DETERMINING THE IMPACT OF

SELECTED VARIABLES ON

THE SALE PRICE

OF REAL ESTATE

THESIS

PRESENTED TO THE GRADUATE COUNCIL OF THE

UNIVERSITY OF NORTH TEXAS IN PARTIAL

FULLFILLMENT OF THE REQUIREMENTS

For the Degree of

MASTER OF SCIENCE

By

Jon E. Martin

Denton, Texas

May, 1989

TABLE OF CONTENTS

LIST OF TABLES

Martin, Jon E., <u>Determining the Impact of Selected Variables on the Sale Price of Real Estate</u>. Master of Science, (Applied Economics), May, 1989, 20 pp., 2 tables, bibliography, 5 titles.

This paper presents the results of a study dealing with a number of issues regarding real estate investment. Utilizing a data set consisting of real estate transactions, questions relative to the impact of certain variables on the sale price are addressed.

CHAPTER I

INTRODUCTION AND PRESENTATION OF THE PROBLEM

Introduction

The use of multiple regression analysis as a tool for real estate valuation has received a great deal of attention in recent years. The purpose of this study is to investigate the importance of certain variables and to determine what influence they have on the sales price.

There have been numerous theories as to the determinants of value since the development of modern value theory in the eighteenth and nineteenth centuries. The traditional approaches to the valuation of real property, the income approach, the cost approach and the sales comparison approach, were developed after the stock market crash of 1929. Depending upon which school of thought you place greater emphasis on determines which approach is more important. However, one concept is common through each approach, and that is the concept of comparison. As Kang and Reichert discussed in a recent paper, the sales comparison approach is favorable when sufficient data are available for similar properties. The main problem with the sales comparison approach is the limited number of comparable properties generally available... Furthermore,

1

the wide range of commercial property characteristics make selection of comparable properties difficult (2, p. 29).

Statement of the Problem

This analysis addresses the question of the impact of financial, physical, and location characteristics on the sales price of commercial grade real estate.

It is because of this problem that multiple regression analysis as a tool for real estate analysis and valuation has received a great deal of attention in the past few years. The use of multiple regression analysis measures the effect and impact various characteristics or variables have on the selling price of real estate. With multiple regression analysis, an equation can be employed to measure individual component values. This technique could assist the appraiser/analyst in conforming to the Federal Home Loan Bank Board's appraisal policies.

In part, The Federal Home Loan Bank Board, as operating head of the Federal Savings and Loan Insurance Corporation, is proposing to adopt a rule and a statement of policy pertaining to appraisal policies and practices of institutions insured by FSLIC. This proposed rulemaking requires the management of insured institutions and service corporations to develop and implement prudent appraisal policies and procedures. Part of the policy reads that

market comparable data analysis be presented so that it contains descriptive information presented with sufficient detail to demonstrate that the transactions were conducted under the terms and conditions of the definition of value being estimated, or have been adjusted to meet such conditions; have a highest and best use equivalent to the best use of the subject property; and that the selected properties are physically and economically comparable to the subject property; and includes a presentation and explanation of adjustments used in the analysis together with appropriate market support (3, pp. 2-10).

Multiple regression analysis would conform with the requirement of the Federal Home Loan Bank Board to support the various adjustments with market evidence, because, as Meacham pointed out, the value the market places on a particular property characteristic can be estimated by long established statistical principles (4, p. 25). The use of multiple regression analysis has been successfully applied to the mass appraisal of residential properties for several years. However, applying multiple regression successfully to commercial properties has had little success. This is due in part on the limited amount of comparable property transactions occurring within a certain market. And, in order to apply multiple regression and obtain valid results, numerous observations must be included in the regression equation.

Delimitations and Assumptions

This analysis is limited to the data for 30 office building sales in Dallas County from 1986 - 1988. This is a convenience sample of office building sales whose statistics were able to be obtained for analysis.

Definition of Terms

CEPSE - The cash equivalent price per square foot reflects the selling price after adjustments for financing.

MTHSLE - Mthsle is a variable designed to measure the impact of inflation or deflation upon the market. It is coded as a continuous variable beginning with a value of 36 for properties sold in January 1986 and ending with 1 for properties sold during December 1988.

FOROWN - The presence of foreign ownership. Coded as a dummy variable with 1 for foreign ownership, and 0 in the absence of foreign ownership.

RO - The overall rate calculated as the properties net operating income/sales price.

OCCUP - The occupancy of the property at the time of sale.

STORIES - Number of stories in the building.

EFFAGE - Effective age of property which reflects present condition and takes into consideration additions, remodeling, etc.

NRA - Net rentable area of the property.

PARK - The existence of various types of parking facilities. Coded as a dummy variable with 1 for good parking and 0 for bad parking facilities.

ACCESS - Coded as a dummy variable with 1 for access to public transportation and 0 for no access to public transportation.

SEC1 - Office building sales in the LBJ/North Dallas area. Coded as a dummy variable with 1 if building is in that sector.

SEC2 - Office building sales in the Oak Lawn area. Coded as a dummy variable with 1 if building is in that sector.

CHAPTER BIBLIOGRAPHY

1. American Institute of Real Estate Appraisers, Ninth Edition.

2. Kang, Han-Bin and Alan K. Reichert "Statistical Models for Appraising Income Properties: The Case of Apartment Buildings." The Real Estate Appraiser and Analyst, Summer 1988 pp. 29-35.

3. Federal Home Loan Bank Board "Appraisal Policies and Practices of Insured Institutions and Service Corporations," Federal Home Loan Bank Board - DRAFT - November, 1987.

4. Meacham, Allen, "Applying Regression Analysis to Real Estate Appraisals," The Real Estate Appraisal and Analyst, Summer, 1988, pp. 23-27.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

A number of articles have been published describing the
applications and limitations of multiple regression analysis
techniques to real estate appraisal. Most researchers have
found that while multiple regression analysis provides good
estimation results, the presence of multi-collinearity make
it difficult to identify the unique value of individual
property characteristics. They have also indicated that the
forecasting ability of multiple regression techniques may be
compromised if the pattern of multi-collinearity among the
regression variables changes over time. As Moore, Reichert,
and Cho pointed out in a recent study, a truly effective
statistical appraisal model will allow the appraiser to make
accurate predictions over a reasonable period of time, and
to explain in a logical and consistent manner the individual
determinants of a property's value (2, pp. 50-56). Gau and
Kohlhepp emphasize the importance of stability in the
regression coefficients when developing an acceptable
prediction model (3, p. 28). Mark discusses two alternative
theoretical models that are useful in interpreting
regression appraisal results; a utility preference model
and a hedonic price model. Researchers interested in
monitoring buyer preferences over time would employ the

utility model which interprets the regression coefficients
as estimates of marginal utility. The hedonic model assigns
cardinal monetary value to the estimated coefficients which
can be interpreted as implicit equilibrium prices at a given
point in time. Regardless of which model is used, both the
researcher and the appraiser need statistically reliable
regression coefficients to reach a proper conclusion
(2, pp. 54-56). In an effort to correct form multi-
collinearity, Gau and Kohlhepp employ principal component
regression and contrast the results with ordinary least
squares regression. They conclude that while PCR does
generate more reliable factor coefficients, the technique
results in a loss of predictive power. The appraiser is
forced to select between estimating a predictive or a
structural model. The authors conclude that statistical
factoring approaches may be the only suitable method to
determine the market value of individual property
characteristics (3, p. 28). On the other hand, many
researchers suggest that other non-factor statistical
techniques may provide reliable results. Anderson finds
that ridge regression yields implicit prices that are more
properly signed and generates a more accurate picture of
which characteristics influence real estate values
(2, p. 40). Jansen and Talwar found that certain key
appraisal characteristics were statistically more
significant using ridge verses OLS and that the rank order

of significance among the regressor variables is more logical with ridge regression (4, p. 64). These studies do not, however, provide evidence regarding the ability of ridge regression to provide superior results over a substantial period of time. Kang and Reichert collected and analyzed data on apartment sales in Los Angeles to generate regression coefficients which were then used to forecast the selling price of apartments in a holdout sample (1, p. 31). The forecasted and actual selling prices were compared to determine the overall accuracy of the regression model. The results indicated that regression models with well defined physical/locational property characteristics alone are effective in forecasting apartment building prices. The study also indicated that including income variables such as gross income and net operating income provide useful information and increase the accuracy of the forecast (1, p. 32). To summarize, the researchers recognize the potential benefits associated with regression techniques and its significance to the appraisal field. The researchers agree further research is necessary into the factors that influence real estate value.

Conclusion and Summary

Numerous articles describe the possible applications of multiple regression analysis techniques to real estate appraisal. The use of multiple regression analysis has been

successfully applied to the mass appraisal of residential properties for several years. However, there are few examples of the successful application of multiple regression analysis to the mass appraisal of commercial properties. As Allen Meacham pointed out, this is due in part on, the numerous mathematical calculations which are time consuming and subject to error and real estate values are subject to many variables (5, p. 25).

However, researchers have concluded that effective multiple regression analysis models can be developed based primarily on physical and financial characteristics. It is agreed that additional research is necessary to identify the proper model specification.

CHAPTER BIBLIOGRAPHY

1. Kang, Han-Bin and Alan K. Reichert "Statistical Models for Appraising Income Properties: The Case of Apartment Buildings." The Real Estate Appraiser and Analyst, Summer 1988 pp. 29-35.

2. Moore, James S. and Alan K. Reichert and Chien-Ching Cho, "Analyzing the Temporal Stability of Appraisal Model Coefficients: An Application of Ridge Regression Techniques" AREUEA Journal Volume 12, No. 1, 1984.

3. Gau G. W. and D. B. Kohlhepp "Multi-Collinearity and Reduced-form Price Equations for Residential Markets: An Evaluation of Alternative Estimation Methods", AREUEA Journal Journal 6, 1978.

4. Jansen, C. T., and P. P. Talwar "Ridge Estimators in House Valuation Models", Interfaces, August 1982, pp. 120-127.

5. Meacham, Allen, "Applying Regression Analysis to Real Estate Appraisals", The Real Estate Appraisal and Analyst, Summer 1988, pp. 23-27.

CHAPTER III

METHODOLOGY

The sample in this analytical study consist of thirty office building sales in Dallas county from 1986 to 1988. The purpose of the study is to attempt to determine the impact of certain factors on real estate values. Information on sales prices of the office buildings is for illustration purposes only. The variables used in the research are basically divided into three categories and are identified in the following table.

TABLE 1

LIST OF VARIABLES

FINANCIAL CHARACTERISTICS

Variable	Label	Type
Sale Price	CEPSF	Dependent
Date of Sale	MTHSLE	Independent
Foreign Ownership	FOROWN	Independent
Overall Rate	RO	Independent
Occupancy	OCCUP	Independent

PHYSICAL CHARACTERISTICS

Variable	Label	Type
Building Height	STORIES	Independent
Effective Age	EFFAGE	Independent
Net Rentable Area	NRA	Independent
Parking Garage	PARK	Independent
Accessibility	ACCESS	Independent

LOCATION CHARACTERISTICS

Variable	Label	Type
LBJ/North Dallas Area	SEC1	Independent
Oak Lawn Area	SEC2	Independent

As can be seen in Table 1, the variables have been separated into three groups. Researchers agree that real estate values are effected by the variables outlined in the previous chart.

Design

Let Y = the dependent variable, the cash equivalent price per square foot, and X = the independent variables, months since sale, stories, effective age, occupancy, net rentable area, parking, foreign ownership, access, overall rate, LBJ/North Dallas area, and the Oak Lawn area.

Collection and Treatment of Data

The reseacher is interested in the impact of each of the independent variables on the dependent variable cash equivalent price per square foot. A multiple regression of the independent variables on one another was employed and standardized residual scores of the variables used in a multiple regression against the dependent variable. By regressing the independent variables against one another, the problems of multi-collinearity can be eliminated (1, p. 120). Employing standardized residuals scores is necessary to determine the importance of each variable free from its unit of measurement. The statistical design of the multiple linear regression is the formula:

$$Y = a + b_1X_1 + b_2X_2...=B_NX_N$$

The dependent variable Y is assumed to be linear in relationship to the independent variables X.

CHAPTER BIBLIOGRAPHY

1. Cohen, Jacob, and Patricia Cohen, <u>Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences</u>, New Jersey, Lawrence Erlbaum Associates, Publishers, 1983, pp. 120-146.

2. Leedy, Paul D., <u>Practical Research</u>: <u>Planning Design</u>; New York, MacMillan Publishing Company, 1980 pp. 173-210.

CHAPTER IV

ANALYSIS OF THE DATA

The following table presents the results of the direct estimation model where the cash equivalent sales price is a function of the physical, locational, and financial factors. The regression coefficients indicate the relationship with the dependent variable Y, the cash equivalent sales price. The regression coefficient for the variable STORIES is negative, indicating the taller a building, the less expensive the building is on a square foot basis. The regression coefficient for the variable EFFAGE is also negative, indicating that as the building increases in age, it decreases in value. The variable for the overall rate, RO, is also negative, indicating the higher the overall rate, the lower the prospective value. The model produced an $R2 = .7818$, which is an indication of the percentage of the variation in the sales price that is explained by the independent variables.

TABLE 2

REGRESSION ANALYSIS OF VARIABLES

FINANCIAL CHARACTERISTICS

Variable	Regression Coefficient	T Ratio	Significance of T Ratio
CEPSF	30.661	0.901	0.379
MTHSLE	2.223	3.807	0.001
FOROWN	16.155	1.724	0.325
RO	-71.586	-0.204	0.841
OCCUP	41.908	2.360	0.030

PHYSICAL CHARACTERISTICS

Variable	Regression Coefficient	T Ratio	Significance of T Ratio
STORIES	-3.380	-1.386	0.183
EFFAGE	-0.045	-0.174	0.864
NRA	0.000	1.229	0.235
PARK	21.710	1.640	0.118
ACCESS	32.345	1.724	0.102

LOCATION CHARACTERISTICS

Variable	Regression Coefficient	T Ratio	Significance of T Ratio
SEC1	5.366	0.492	0.628
SEC2	9.757	0.437	0.667

A look at Table 2 confirms the importance of the financial characteristics on the sale price of office buildings in Dallas County. According to Table 2, the months since the sale and the occupancy of the building at the time of this sale play an important part in the sale price of buildings. The remaining variables were not statistically significant at the .0001 level in this analysis.

Another application which could be very useful is the predicted/fitted value the dependent variable. As a supplement to the sales comparison approach, the predicted/fitted value option can increase the interpretation of market data. The example utilized in this study involve determining the value, the CEPSF, of a 12 story office building with an effective age of 40 months. The occupancy in the building is 85 percent, the net rentable area is 150,000 square feet, parking is good, no presence of foreign ownership, no access to public transportation, an overall rate of 9.5 percent and located in sector 2. With these characteristics, the model estimated a predicted/fitted value of $69.78 per square foot. The unusualness (leverage) value indicates how close the specified data point is to the rest of the data. If the data point is not close to the rest of the data, it means that you are extrapolating beyond the data, and the prediction values are limited. An unusualness value is basically the same as leverage, and a value much greater than 1 should be examined with caution. The model indicated a value of 1.5123, which is a good fit.

CHAPTER V

FINDINGS, IMPLICATIONS, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the impact that certain variables had on the cash equivalent sales price. The means to measure the variables and their impact was given careful consideration. The results of this study indicate that the variables can be effective in interpreting the impact the variables have on the sales price per square foot. With this knowledge, the appraiser can better justify the adjustments made in the sales comparison approach. As Meacham pointed out, regression analysis provides a defensible estimate of a range of values (1, p. 32).

CHAPTER BIBLIOGRAPHY

1. Meacham, Allen, "Applying Regression Analysis to Real Estate Appraisals," _The Real Estate Appraisal and Analyst_, Summer 1988, pp. 23-27.

BIBLIOGRAPHY

Books

Cohen, Jacob and Patricia Cohen, Applied Multiple
     Regression/Correlation Analysis For The Behavioral
     Sciences, New Jersey, Lawrence Erlbaum Associates,
     Publishers, 1983

Leedy, Paul D., Practical Research: Planning And Design, New
     York, MacMillan Publishing Company, 1980.

Articles

Kang, Han-Bin and Alan Reichert, "Statistical Models for
     Appraising Income Income Properties. The Case of
     Apartment Buildings," The Real Estate Appraiser
     and Analyst, Summer 1988, pp. 29-35.

Moore, James and Alan Reichert and Chein-Ching Cho,
     "Analyzing the Temporal Stability of Appraisal
     Model Coefficients: an Application of Ridge
     Regression Techniques," AREUEA Journal, Vol 12,
     No. 1, 1984

Meacham, Allen, "Applying Regression Analysis to Real Estate
     Appraisals," The Real Estate Appraiser and
     Analyst, Summer 1988, pp. 23-27.