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The Stability of Market Extracted Overall Capitalization Rates*

Willard McIntosh
University of Kentucky

William M. Whitaker III
Georgia Southern University

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Introduction

The traditional use of the income approach in the valuation of income producing property requires the determination of an appropriate overall capitalization (cap) rate. The rate is typically obtained from an examination of market transactions.

The use of the capitalization technique has historically required that properties used as comparables be as similar as possible in terms of location, size, time of sale, and other relevant characteristics. Very little research has been conducted to examine the sensitivity of this technique to those factors. The purpose of this paper is to develop a general value model and then to test the sensitivity of the model to different factors which would be expected to alter the basic relationship.

Review of the Literature

Sirmans, Sirmans, and Beasley (1984, 1986) studied the relationship between net operating income and sales price of 137 apartment communities in the Chicago area. The properties were drawn from three geographical locations and were also segmented into three, size categories. A model, which depicted sales price as a function of net operating income, two area dummy variables, and a variable for the time when the building was sold, was estimated using multiple regression techniques. The model was estimated in both a linear and a log-linear form.

In addition to estimating the model as specified over the total sample, the researchers also estimated a reduced version of the model (excluding area dummies) over each of the three geographical areas from which the sample observations had been drawn. The quite diverse values of the parameter estimates over the geographical subsamples lead the authors to conclude that the model parameters were not stable from residential neighborhood-to-neighborhood.[1]

Brennan, Cannady, and Colwell (1984) studied the nature of Chicago office rents. Their results demonstrated a significant effect of distance to the central business district (CBD) on rents realized. The closer an office building was to the corner of LaSalle and Madison Streets, the greater the observed

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rental price. Other factors which significantly influenced rent per square foot included lease features, property size, and proportion of space unusable.

Frew and Jud (1988) studied determinants of office rent prices in Greensboro, North Carolina. The rental price per square foot was tested against vacancy rate, distance from the CBD, building age, number of floors, common area space, and location near a major highway using both ordinary least squares and two-stage least squares. Vacancy rates, age, floors, and highway location are found to significantly influence rents. The functional form is investigated and a square root specification is suggested for use in calculating the rental demand elasticity.

Downing (1973) examined factors which affected the value of commercial sites in an urban area. He discovered that distance to CBD, along with factors such as traffic levels, median income of individuals, zoning, lot size, and time, influenced the price per square foot of commercial lots.

The Value Model

The general value model utilized in this study expresses sales price of the office building as a linear function of net operating income (NOI) and distance to CBD (DIST). The coefficient of NOI is therefore the estimate of the market multiplier and its inverse would estimate the market capitalization rate.

It has been extensively demonstrated that risk and return in investments are highly correlated. A variety of risks are associated with ownership of commercial office buildings. One major risk is that associated with vacancy. It has been hypothesized that the relationship between vacancy risk and structure size is inverse. To the extent that larger structural size is associated with risk reduction, then capitalization rates which are a direct function of perceived risk would be shifted. According to Plattner, "Risk is largely determined by the certainty of rental income and the control of operating expense. Large-scale professional buildings, for example, tend to have a diversified and, thus, a fairly certain source of income. They are therefore the least risky of the group. Small scale buildings, on the other hand, are the riskiest because they lack this quality."[2] Risk reduction, as described by Plattner, would be expected to produce downward shifts in capitalization rates and upward shifts in net income multipliers with increasing size of the office building.

The assertion of shifting multipliers associated with size of structure cannot be measured by the incorporation of dummy variables for size categories in the model. The typical 0 or 1 dummy variable measures a shift in the value of the constant. It does not measure the shift in the value of the multiplier for net operating income. Therefore, we will test the assertion by dividing our sample into subsamples based on different sizes of buildings (net rentable areas) and test the stability of the parameters over the various subsamples using the Chow test.

Another potential influence on office building value is in the possible influence on changing expectations of different phases of the business cycle. Fluctuations in economic activity have historically exhibited wave-like movement or behavior. This cycle behavior in the aggregate economy has been attributed to the combined interaction between the accelerator and the multiplier. Whatever the correct explanation for a cycle may be, business cycles still exist. They are part of the macro environment.

In this study, we are postulating that the Dallas market became significantly overbuilt after the trough of the business cycle recorded in late 1982. Thus, reduced values of the net income multiplier are expected with associated lack of stability in model parameters.

In order to test this perception, it is once again not appropriate to use dummy variables for different time periods. If there is an impact, it will occur as a shift in the multiplier, not as a shift in the constant. Therefore, we will have to investigate this issue by the same split sample technique used in the investigation of size.

The Dallas Office Sample

Data were collected on 89 office building transactions in the Dallas area from January 1979 through January 1985. The data consisted of information on (1) selling price (SP), (2) annual net operating income (NOI), (3) distance in miles to the CBD (DIST), (4) net rentable area (NRA), and (5) date of the transaction.

The net rentable area was used as the measure of size by which to partition the sample into subsamples. Four divisions were utilized with estimation of the model over each partition: (1) less than 50,000 square feet, (2) between 50,000 and 100,000 square feet, (3) between 100,000 and 150,000 square feet, and (4) over 150,000 square feet.

The date of the transaction was used to allow division of the sample into subgroups based on phases of the business cycle. The years 1979 to 1982 were basically years of contraction (two recessions, back-to-back). Sustained expansion finally began in November 1982 and continued through the balance of time under study (January 1985).[3]

Since the transactions were collected at different points in time, the model estimation is subject to spurious results caused by inflation in the data. To remove the effects of inflation, the U.S. Department of Commerce Construction Cost Index[4] was used to deflate sales price and operating income data prior to model estimation.

Results

Multiple regression analysis was used to estimate the relationship between net operating income, distance, and value.[5] The general value model which was estimated over the sample and subsamples is

$$SP = \beta_0 + \beta_1(NOI) + \beta_2(DIST) + \mu$$

where: SP   = sales price of the office building,
               NOI   = annual net operating income,
               DIST   = distance in miles from the central business
                                     district,
               μ = an error term,
               $\beta_0, \beta_1,$
               and β_2 = parameters.

Table I contains the results from estimation of the general value model over the entire sample in the market-wide column. The coefficient of the constant is not significantly different from zero, an expected result. The coefficient of NOI is highly significant with a value which implies that one dollar of current annual net operating income converted into $12.28 of value in Dallas during the early 1980's. The coefficient for the distance from the CBD variable is significant and negative. For each mile from the CBD, the typical office building lost $120,725 in value. Multicollinearity was not a problem in the model.[6] Although only a two independent variable model, over 95 percent of the variation in the dependent variable was explained. A highly significant F-value for the model fit was therefore logical and observed.

Size-Risk Relationship

If the inverse relationship of vacancy risk and size exists, then larger buildings will be disproportionately preferred to smaller buildings. This would be reflected through a higher estimated net income multiplier over a subsample of larger properties. The results of general value model estimation by building size are presented in Table I in the size of building columns. Consistent with prior results and expectations, the coefficient of the constant is not significant.

The estimated net income multiplier is significant over all four subsamples but appears to make a sizeable shift upwards for the over 150,000 square feet structures. This would be consistent with reduced risk through tenant diversification in larger structures. Another risk-related factor is the bias of institutional investors (both debt and equity oriented) against small deals. On larger properties, there is less risk of nonavailablity of funds.

The distance to the CBD coefficients is insignificant except for the largest structures. This result is consistent with a difference in the sensitivity of low-rise office parks and of high-rise office buildings to location near the downtown. Typically, the larger structures contain tenants with both input and output linkages to other downtown professional services. The office parks, by contrast, tend to link with major transportation arteries and airports.

In order to test whether the perceived differences in coefficients were significant, a Chow test was conducted. The null hypothesis of equal coefficients was rejected. The parameters of the general model were found to be

TABLE I

GENERAL VALUE MODEL
(Dependent Variable = Sales Price)

Independent Variable	Market-Wide	Net Rentable Area (sq. ft.)				Economic Conditions	
		<50,000	50,000-100,000	100,000-150,000	>150,000	Pre-Nov. 1982	Post-Nov. 1982
Constant (β_0)	428,869 (.709)	96,637 (.806)	756,142 (1.560)	982,474 (1.174)	3,135,716 (.880)	572,338 (.676)	-223,623 (-.314)
NOI	12.278 (41.670)⁻	9.786 (18.731)⁻	10.010 (12.561)⁻	9.961 (13.795)⁻	12.503 (11.163)⁻	12.566 (27.716)⁻	11.894 (48.460)⁻
DIST	-120,725 (-2.261)⁻	7,455 (.636)	-38,680 (-.985)	23,271 (.377)	-563,192 (-1.933)*	-166,122 (-1.707)*	-44,114 (-.903)
R^2	.953	.940	.900	.959	.893	.940	.988
Adjusted R^2	.952	.937	.890	.950	.880	.938	.987
F	880.443⁻	244.513⁻	94.102⁻	105.351⁻	66.804⁻	384.476⁻	1,371.381⁻
d.f.	2,86	2,31	2,21	2,9	2,16	2,49	2,34
n	89	34	24	12	19	52	37
F (Chow Test)	-	5.754⁻ with 3,77 d.f.				.877 with 3,83 d.f.	

t-ratios are given in parentheses.
* Indicates significance at the .10 level.
** Indicates significance at the .05 level.

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unstable over different building sizes. Therefore, adjustments to an overall market rate for size of the structure would be essential in value estimation.

Economic Conditions

To the extent that business cycles are related to construction cycles and in turn produce overbuilt and underbuilt market situations, they may in turn produce unstable capitalization rates and net income multipliers. The time interval of this study basically covers a sustained contraction followed by the early stage of recovery. The month of November 1982 is used to divide the sample into contraction and expansion time periods.[7]

The results of general value model estimation over the two time periods are presented in Table I in the economic conditions columns. Once again, the coefficient of the constant remains insignificant. The estimate of the net income multiplier is significant in both time periods and appears to fall about seventy cents during the early recovery period which would be consistent with lower multipliers as the overhang of excess building space becomes more acutely felt.

The coefficient for the distance to the CBD variable is only significant over the pre-November 1982 subsample. Based on the findings of the previous section, significance of distance is closely related to building size, not phase of the business cycle. In order to once again test whether perceived coefficient shifts are statistically significant, the Chow test was performed. The null hypothesis of equal coefficients was accepted in this analysis. We must therefore conclude that the multiplier movement was not statistically significant.[8]

Alternative Model Specification

In the valuation of office structures, appraisers sometimes utilize multipliers of net income per square foot rather than total net income for the property. While the normal approach to valuation uses aggregate data, the stability of multipliers obtained from per square foot data also warrants investigation. The parameters of the model were reestimated with sales price and NOI converted to per square foot data and the results are reported in Table II.

Using per square foot data, the strength of the fit deteriorates as evidenced by declining R^2s. The multipliers shift downward in value from those in Table I with the conversion to per square foot. The shifts in coefficient are of a similar pattern to those in Table I and the conclusion of unstable parameters as building size changes is again reached.

The findings of this investigation into the stability of cap rates are briefly summarized in Table III. Large observed F-values for the Chow test are associated with rejection of the null hypothesis of no change in parameters. Rejection of the null hypothesis is described as unstable. Small Chow F-values cause acceptance of the null hypothesis and are identified as situations where the model parameters are stable.

TABLE II

GIM VALUE MODEL
(Dependent Variable = Sales Price)

Independent Variable	Market-Wide	Net Rentable Area (sq. ft.)				Economic Conditions	
		<50,000	50,000-100,000	100,000-150,000	>150,000	Pre-Nov. 1982	Post-Nov. 1982
Constant (β_0)	-465,396 (-.804)	-38,622 (-.288)	-103,391 (-.176)	639,100 (.205)	14,393.166 (.004)	-306,208 (-.542)	-651,513 (-.684)
PGI	7.598 (36.904)~	7.226 (17.072)~	6.692 (11.371)~	6.319 (2.838)~	7.267 (7.774)~	6.811 (30.575)~	8.998 (36.957)~
DIST	37,481 (.716)	15,511 (1.190)	19,729 (.484)	188,380 (1.323)	158,210 (.516)	86,510 (1.303)	-52,772.529 (-.789)
R^2	.945	.931	.881	.734	.802	.955	.980
Adjusted R^2	.943	.926	.869	.646	.776	.953	.979
F	681.142~	196.229~	77.438~	8.295~	30.416~	481,337~	778.606~
d.f.	2,80	2,29	2,21	2,6	2,15	2,45	2,32
n	83	32	24	9	18	48	35
F (Chow Test)	-	1.779 with 3,71 d.f.				17.326~ with 3,77 d.f.	

t-ratios are given in parentheses.
* Indicates significance at the .10 level.
** Indicates significance at the .05 level.

TABLE III

GENERAL CONCLUSIONS OF COEFFICIENT STABILITY

Model Version	Nature of Stability by	
	Size of Building	Economic Condition
Price on NOI and DIST	Unstable	Stable
Price per Sq. Ft. on NOI per Sq. Ft. and DIST	Unstable	Stable

The size of building consistently causes capitalization rates and, in turn, income multipliers to change. As buildings get larger, the cap rate falls. Apparently, the risk of vacancy decreases with size and brings down cap rates. The basic conclusion is that cap rates are not stable when buliding size changes.

The portion of the business cycle investigated was that from a peak through a trough to a new peak, with most observations concentrated around the trough. The cap rates and multipliers were surprisingly stable during the period of the cycle investigated. More data and more detailed investigation are needed in this area.

Implications for the Use of Overall Cap Rates

The general conclusion reached here is consistent with that reached by Sirmans, Sirmans, and Beasley (1984, 1986) in their studies of apartments. The use of a single, market extracted overall capitalization rate in valuing office buildings is not appropriate. The net income multiplier and its associated inverse, the cap rate, do not remain stable over different sizes of office buildings. While they remain relatively stable over the business cycle, data limitations preclude a clear verdict. An alternative formulation of the model using per square foot data was also unstable over building size.

A heartening result for appraisers and analysts is that if you correctly adjust for a limited number of factors (size for example), the prediction of the value of office buildings based on income and distance is very good. As an intermediate checkpoint on the way to value, the model has continuing usefulness.

Conclusions

This study analyzed factors which influence the value of office buildings in a metropolitan area. Data were collected over 89 office property transactions in the Dallas area. The objective was to examine the validity of using market extracted overall capitalization rates as a method for estimating the value of office properties. The sales prices and annual net operating incomes of office properties sold in different locations, sizes, and economic conditions (recession and expansion) were analyzed.

A general value model was developed which related sales price to annual net operating income and distance to the CBD. The parameters of the model were estimated over the entire sample, the sample split by size categories, and the sample split by economic conditions. The statistical technique of ordinary least squares was utilized on the single equation model. The Chow test was used to determine parameter stability between or among sample subsets.

The results indicate that an extremely close positive relationship exists between the sales price of office buildings and the current annual net operating income. A statistically significant negative relationship exists between sales price and distance to the CBD primarily for larger structures. Smaller structures are not significantly tied to CBD activity.

In the analysis across different sizes of structures, statistically significant parameter shifts occur in the model. The multiplier is unstable and the preference is for higher multiples on larger structures. The analysis of different business conditions did not reveal significant parameter shifts. An alternative model formulation using per square foot data reinforced the conclusion that multipliers and cap rates are unstable over different building sizes.

The application of a single overall capitalization rate to an annual net operating income in order to obtain a value has been found to be insufficient, in some cases, as a valuation technique. Cap rates shift under different sets of circumstances and adjustments are therefore needed.

Endnotes

[1] The authors did not report any statistical tests, such as a Chow (1960) test, for structural stability over the subsamples. Given the obvious magnitude of the changes, this is not a major concern.

[2] See Plattner (1988), page 5.

[3] November 1982 is recognized by the National Bureau of Economic Research as the month the 1981-82 United States Recession ended.

[4] Construction Cost Index data is normally found in the **Survey of Current Business**. Since the U.S. Department of Commerce has recently revised values of the series, the authors obtained the index values directly from Business Statistics Branch Staff.

'The ordinary least squares (OLS) estimating technique was used for the model since the assumptions of the linear model appeared appropriate. Discussion of the technique can be found in Johnston (1984), pages 168-200, and other similar texts.

⁶The simple correlation coefficient between the variables NOI and DIST was $-.064$.

⁷The two subsamples created pre- and post-November 1982 were investigated for bias in size groupings. Each of the size categories was well represented in both subsamples.

⁸A longer period of observation covering several complete cycles might produce a more significant result.

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Willard McIntosh is an Assistant Professor of Finance and Real Estate and Director of the Center for Real Estate Studies, College of Business and Economics at the University of Kentucky and William M. Whitaker III is Professor of Finance and Head, Department of Finance and Economics at Georgia Southern University.