is condominium. All the three types of houses have some outliers.

Graph 9: Box-plot between Price and region h:

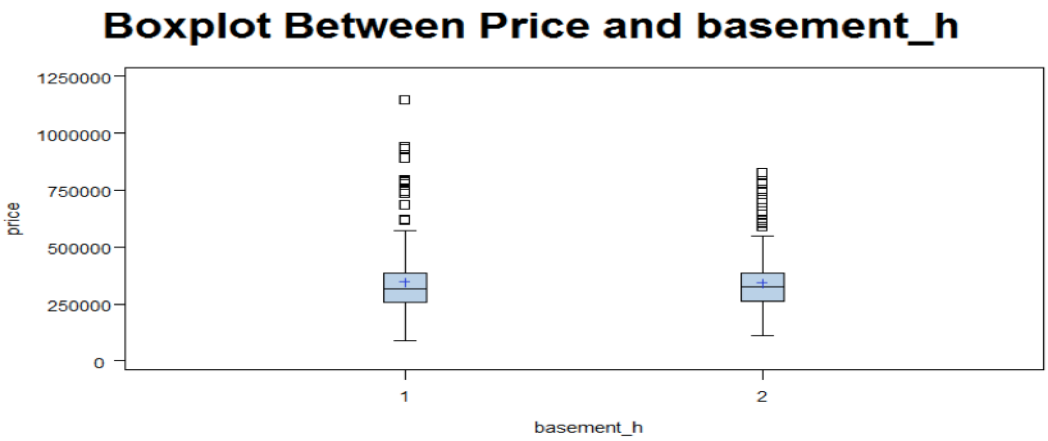
From the box-plot between price and region_h, it has been observed that when the price range is between 20,000 and 55,000 the region is rural, when the price range is between 20,000 and 53,000 the region is urban, and when the price range is between 15,000 and 55,000 the region is suburban. All three regions have some outliers.

Graph 10: Box-plot between Price and garage_h:



From the box-plot between price and garage_h it has been observed that when the price range is between 10,000 and 55,000 the garage is detached, when the price range is between 20,000 and 57,000 the garage is attached, and when the price range is between 11,000 and 60,000 there is no garage. All three garage types have outliers.

Graph 11: Box-plot between Price and basement_h:



From the box-plot between price and basement_h it has been observed that when the price range is between 10,000 and 60,0000 there is a basement and when the price range is between 12,000 and 58,000 there is not a basement. Both of the basement types have some outliers.

As we can see from the figures, the various categorical predictors all have the outliers. Now as we did some primary analysis for different predictors, we cannot give up any predictors from the information above.

III. REGRESSION

3.1. Based on all the information and outputs above, our initial model would be:

Price= $\beta_0$size+ $\beta_1$region_h+ $\beta_2$type_h+ $\beta_3$yards+ $\beta_4$age+ $\beta_5$floors+ $\beta_6$hoa+ $\beta_7$bedrooms+$\beta_8$bathrooms+ $\beta_9$garage_h+ β_{10}basement_h+ ε.

From the scattered plots, it is clearly seen that the linear relation is negative between price and age. The normal thinking is that the price will go down with the age goes up. That is to say, the coefficient between price and age is negative. Although the dots are dispersed and the linear relation is not obvious, we still put that in into the initial model. Secondly, the relationship between price and size is positive, as observed in the scatterplot, so we include this in the initial model. We also include all other numeric predictors into the initial model. As for the four categorical predictors, we use the side-by-side box plots to see the distribution. By observing the boxplots, some outliers were existent. But we still include them in the initial model. Initially, we include all potential predictors in the model, assuming that they may have an influence on the price.(Articles &Statistical Papers, December 1992)

3.2. Then let us begin to do the multiple regression analysis.

Graph 12: Scatter plot between predicted value and student zed residual

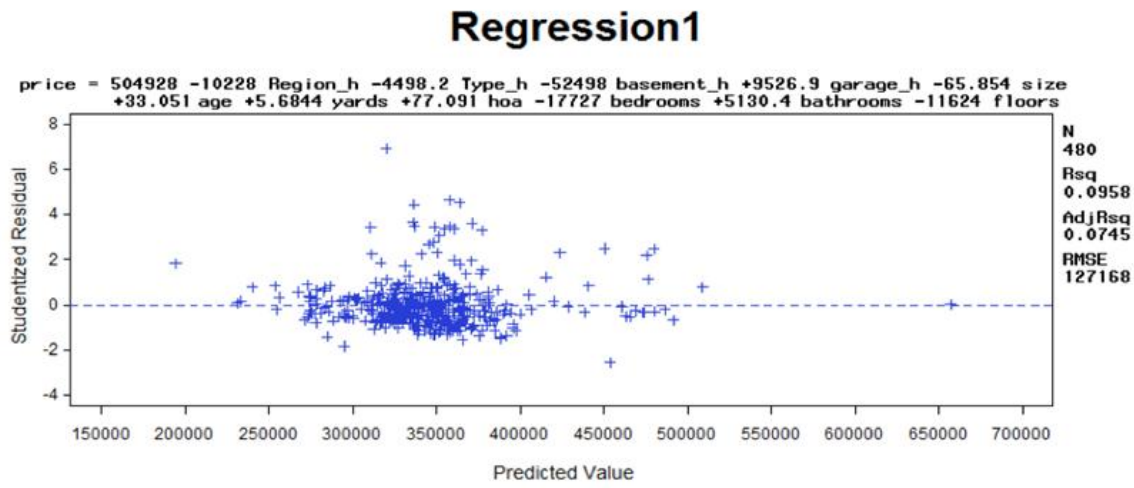


Table 4: Regression Analysis of Real Estate predictor variables

The REG Procedure
Model: MODEL1
Dependent Variable: price

Number of Observations Read	480
Number of Observations Used	480

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	8.018248E11	72893161580	4.51	<.0001
Error	468	7.568353E12	16171695029		
Corrected Total	479	8.370178E12			

Root MSE	127168	R-Square	0.0958
Dependent Mean	344294	Adj R-Sq	0.0745
Coeff Var	36.93582		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	504928	47452	10.64	<.0001
Region_h	1	-10228	8825.20509	-1.16	0.2471
Type_h	1	-4498.21798	7515.92067	-0.60	0.5498
basement_h	1	-52498	16677	-3.15	0.0017
garage_h	1	9526.91148	9439.83735	1.01	0.3134
size	1	-65.85399	27.29726	-2.41	0.0162
age	1	33.05113	195.33657	0.17	0.8657
yards	1	5.68443	2.57136	2.21	0.0275
hoa	1	77.09061	12.40316	6.22	<.0001
bedrooms	1	-17727	8460.63356	-2.10	0.0367
bathrooms	1	5130.44606	8471.02453	0.61	0.5450
floors	1	-11624	17136	-0.68	0.4979

3.3.***The fitted quadratic model:***

Price=504928-10228Region_h-4498.217Type_h-52498Basement_h+9526.911 Garage_h-65.854Size+33.051Age+5.6844Yards+77.091Hoa-17727Bedrooms +5130.446Bathrooms-11624Floors

The adjusted R^2 is 0.0745, which indicates this model fits the data well. The F-test (ANOVA) tests whether $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$. The p-Value is < 0.0001, indicating that overall the explanatory variables are significant to the response variable.

Parameter estimates and standard errors of the estimates, along with t-tests and p-values are also given. The t-test tests whether each explanatory variable is zero. Hence, only HOA is significant because the p-value < 0.0001. We can then put the HOA into this model.

Dependent Variable: price

Number of Observations Read	480
Number of Observations Used	480

Analysis of Variance

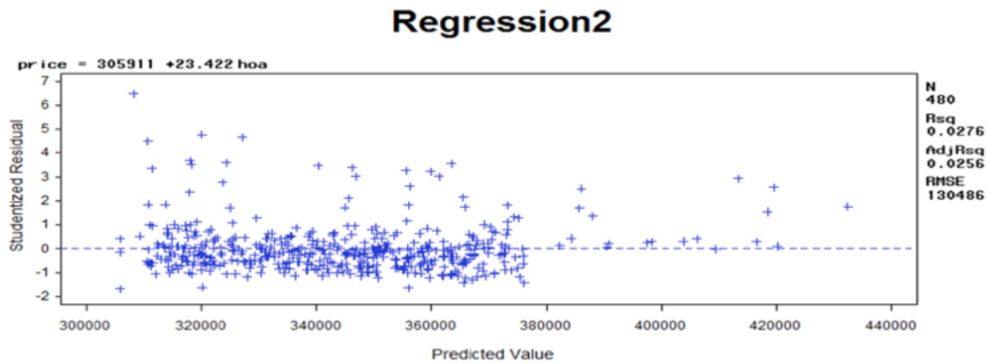
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2.314231E11	2.314231E11	13.59	0.0003
Error	478	8.138755E12	17026684074		
Corrected Total	479	8.370178E12			

Root MSE	130486	R-Square	0.0276
Dependent Mean	344294	Adj R-Sq	0.0256
Coeff Var	37.89964		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	305911	11994	25.50	<.0001
hoa	1	23.42238	6.35320	3.69	0.0003

Table 5: Analysis of Variance for dependent variable price



Graph 13: Scatter plot between predicted value and student zed residual

From the result, the p-value=0.0003, which means that HOA variables are significant in relation to the response variable. At the same time, the adjusted R-Sq=0.0256, which means that it explains 2.56% of the change in price. Finally, we get the following equation:

Price=305911+23.422hoa.

However, the above residual plot shows that the assumption of constant variance is not met. So we need to check for multicollinearity as well as influential observations.

3.4: Multicollinearity

Table 6: Multicollinearity

The REG Procedure
Model: MODEL1
Dependent Variable: price

Number of Observations Read	480
Number of Observations Used	480

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2.314231E11	2.314231E11	13.59	0.0003
Error	478	8.138755E12	17026684074		
Corrected Total	479	8.370178E12			

Root MSE	130486	R-Square	0.0276
Dependent Mean	344294	Adj R-Sq	0.0256
Coeff Var	37.89964		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance	Variance Inflation
Intercept	1	305911	11994	25.50	<.0001	.	0
hoa	1	23.42238	6.35320	3.69	0.0003	1.00000	1.00000

Table 7: Regression Procedure collinearity diagnostics

The REG Procedure
Model: MODEL1
Dependent Variable: price

Collinearity Diagnostics

Number	Eigenvalue	Condition Index	--Proportion of Variation- Intercept	hoa
1	1.86801	1.00000	0.06600	0.06600
2	0.13199	3.76197	0.93400	0.93400

Tolerance is the proportion of each variable's variance not shared with the other explanatory variables. Small tolerance values indicate collinearity. In general, we should ensure the tolerance is greater than 0.2. If we notice the tolerance value of HOA its 1.000 which is greater than 0.2, this variable has no tolerance problem.

Then we need to find the outliers. Studentized residuals greater than 1.5 or less than -1.5 should be deleted because they are outliers. From these 480 data, #13 #24, #62, #63, #351, #371 should be deleted. In the second round, we need to delete #87, #96, #106, #108, #109, #118, #398. In the third round, we delete #135 #153, #157, #170, #211, #218, #224, #436. In the fourth round we delete #236, #242, #244, #268, #270, #284, #293, #313, #437, #217 and finally in total, we delete 26 data of 480.

After that, we need to check for multicollinearity again.

\

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance	Variance Inflation
Intercept	1	312638	12035	25.98	<.0001	.	0
hoa	1	17.85426	6.37536	2.80	0.0053	1.00000	1.00000

The REG Procedure
Model: MODEL1
Dependent Variable: price

Collinearity Diagnostics

The REG Procedure
Model: MODEL1
Dependent Variable: price

Number of Observations Read	449
Number of Observations Used	449

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.251753E11	1.251753E11	7.84	0.0053
Error	447	7.134306E12	15960416364		
Corrected Total	448	7.259481E12			

Root MSE	126335	R-Square	0.0172
Dependent Mean	341917	Adj R-Sq	0.0150
Coeff Var	36.94888		

Table 8: Regression procedure dependent variable price

From the data, the tolerance of the HOA variable is greater than 0.2, which indicates that it has no tolerance problem.

Table 9: Regression Procedure Dependent Variable price

The REG Procedure
Model: MODEL1
Dependent Variable: price

Number of Observations Read 449
Number of Observations Used 449

Stepwise Selection: Step 1

Variable hoa Entered: R-Square = 0.0172 and C(p) = 2.0000

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.251753E11	1.251753E11	7.84	0.0053
Error	447	7.134306E12	15960416364		
Corrected Total	448	7.259481E12			

3.5. Then we use the Stepwise Regression method to get the equation:

Table 10: Analysis of Variance

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.251753E11	1.251753E11	7.84	0.0053
Error	447	7.134306E12	15960416364		
Corrected Total	448	7.259481E12			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	312638	12035	1.076977E13	674.78	<.0001
hoa	17.85426	6.37536	1.251753E11	7.84	0.0053

Bounds on condition number: 1, 1

All variables left in the model are significant at the 0.1500 level.

All variables have been entered into the model.

The REG Procedure
Model: MODEL1
Dependent Variable: price

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	hoa		1	0.0172	0.0172	2.0000	7.84	0.0053

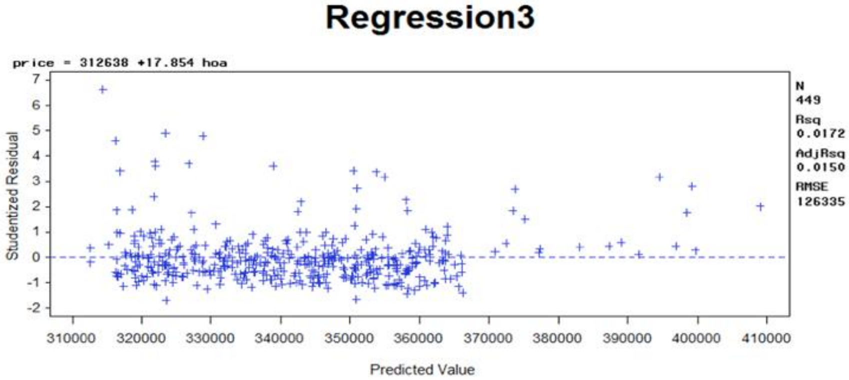
Table 11: Regression results, stepwise model

The intercept for HOA is not significant because the p-value is 0.053 which is > 0.001.
From the multiple regression model we can get the equation as:

Price=312638+17.854Hoa.

Finally, we need to check the variance.

Graph 14: Scatter plot between predicted value and student zed residual



Through this diagram, it can meet the requirement of constant variance in general. So the best model is: **Price=312638+17.854Hoa**.

IV. CONCLUSION

This paper is about what factors would have influence on the price of the houses. Firstly, we did the preliminary analysis and chose 12 variables to predict the price. Then we used the method of multiple linear regression to analyze how these factors affect the price of the houses. After the analysis, we chose seven variables (HOA, size, age, yards, floors, bedrooms, bathrooms) to include in our model. There were many outliers, and finally, we included HOA in our model. Because the easiest model is the best, we chose to use one variable to for prediction. Finally, we got the equation: **Price=312638+17.854Hoa**

Once we solved this paper question, we got a clear idea that HOA is one of the most useful indexes to estimate the price of house. At the same time, it has most important influence on the price. When we look forward to buying a house, we can include the information of HOA in this regression model, and construct an estimate quote for the price and compare that with the real price. Then we can decide whether to buy or not.

However, when you decide to buy a house you should consider other factors that influence the price, including the region, age, size, area, yards, number of bedrooms, floors and bathrooms etc. All of these elements will have a large or small influence on the price. If we want to get a more precise model, many other factors should be considered. However, it may consume too much time to collect the data and find the best regression model.

REFERENCES

[1]. A procedure for stepwise regression analysis (Articles &Statistical Papers, December 1992, Volume 33, Issue 1, pp 21-29

[2]. How to use SAS® to fit Multiple Logistic Regression Models Anpalaki J. Ragavan, Department of Mathematics and Statistics, University of Nevada, Reno, NV 89557(369-2008)

[3]. Introduction to Linear Regression Analysis (By Douglas C. Montgomery, Elizabeth A. Peck, G.)

[4]. Lipsey R.G. & Rosenbluth G. "A Contribution to the New Demand Theory: A Rehabilitation of the Giffen Good." *Canadian Journal Econ*. 4 (May 1971), pp. 131-163.

[5]. The Little SAS Book for Enterprise Guide 4.2 (By Susan J. Slaughter, Lora D. Delwiche)

[6]. Muth R. "Household Production and Consumer Demand Functions Econometrica 34 July 1966 pp. 699-708

[7]. S. Rosen "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition" Author(s): Journal of Political Economy, Vol. 82, No. 1 (Jan. - Feb., 1974), pp. 34-55Realtor.com. http://www.realtor.com

[8]. Regression with SAS (http://www.ats.ucla.edu/stat/sas/webbooks/reg/chapter1/sasreg1.htm)

[9]. ReliaSoft's Experiment Design and Analysis Reference

[10]. SAS System for Regression (Third Edition, By Rudolf J. Freud, Ph.D., Ramon C. Littell, Ph.D.)

[11]. Statistics Using SAS Enterprise Guide (By James B. Davis, Ph.D.)

[12]. Using Multivariate Statistics (FIFT H EDITION, Barbara G. Tabachnick California State University, Northridge Linda S. Fidell California State University, Northridge