Property Valuation Model
Effect of Traffic Noise on Property Value

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Abstract— **One of the questions appraisers constantly face when performing an appraisal is: how much data, supporting information, and analysis are enough? The author of this paper attempts to answer this question, by providing a model that helps in the process of property valuation. The real estate values of properties in this study were estimated using a pricing model that combined the fundamental characteristics of a property with the level of noise emitted from the nearby freeway. The hypothesis in this study was "noise emitted from traffic along Interstate-5 has a negative impact on the property value". If noise was eliminated the property value would increase. A statistically significant valuation model could be developed using stepwise regression.**

Index Terms- **appraisal, property valuation, stepwise regression.**

I. Introduction

THE purpose of this project is to develop a model for estimating the market value of residential properties. The property value is a function of classical factors such as the property square footage, year of construction, amenities, and the current market conditions determined by sales in the immediate area. Another important factor that the author of this paper studied was the negative impact of freeway traffic noise on the value of the residential properties.

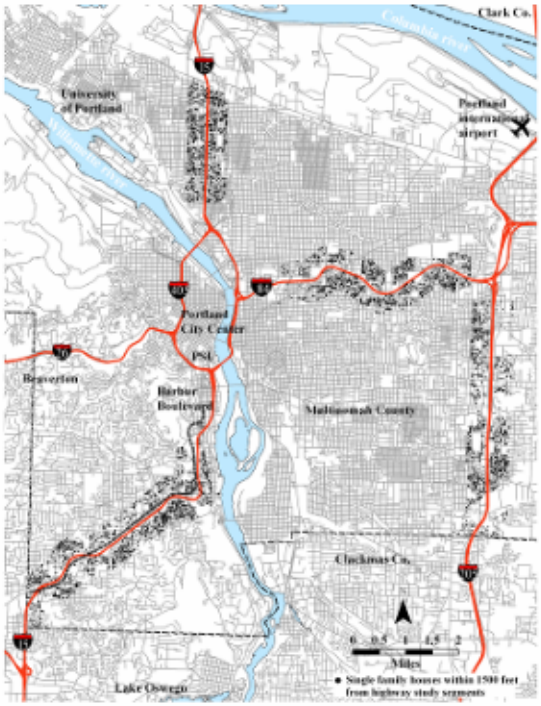
Giuliano claimed that "the relation between land value and freeways no longer exist because the cities are already built up and the freeway system was completed long ago" [1]. The National Cooperative Highway Research Program (NCHRP) Report 423A defined the impact of the development of adding new lanes and intersections to existing freeways on land use and value. NCHRP mentioned that "there will be redistribution in the metropolitan growth around a freeway corridor, increased land values, and a concentration of development around interchanges" [2].

Boarnet and Charlempong proved that the construction of the first two portions of the Orange county toll road network created accessibility premiums that were reflected in home sales prices. In their study, they took into consideration the neighborhood characteristics as independent variables such as crime rate and quality of schools [3].

The hypothesis of this study was*:* noise generated from Interstate-5 has a negative impact on the nearby land value in Portland, Oregon.

The properties studied in this project are located as far as approximately 2.5 miles of I-5 north of Portland, 5.3 miles of I-5 south of Portland, and one mile on either side of I-5 corridor. Figure (1) shows a map with the area under investigation.

Figure (1)
Area of Study



II. Methodology

A. The Data

The study used two sets of data; the level of noise in decibels generated by traffic along the I-5 freeway corridor in Portland, provided by the Federal Highway Administration (FHWA), and the properties and their characteristics provided by the Regional Land Information System (RLIS) for the city of Portland. After data cleaning, the final sample size with complete data was 1100 records. To assess the reliability and generalizability of the findings, the final sample was divided into two sets of data. The sub-samples were formed in a random fashion. Researchers assign 75% of the data set to the analysis sample and 25% to the holdout sample. The data set to derive the model was formed with 800 records, while the second data set of 300 records was left to test that model.

Every record in the data set included a group of variables,

among which are the property market value (MV), total square footage (TA), building square footage (BA), number of bedrooms (BR), number of bathrooms (BT), total number of other rooms (OT), garage capacity (GC), number of fire places (FP), AGE of the property (AG), Noise level around the property (NS), and the distance from the freeway (DT). Table (1) provides a descriptive summary of these variables.

B. Stepwise Regression

Because of the relationship between the total area of the building and the number of bedrooms, and the relationship between the noise and the distance from the freeway, the stepwise regression model was appropriate for application for this model. Stepwise regression analysis was used to identify the least subset of input variables to minimize the average squared error. The market value of the property was the dependent variable (MV), while the other property characteristics were the independent variables.

Starting with the variable that had the most correlation value with the independent variable MV; the building area (BA), the model was tested. Adding one more variable at a time to the ones that were already added and tested, searching through all of the variables not in the model and finding the variables that most decreased the average squared error and that increased the R-square. Table (3) shows a summary of 7 iterations of different independent variables included in the model.

III. RESULTS

Table (1) provides a descriptive summary of all the variables in the data set. The minimum value for the age variable (AG) showed 0, this means that the house was evaluated in the same year it was built.

Table (1)
Descriptive summary of the data

	Min	Max	Mean	Std.
MV ($)	63830	595620	171265.64	60159.199
NS (dB)	55.2	88.3	67.018	7.1154
DT (ft)	160.07	2326.13	1257.7081	489.53390
BT	0.5	3.5	1.626	.6524
BR	0	7	2.96	.993
GA	1	4	1.27	.494
FA	0	1	.70	.459
BA	688	6432	1615.42	580.783
TA	2080	45637	6805.88	3257.874
OT	0	7	.73	1.078
AG (year)	0	120	49.99	25.022

The correlation between the independent variables and the dependent variable MV was useful in the process of creating the linear model as for which variable to start with in that process. Table (2) shows the correlation and its significance. The building area had the most-correlation with a significance level of 0.01. PC in the table is the Pearson's Correlation. Distance and number of fire places were not significantly correlated, while the other variables had a statistically significant correlation with the property value.

Table (2)
Correlations of the independent variables with property value

	BA	DT	NS	BT	BR	GA	TA	OT	AG	FP
PC	0.75	0.07	0.37	0.58	0.35	0.41	0.48	0.27	0.39	0.03
Sig.	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.41

An iterative algorithm of adding variables, removing variables, and searching through all of the variables not in the model was employed to find those variables that most decreased the ASE or invariably increase the R-squared value.

Table (3)
Models summary with dependent variable MV

Model	R	R Square	Model variables
1	.75	.560	BA
2	.81	.653	BA, AG
3	.82	.680	BA, AG, TA
4	.83	.689	BA, AG, TA, NS
5	.83	.693	BA, AG, TA, NS, DT
6	.83	.696	BA, AG, TA, NS, DT, BT
7	.84	.698	BA, AG, TA, NS, DT, BT, GA

R-squared is the percent of the property value explained by the independent variables. Table (3) shows that in model 7, the 7 independent variables explain 70% of the variance reduction.

Table (4)
The Regression Model

Variable	B	ß	Sig.
(Constant)	-35706		.07
BA (ft^2)	59	.57	.01
AG(year)	-488	-.20	.01
NS (dB)	-1308	-.16	.01
TA(ft^2)	2.6	.14	.01
BT	6685	.07	.01
DT (ft)	10	.08	.01
GA	5468	.05	.04

According to the results of the model represented in table (4), the building area had a statistically significant positive effect on the value of the property. The total value of the property increases by about $59 for every square foot increase in the building area. The noise had a statistically significant negative coefficient. The negative value was around $1308

per one decibel above 55 decibels. 55 dB is the average background noise in a house. When the sound emitted from the freeway exceeded 55 dB, it was defined as noise pollution.

The age of the building had a statistically significant negative effect on the market value of the property. The value decreased $488 yearly.

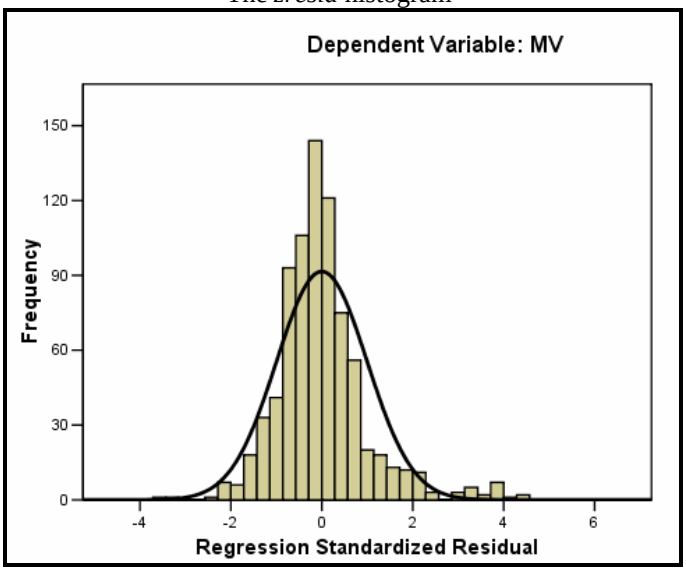
Distance from the freeway had a positive effect on the property value, the further the house is from the highway, the higher was the price. This is consistent with the observation that the noise level had a negative impact on the property value, since the noise level decrease when the distance increased.

Having a garage in the house increased the house value by about $5468, while an added one bathroom had the effect of increasing the price of the house by about $6685.

Significance of the individual independent variables in the model varied from 0.01 to 0.04, while the constant had a significant level of 0.07. The overall significance of the model was below 0.05, so the model is statistically significant.

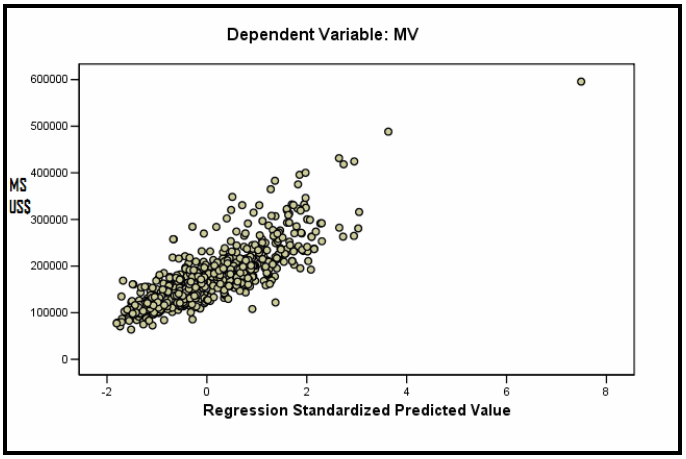
The *zresid* histogram in figure (2) provides a visual way of assessing the assumption of normally distributed residual error.

Figure (2)
The *zresid* histogram



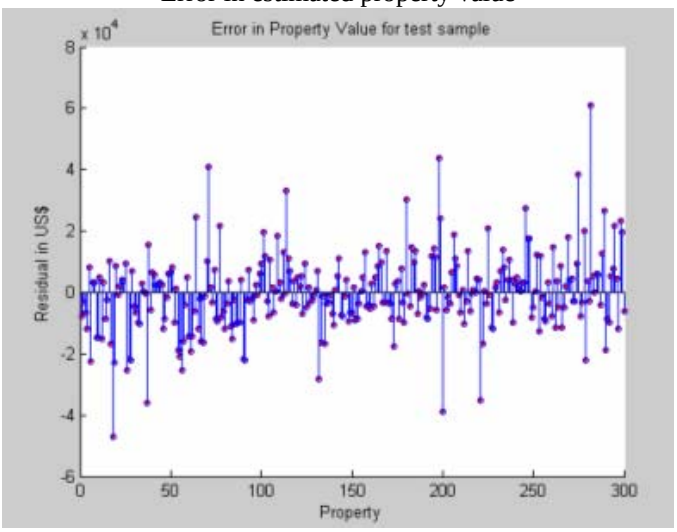
Plot in figure (3) reflects the standardized predicted value vs. property observed values. The more the points are dispersed around the trend, the higher the standard error of estimate. The trend in the center of the plot reflects the fact that the model explains 70% of the variance.

Figure (3)
Regression Standardized Predicted Value



The following plot shows the result of testing the model with the second set of data (300 records).

Figure (4)
Error in estimated property value



While the mean of the market value of a property was $136,080, the mean of the estimated value was $136,820 with an absolute mean error of $740. Maximum error was $60,860 and the minimum error was negative $47,000.

IV. Discussion

This study showed that noise emitted from the nearby freeway had a statically significant negative impact on the property value. This testifies that rejecting the null hypotheses is valid with confidence level of at least 95%. An important factor that was not taken into account when the noise level was measured is the presence of barriers surrounding the property. These barriers could be in the form of other houses surrounding the property under study.

The total square footage of the property building accounted for a major percent of the property value. Although the model didn't include the number of bedrooms, it fairly reasonable to judge that it is strongly related to the building square footage. While age of the building had a negative impact on the market

value of the property, this could be inaccurate in the case of a house that went under renovation and updates.

V. CONCLUSION

The primary finding of this study was the negative relation between the market value of a property and the noise level emitted from the nearby freeway. A statistically significant model with 7 independent variables explained 70% of the variance in the market value of the property.

The presence of a barrier in the form of surrounding buildings might block some of the calculated noise and should be taken into consideration. If the City of Portland invested in adding noise barriers along the freeway, noise could be reduced. Reduced noise level would increase the property value significantly.

REFERENCES

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[3] Boarnet M. G., Haughwout A, *Do Highway matter? Evidence and Policy of Highway's Influence on Metropolitan Development.* Brooking Institute Center, 2000.