AREUEA Journal, Vol. 18, No. 4, 1990

A Different Look at Commercial Real Estate Returns

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Commercial real estate makes up a relatively small percentage of most institutional portfolios, even though the existing literature has consistently reported attractive risk-return characteristics that would suggest much larger allocations. This discrepancy has been explained by a perceived lack of comparability between return series calculated for real estate and those calculated for other asset classes. Just as investors actively involved in the futures markets do not consider individual common stocks to be traded continuously, those active in the stock market do not consider real estate to be traded continuously. In both cases, adjustments to reported returns are necessary to achieve a degree of comparability. This study makes such adjustments, using sales data from properties that help comprise the National Council of Real Estate Investment Fiduciaries/ Frank Russell Company (NCREIF/FRC) Index to generate a "transaction-driven" commercial real estate return series. Examination of the risk-return characteristics of this series shows that it is quite different from traditionally reported real estate return series and far more consistent with risk-return characteristics that have been reported for other asset classes.

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Date Received: January 31, 1989; Revised: July 19, 1990.

INTRODUCTION

The observed discrepancy in the reported evidence on real estate returns and the portfolio allocation decisions made by institutional investors has motivated considerable research and commentary. The existing real estate literature, using data from the last ten to thirty years, has fairly consistently reported three key results: real estate has provided higher risk-adjusted returns than stocks or bonds,[1] real estate has exhibited low or negative correlations with these more traditional institutional investments, and real estate has exhibited high correlations with inflation, both expected and unexpected. Given these results and the fact that commercial real estate wealth in the US is over 50% of the capitalization of the Wilshire 5000,[2] one would expect it to figure prominently in the institutional investor's portfolio. In practice, however, one observes that equity real estate investments account for less than 5% of large pension funds' portfolios[3] and an even smaller portion of smaller funds' portfolios. These seemingly contradictory observations may be explained by problems in the application of traditional performance evaluation techniques to real estate.

Traditional investment performance evaluation requires calculation of the mean and standard deviation of a return series as well as its correlation with other series. By its nature, real estate suffers from problems in the calculation of each of these statistics. Many such problems result from the unusual degree of control "enjoyed" by the real estate investment manager (relative to stock and bond managers) over the asset's reported returns. The most frequent charge made by critics is that the return streams reported in the literature have been smoothed, both by the nature of the appraisal process and possibly even by

[1] The New Equilibrium Theory of Ibbotson, Diermeir and Siegel [8] would maintain that "realized" real estate returns are lower and hence, risk-adjusted returns much more in line with those of other assets. Their theory models investors seeking to maximize returns "net" of all costs, including information and liquidity costs that are assumed away in traditional finance paradigms such as the CAPM and APT.

[2] See Ibbotson and Siegel [9], Goldman and Sachs [19], or Salomon Brothers [12] for real estate aggregates. For an estimate of the value of commercial real estate as distinguished from all real estate (i.e., including residential), see Miles [10].

[3] See *Pensions and Investment Age* [14]. Clearly, there is considerable indirect pension real estate ownership through their corporate equity holdings; but, such real estate holdings do not "perform" under the corporate umbrella as does direct "fee" ownership (see Miles *et al.* [12]).

active manipulation of the return calculations. This smoothing results in a reported variance that is biased downward from the true variance.

In addition, the coefficients of correlation with other assets also will be biased when a smoothed return stream is used in their calculation. Theoretically, the direction of the bias is unknown. However, if information, such as interest-rate changes, enters markets as random shocks, then these shocks would be expected to impact stock and bond prices immediately. Their effect upon real estate values would be spread over several periods due to the nature of the appraisal process (i.e., the use of "comparable" sales transacting at different points in time to estimate value). This would lead one to believe that the co-variance of real estate returns with the returns of assets such as stocks and bonds would be biased toward zero. (The effect on the correlation would depend on whether the reduction in variance in the denominator or the reduction in covariance in the numerator dominates.) As a result, critics heavily discount any evidence based upon traditional performance measures (using mean-variance criteria) that show investments in real estate dominating the mixed-asset efficient frontier.

In this study, the "smoothing" criticism levelled against appraisal-based returns is addressed by the development of transaction-driven real estate return series from data on two sets (one sold, one unsold) of four different types of commercial properties. The transaction-based returns are calculated using asset prices generated by a hedonically oriented multifactor asset pricing model for each property type. These pricing models are formulated as functions of observed variables with parameters estimated by regressing actual sales prices of the *sold* set of properties against a vector of observable indicator variables for those same properties. The transaction-driven return series are then generated by pricing each *unsold* property in each quarter, using the unsold properties' observed variables and the parameters estimated from the sold sample. Combining those prices with operating cash flows, total returns and return indices are calculated.

The resulting indices are tested to see whether the alternative transaction-driven return series are statistically different from the appraisal-based return series (again for the unsold or control sample), and their behaviors over time are compared. These comparisons allow some conclusions as to how much 'smoothing' of the real estate return series can be attributed to the use of traditional appraised values instead of values derived from a more market-driven model, with obvious implications for the calculation of efficient mixed-asset portfolios.

This paper is arranged as follows. In section two, the conceptual model to be used in the analysis is reviewed. In section three, hedonic price estimates are obtained as a basis for comparing the two types of returns. These alternative sets of real estate return series are analyzed in section four. The appraisal-based return series is examined and compared to results of previous appraisal-based real estate return studies. The transaction-driven return series is examined and compared to the corresponding appraisal-based return series for evidence of the appraisal "smoothing" phenomenon. The diversification potential for real estate as part of a larger mixed-asset portfolio based on the characteristics of each series is then explored, followed by conclusions in section five.

THE PRICING MODEL

Drawing upon a number of different theories taken from the urban economic and financial literature, this model uses the statistical work of Guilkey et al. [3] to posit that there are five essential determinants of real property value—national location, metropolitan location, lease structure, physical structure, and historical financial performance. The logic behind the pricing equations follows from basic valuation methodology. This methodology holds that the value of an income-producing property is a positive function of its stabilized net income and a negative function of a market capitalization rate, with adjustments for the variety of factors that make each property unique.

The pricing of real estate as a function of these essential determinants of value is analogous to the multifactor pricing of common stocks. In real estate markets characterized by indivisibilities, informational asymmetries, and a high degree of illiquidity, unsystematic risk associated with ownership of real property cannot be costlessly diversified away. Thus, in order to compensate investors who are assumed to be risk averse, such risk, which is hypothesized to arise from the five essential determinants of value, must be priced. Because these unsystematic factors are unobserved, they can only be measured to the extent that they are highly correlated with identifiable and observable proxies.

National Location

The health of the local market economy in which a particular property is located relative to that of other local markets across the nation is expected to impact heavily on the discount rate associated with property ownership. Most real estate researchers and practitioners assert that real estate trades in a set of local markets rather than in either a single national market or a set of regional markets, so that the health of a property's market relative to the health of other properties' markets should explain some part of both the expected cash flows and the appropriate discount rate.

In order to assess this element of value, county socioeconomic data were chosen to proxy as local-market economic health measures. First the county in which each property is located was identified. County variables selected for inclusion from other databases were: population, total employment, unemployment rate, total per capita personal income, and per capita personal income by employment sector (construction, finance insurance and real estate, manufacturing, retail, service, and wholesale).[4] Construction and finance insurance and real estate earnings were selected to proxy as the supply variable, while, depending upon the type of property in question, the other earnings figures were selected to proxy for demand variables.

These variables should be expected to pick up the effects of current local economic conditions. In order to assess expected future economic conditions, the four-quarter change in each variable was calculated and used as a proxy for expected future changes.

Metropolitan Location

The urban economic literature provides a number of theories explaining the impact of locational parameters on land use decisions. Many researchers have postulated that the location of a particular property, both with respect to the center of its metropolitan area and with respect to the major transportation arteries in its market area, is a fundamental determinant of value. Variables chosen to proxy for this element of value were: central business district, major suburban concentration, or free-standing location; and access distances to nearest limited access highway, rail line, and major airport (measured as

[4]Unfortunately, no universally available variables could be found to reflect the importance of differing tax treatments or regulatory attitudes across local markets. It is also important to remember that "market" boundaries usually do not coincide with county lines, so that county measures may be less than accurate for properties located within one county, but very close to another county.

adjacent, less than one mile, one to five miles, or greater than five miles).

This particular element of value is perhaps the most difficult to capture without a personal assessment of each property and its neighborhood. Ideally, one would like to have measures of locational quality by block in order to better capture the effects of a property's situs; i.e., its interactions with its surrounding physical and socioeconomic environment at the neighborhood level. The proxies chosen for this analysis are crude, at best, and miss a number of important time-varying attributes, such as neighborhood life cycle (growth, maturity, or decline) and, to a large extent, situs itself (surrounding land uses and characteristics and their interactions with the property in question).

Physical Structure

The built structure contributes significantly to how well a particular property is suited for its "highest and best use." First, remaining physical usefulness encompasses both the utility that a particular property can provide to users and physical depreciation that the property has suffered over time. Second, functional obsolescence captures the loss of value from changes both in building technology and in users' preferences. As the physical structure of a property deteriorates, vacancies rise and rents fall. Thus, the value of that property should fall and the variability of returns may rise. Once again, investors must be compensated for bearing such risk.

Variables chosen to proxy for remaining physical usefulness and functional obsolescence were: physical age, date of last major renovation, number of stories, number of buildings, extra land available that could be sold or developed, gross and net leasable square footage. (Square footage of finished office space was collected for industrial properties.) Each of these variables may proxy for one or both of the physical structure elements of value.[5]

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[5]The intertemporal and user dependent nature of functional obsolescence renders this element of value particularly hard to capture without much more detailed property and local market information than was available for this study. For example, number of stories helps capture the element of useful size for office buildings, but captures functional depreciation for industrial warehouses. (Only older, less economically useful warehouses are multistory. More modern warehouses are usually single story but with higher ceilings than their predecessors.)

Lease Structure

Any attempt to value an equity interest in a property encumbered by leasehold interests must integrate into its analysis the variability of returns and value attributable to differing lease structures. The lease structure of one property relative to another should be expected to impact upon value because the lease structure contractually determines a major portion of the cash flows. Quarterly cash flows reflect the contractual lease terms in effect for that quarter. (Unfortunately, lease payments that are above or below local market rates are not identified.)

Variables indicating the expected effect of lease terms on future cash flows are also needed in order to explain the differing effects of leasehold interests on property values. Four such variables chosen for inclusion in this study are weighted average remaining lease maturity, tenant credit quality, weighted average percentage of expense increases that may be passed through to tenants, and number of tenants. Weighted average lease maturity gives the remaining time that the property is contractually encumbered, weighted by the percentage of net rentable square feet subject to the maturity of each differing lease. (This lease measure is imperfect because many of the individual leases contain option(s) to renew under the same or modified terms and because the probability of default varies.)

Three binary and one continuous variable relating to tenants were tested: greater than 80% major credit tenants; 20-80% major credit tenants; less than 20% major credit tenants, and number of tenants. The binary variables would be expected to capture some of the variability in property value associated both with probability of default and with the greater bargaining power that major credit tenants hold relative to minor credit tenants. The number of tenants could capture some of the variability in value attributable to differing levels of diversification.

In order to capture the effect of varying inflation protection within the lease contracts, the weighted average percentage of expense increases that may be passed through to tenants was calculated. However, the effect of this variable interacts with lease maturity in that inflation protection for very short maturity contracts is of very small order of magnitude, while that for very long lease maturities is quite pronounced. Thus, a lease variable called "bond" was created from a combination of the maturity and expense pass-through variables. If a property had remaining maturity of greater than or equal to five years and had percentage of pass-throughs greater than 70%, then this binary variable was assigned a value of 1; else it was assigned a value of 0. This variable should pick up the effect on property value of leases that result in cash flows that essentially resemble a coupon bond. Such a lease would be missing both the upside "pop" in a market where rents were rising and some of the hedge potential against unexpected inflation.

Financial Structure

The financial operating performance of each property in each quarter is, of course, a fundamental determinant of value. Measurements of net income, capital improvements, partial sales, and appraised value were collected from the NCREIF/FRC database and later cross-referenced to fund managers' books to ensure their validity. From these data, three variables were derived. Stabilized income was defined as the highest to-date four quarter average net income. The trailing four-quarter coefficient of variation was calculated as a measure of risk. A low vacancy penalty function was defined as the stabilized quarterly income minus the actual average trailing four-quarter income. (All three financial measurers are of course theoretically incomplete because they are based upon historical rather than expectational data. From a pricing standpoint, this incompleteness suggests the importance of using the other four elements of value discussed above.)

HEDONIC ESTIMATES OF PROPERTY VALUES

Estimation Methodology

It is highly probable that a sample consisting only of sold properties is biased relative to the set of all properties from which it was drawn because the sold subset of properties is not chosen randomly by property managers. In order to estimate the value equation correctly, one needs to also understand the motivations behind managers' decisions to sell. Only then can one properly adjust for the sample bias present in a sample of sold properties.

In the estimation procedure, this bias is both tested and corrected for by combining the analysis of determinants of value with a probit analysis of whether or not a property was sold. The probit model may be written in the following general form:

$$Y_i = f(X_i, \beta, \varepsilon_i) \qquad i = 1, 2, \ldots, N \qquad (1)$$

where: Y_i is equal to 1 if the property belongs to the sold sample or equal to 0 if the property belongs to the control sample; X_i is a vector of independent variables representing property characteristics; β is a vector of parameters for the independent variables; ε_i is a normally distributed random disturbance term with mean zero and variance one; and N is sample size.

The estimation procedure is further complicated by the fact that, while all eligible sold properties have been included in the database, only a subset of the unsold properties have been chosen. Therefore, choice-based sampling methods are used to correct for the nonrandom nature of this sample. Essentially, the correction procedure involves the use of a weighted likelihood function where the weights for the sold and unsold properties are determined by the actual frequencies in the set of all properties (see Guilkey et al, [3]).

This study employs regression models of the general form:[6]

$$P_i = f(N_i, C_i, S_i, L_i, F_i, \theta, \mu_i) \quad i = 1, 2, \ldots, N^* \qquad (2)$$

where P_i is sales price for property i; N_i is location of the property's county; C_i is location of the property within the property's county; S_i is physical structure; L_i is lease structure; F_i is financial history; θ is a vector of parameters for the independent variables; μ_i is a normally distributed disturbance term with zero mean and unknown constant variance; and N^* is sample size. Because parameter estimates are believed to differ across property types, one model is estimated for each of four property types: office, retail, industrial warehouse, and industrial research and development (R&D). The actual proxies for each determinant vary by property type to reflect differences among property types. For example, distance to an interstate highway is a critical market location variable for industrial but not office properties. Similarly, change in per capita income is a better

[6]The multifactor asset-pricing approach was introduced into the real estate returns literature by Hoag [6] in a study of industrial properties. He apparently regressed sales price against five vectors of variables relating to national economic, regional economic, locational, temporal, and property-specific financial determinants of value. Unfortunately, Hoag provided little documentation on the make-ups of these five vectors or of his estimation procedure, so that his paper provided little guidance with regard to setting up such a model.

measure of expectations for the markets' quality (in-nation location) for retail properties, while change in wholesale earnings is a better measure for industrial properties.

Equations (1) and (2) represent the two equations to be estimated. The independent variables in equation (1) represent observed variables that determine whether or not a property is sold, while the ε includes all unobservable factors. Equation (2) is the value equation that is hypothesized for all properties. While one can only observe value for the subset of properties that were sold, this does not create a problem if the observable independent variables can completely account for the selective nature of the sold sample. If there are unobserved variables that affect whether or not a property is sold, and that also affect property value, then ε and μ will be correlated. Estimation procedures that ignore this correlation will produce biased parameter estimates for equation (2). The appropriate statistical procedure to account for this correlation involves the joint maximum likelihood estimation of (1) and (2).

The Estimates

For each type of property, relevant observed independent variables were selected from the database to represent each of the five essences of value. These variables were "priced" from the sold sample using the joint probit–regression methodology discussed above (variables with *t*-statistics less than unity were deleted). The resulting parameter estimates for retail properties are presented in Table 1. Because the absence of a block-by-block location quality measure is a major shortcoming of the database and because such location is most critical for retail properties, it is logical that the retail group should be most susceptible to omitted variable bias.

For the other three property types, results of the joint estimation procedure indicated no presence of sample selection bias (i.e., the estimated correlation in the error terms was not significantly different from zero). Consequently, OLS estimates were used for these three property types. (The estimates of the pricing equations for these three property types appear in Table 2.)

Overall, the results are quite strong with significant parameter estimates in expected directions. The probit results for the retail sales equation are not discussed in depth because this equation was estimated only as a control for the pricing equation. At the bottom of joint estimation results in Table 1 is *rho*, the

TABLE 1

Retail Properties

Joint Estimation Sampling Weights:
Sold: 0.471
Unsold: 2.095
Maximum Likelihood Estimates of Selection Model
Number of Observations: 87
Log-Likelihood: − 173.59
Probit Estimates

Variable	Coefficient	Std. Error	T-ratio
Intercept	− 1.81878	2.805	− 0.6484
Major Credit	2.93735	1.499	1.959
Construction Earnings	3.57456	1.779	2.009
Income Per Capita	− 0.563060	0.3055	− 1.843
Changes in Construction Earnings	− 26.2933	9.474	− 2.775
Change in Income Per Capita	196.848	68.88	2.858
Highway Access	0.924215	0.4512	2.048
Holding Period	− 0.0110155	0.01386	− 0.795

Pricing Estimates
Number of Observations: 58

Variable	Coefficient	Std. Error	T-ratio
Intercept	49.5697	17.18	2.885
Stabilized Income	39.2868	1.985	19.790
Low Income	− 16.0135	5.838	− 2.742
Caprate	− 26.2102	7.658	− 3.423
Capital Improvements	3.03674	1.034	2.937
Holding Period	− 0.0565530	0.03908	− 1.447
Expense Pass-through	− 0.0883716	0.04224	− 2.092
Income per Capita	0.61854	0.2494	2.466
Change in Population	209.140	42.46	4.926
SIGMA	3.74749	0.4764	7.866
RHO	− 0.870060	0.3629	− 2.398

correlation between the error terms in the probit and the price equation. As *rho* was significant only for the retail property sample, the right-hand-side variables for the other three property types represent fairly complete model specifications.

As examination of the office pricing equation in Table 2 illustrates this methodology. Price per square foot is expressed as a function of stabilized four-quarter-average net income per square foot and a capitalization rate proxy Caprate. (The

TABLE 2

OLS Pricing Estimate for Office, Industrial Warehouse, and Industrial R&D Property Types

Office

F-Value: 54.912 | Adjusted *R*-square: 0.9105 | *N* = 54

Variable	Coefficient	Std. Error	T value
Intercept	221.88	45.57	4.87
Stabilized Income	18.418	4.574	4.027
Caprate	10.407	2.428	−4.29
Low Income	−13.41	3.553	3.775
Stories	2.0715	0.4320	4.795
High Income	34.924	7.279	4.798
Capital Improvements	14.485	3.395	4.267
Major Credit	11.245	3.966	2.835
Bond	−13.86	4.347	3.19
Holding Period	−0.2868	0.0716	−4.00
Change in Population	693.9	132.7	5.228

Industrial Warehouse

F-Value: 19.559 | Adjusted *R*-square: 0.6859 | *N* = 102

Variable	Coefficient	Std. Error	T-value
Intercept	0.8401	4.635	0.181
Stabilized Income	17.18	3.18	5.403
Low Income	−5.596	2.489	2.249
High Income	5.463	3.111	1.756
Change in Population	117.22	39.411	2.974
Number of Buildings	2.019	0.4320	4.674
Age	0.3046	0.0975	−3.124
Percentage Office	14.628	7.626	1.918
Highway Access	−1.460	0.9482	−1.540
Free Standing	7.1041	2.612	2.720
Minor Credit	−1.326	1.209	−1.097
Income Per Capita	0.906	0.296	3.063
Changes in Wholesale Earnings	18.784	15.59	1.205

Industrial R&D

F-Value: 38.205 | Adjusted *R*-square: 0.6845 | *N* = 35

Variable	Coefficient	Std. Error	T-value
Intercept	−22.109	9.572	−2.310
Stabilized Income	31.501	3.629	8.680
Low Income	−23.960	5.336	4.490
Lease Maturity	1.005	0.2719	3.697
Percentage Office	13.232	4.875	2.714
Income Per Capita	1.976	0.587	3.368
Wholesale Earnings	−10.408	2.487	−4.185
Change in Service Earnings	202.25	46.534	4.346

NCREIF/FRC national composite quarterly income return for all property types is used as the capitalization rate proxy.) Both variables have the expected signs. Other variables in the pricing equations are included to control for property-specific variations in office price per square foot. The penalty function—Low Income—is included to pick up the effects of any current low occupancy. Its coefficient should be negative, as larger deviations below stabilized income (indicative of high vacancy for that quarter) should reduce value. Effects of central urban location and size are captured by the variables Stories (number of stories) and High Income.[7] Because both central urban location and size should increase value, the expected signs of both Stories and High Income are positive.

Capital Improvements (capital improvements per square foot in the last four quarters) picks up the effects of recent or ongoing renovations. Capital Improvements should increase value so the sign of Capital Improvements should be positive. Major Credit (greater than 80% major credit tenants) and Bond (greater than five years weighted average lease maturity remaining and greater than 70% of expense increases passed through to tenants) adjust for lease differences. Leases to major credit tenants reduce risk to the lessor, so that Major Credit should be positive. The interaction of long leases and high pass-throughs of expenses reduces risk, but also precludes rent increases in hot markets, so that the sign of Bond is ambiguous. Holding Period is the holding period in the investment manager's portfolio, with the negative sign indicating that more recent acquisitions are more valuable, i.e., that managers have learned from "sales experience". Finally, Change in Population (four quarter average change in population) adjusts for local market differences. Increasing population would, in general, suggest continued increases in the future which would be expected to lead to increases in property value, so that Change in Population should be positive. In all cases variables have the expected signs, and both the F-statistic and the adjusted coefficient of determination are high, indicative of strong estimated relationships.

[7] For office and industrial warehouse properties, the distribution of stabilized income was skewed to the right. Because the value of income properties is so highly dependent upon stabilized income, this skewness biases transaction price estimates upward. In an effort to capture the effects of this skewness, a dummy variable for unusually high stabilized income is defined for each property type. This variable takes on a value of one if stabilized income exceeds the mean plus one standard deviation and a value of zero otherwise.

The logic for the remaining three equations is similar, although different variables are significant for different types of properties. For retail properties (Table 1), sales price again is explained by Stabilized Income, Caprate, Low Income, Capital Improvements, Holding Period, and Change in Population. Value also is explained by the additional lease variable Expense Pass-through (percentage of expense increases that are passed through to tenants) and the additional county variable Income Per Capita (income per capita). Expense Pass-through, like the variable Lease Maturity, is indicative of lower risk, so that it would be expected to have a positive sign. Income Per Capita should be positive, as higher income per capita should lead to higher retail property sales that would, in turn, be capitalized in higher retail property sales prices. All variables except Expense Pass-through have the expected signs, and, as with the office equation, both the F-statistic and adjusted coefficient of determination are high.

For industrial warehouse properties, Stabilized Income, Low Income, High Income, and Change in Population again help explain sales price. Additional variables in the pricing model for this property type include the number of buildings on the property (Number of Buildings), the physical age of the buildings (Age), the percentage of finished office space in the buildings (Percentage Office), the distance to nearest limited access highway (Highway Access), a dummy locational variable for free-standing properties (Free Standing), a poor credit risk lease variable (Minor Credit), and two county variables, income per capita and change in per capita earnings in the wholesale sector.

In general, the number of buildings on the property helps proxy for the size of the overall development, so that Number of Buildings should be positive. Since physical deterioration increases with age, Age should be negative. The percentage of finished office space is an indicator of the quality and potential for upgrade to office R&D status, so that Percentage Office should be positive.{of access should increase the value of warehouse properties, so that Highway Access (distance) and Free Standing should be negative. Because low credit tenants are riskier, Minor Credit should be negative. The level of income per capita and the change in wholesale earnings are rough indicators of county demand for warehouse space so that Income Per Capita and Change in Wholesale Earnings should be positive. All variables except Free Standing have the expected signs. The F-statistic indicates a fairly strong relationship, but the adjusted coefficient of determination is low relative to that of the other property types. The unexpected positive significant coefficient of free standing may be attributable to the fact that many of the free-standing properties that were sold are special use buildings that were sold to tenants.

For industrial R&D properties, sales price again is explained by Stabilized Income, Low Income, Percentage Office, Income Per Capita, and, additionally, is explained by Lease Maturity (weighted average remaining lease maturity), earnings per capita in the wholesale sector and change in service sector earnings. The effect of Lease Maturity is ambiguous for the same reason as the Bond variable in the office equation. High wholesale earnings indicate a heavily industrial market and, thus, a less-than-ideal location for the upgrade R&D product. Rising service sector earnings indicate rising demand for industrial R&D space, so that Change in Service Earnings should be positive. Signs are in accordance with this scenario. Both the adjusted coefficient of determination and the F-statistic are high.

Evaluation of the Pricing Accuracy: Transaction versus Appraisal

One way to assess the relative accuracies of the transaction estimates versus the appraised values is to compare how each differs from actual sales price. For each property in the sold sample, the appropriate pricing equation was re-estimated without the observation corresponding to that property. The resulting parameter estimates were then used to price that property, producing "out-of-sample" price estimates. These estimates were then subtracted from the actual sales price. Similarly, the last appraised value reported in the quarter prior to sale was subtracted from the actual subsequent sales price. The means of these differences were then calculated on both a signed and absolute value basis in order to estimate both the "average" and "average absolute" error in each type of estimate. This methodology is biased in favor of appraised values, in that appraisals in the quarter prior to sale are often done when the appraiser is aware of a fully executed sales contract so that he will appraise the property at exactly the sale price.[8] For a discussion of appraisal "errors" out further than one quarter, see Cole, et al. [2].

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[8]In fact, four office, four retail, two warehouse and three R&D properties were appraised at gross sales.

TABLE 3

Actual Sales Price Less Estimated Price

Office Properties
(price per square foot)

	Mean	Standard Deviation
Actual Price —Last Appraised Value*	4.70	10.98
Absolute Value (Actual— Appraised)	6.95	9.69
Actual Price—Transaction Estimate	0.34	13.04
Absolute Value (Actual—Transaction)	9.57	8.78

Retail Properties
(price per square foot)

	Mean	Standard Deviation
Actual Price—Last Appraised Value	1.75	2.95
Absolute Value (Actual—Appraised)	2.42	2.43
Actual Price—Transaction Estimate	0.02	4.80
Absolute Value (Actual—Transaction)	3.75	2.95

Industrial Warehouse Properties
(price per square foot)

	Mean	Standard Deviation
Actual Price—Last Appraised Value	1.67	3.96
Absolute Value (Actual—Appraised)	2.80	3.25
Actual Price—Transaction Estimate	0.02	0.40
Absolute Value (Actual—Transaction)	5.10	3.92

Industrial R&D Properties
(price per square foot)

	Mean	Standard Deviation
Actual Price—Last Appraised Value	3.12	5.45
Absolute Value (Actual— Appraised)	3.58	5.15
Actual Price—Transaction Estimate	-0.27	9.28
Absolute Value (Actual—Transaction)	0.08	0.34

*The last appraised value was equal to gross sales price for four office, four retail, two warehouse, and three R&D properties indicating that the appraiser had adjusted his opinion of value to reflect knowledge of the impending sale.

The results in Table 3 show that the mean errors for the transaction series are, in every case, less than those of the appraisal series, but with greater dispersion, also in every case. The mean absolute errors of the transaction series are somewhat greater than those of the appraisal series, but are still small relative to the actual prices. Dispersions are roughly similar. These results suggest that the statistical model outperformed appraisals in a portfolio context, but that appraisals were superior in predicting individual prices.

PERFORMANCES OF THE APPRAISAL AND TRANSACTION RETURN SERIES

The coefficients from the four asset pricing models are applied by property type to the control sample in order to estimate a sale price for each of these properties for each quarter in which they appeared in the NCREIF/FRC Property Index from January 1982 through December 1986.[9] Estimated sales prices are used in place of appraised values in the construction of a transactions-based holding period return series for each property. Using each of these transaction-based return series, value-weighted return series are constructed for each property type. Finally, a composite real estate return series is constructed as the value-weighted average of all properties in the unsold control sample.

Table 4 presents univariate statistics for both appraisal-based and transaction-based quarterly value-weighted returns for each of the four property types, for the composite real estate return series, and for common stocks, corporate bonds and Treasury bills, respectively, over the same sample period. Stock, bond and bill returns are based on Ibbotson [7] data.

Appraisal Results

An examination of the appraisal-based returns reveals that, over the 1982–86 period, Industrial R&D properties provided the highest nominal quarterly returns (3.16%) while Office provided the lowest returns (2.57%). Retail and Industrial Warehouse returns were approximately the same at 2.78% and 2.74%,

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[9]While examination of annual returns would be interesting, the current database contains only five years of data (i.e., only five annual time-series datapoints), limiting the usefulness of such an exercise. As time passes and more datapoints become available, there is much to recommend such analysis.

TABLE 4

Univariate Statistics

(nominal quarterly returns)

	Office	
	Appraisal	Transaction
N	20	20
Mean	0.0257	0.0327
Std Dev	0.0149	0.0923
Skewness	0.6828	0.7606
C.V.	0.5823	2.822

	Retail	
	Appraisal	Transaction
N	20	20
Mean	0.0278	0.0301
Std Dev	0.0133	0.0443
Skewness	1.691	−0.609
C.V.	0.4768	1.4740

	Industrial Warehouse	
	Appraisal	Transaction
N	20	20
Mean	0.0274	0.0192
Std Dev	0.0088	0.0074
Skewness	0.6767	- 1.185
C.V.	0.3224	0.3880

	Industrial R&D	
	Appraisal	Transaction
N	20	20
Mean	0.0316	0.0132
Std Dev	0.0181	0.0179
Skewness	0.4142	−0.5921
C.V.	0.5711	1.3591

	All Real Estate	
	Appraisal	Transaction
N	20	20
Mean	0.0267	0.0274
Std Dev	0.0105	0.0508
Skewness	0.8269	−0.7873
C.V.	0.3919	1.8530

	Financial Assets		
	Common Stocks	Corporate Bonds	Treasury Bills
N	20	20	20
Mean	0.0490	0.0540	0.0209
Std Dev	0.0771	0.0648	0.0044
Skewness	0.0538	0.0807	0.5024
C.V.	1.5729	1.1996	0.2130

respectively. Composite appraisal-based real estate returns for 1982–86 were 2.67%. These returns are sharply lower than those reported by Hartzell et al. [4] for the period from 1978–1983, and somewhat lower than those reported by Miles and McCue [11] for the period from 1973–1981, when inflation rates were higher. (Researchers have consistently reported a high and positive correlation between real estate returns and inflation.)

The relative variabilities of returns on the four property types also differ considerably from those previously reported in the real estate literature. As measured by the coefficient of variation, the variability of returns on industrial warehouse properties is one third less than that on office or retail properties. While traditional wisdom has held that industrial properties occupy the low risk/low return end of the real estate investment spectrum, neither Hartzell et al. [4] or Miles and McCue [11] found evidence to support this notion.

These differing results may be attributable to the separation of industrial R&D properties from industrial warehouse properties in the current study. It can be seen that the industrial R&D returns ($CV=0.57$) are substantially more volatile than industrial warehouse returns ($CV=0.32$), indicating that industrial R&D returns are more comparable to office returns ($CV=0.58$) than to warehouse returns.[10]

Office returns show the highest level of volatility, a reflection of the turmoil in the office markets during this period when office vacancies increased dramatically from historic levels. Variability of retail returns ($CV=0.48$) during this period fell between that of office and industrial warehouse, in keeping with conventional wisdom.

Returns on common stocks (4.90%) were considerably higher over the sample period than any of the appraisal-based real estate returns (as expected with the bull market starting in August 1982), but volatility was also much higher ($CV=1.57$). Corporate bond returns also were higher (5.40%) and more variable ($CV=1.20$), while Treasury bill returns were lower (2.09%) and less variable ($CV=0.21$). Thus, the appraisal-based real estate returns for each property type were bounded in terms

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[10]The lower variability of industrial warehouses and higher variability of industrial R&Ds must be partly attributable to the relative sample sizes from which these results were calculated (see Tables 2(B)–(C)). Even so, an examination of the individual extreme values in each return series reveals that the range of values is greater for the R&D (and office) properties than for the warehouses, so that the basic result holds.

of both risk and return by stocks and corporate bonds above, and by Treasury bills below.

Contrary to conventional wisdom, all four property types have very similar mean returns and have standard deviations similar in magnitude to that of T-bills. If the appraisal-based returns are accurate measures of investment performance, then there is very low risk in any property type, and property type distinctions do not seem terribly important.

Transaction-Based Results

Transaction-based composite real estate returns were very close to the appraisal-based composite returns (2.74% vs 2.67). However, industrial R&D returns fell from highest to lowest (3.16% to 1.32%), while office properties rose from lowest to highest (2.50% to 3.27%). The moves by office and industrial R&D may be attributable to the use of a single capitalization rate proxy instead of property-type-specific proxies. Appraisers increased capitalization rates for office properties relative to industrial properties during the later part of the sample period to reflect the perceived risks attributable to overbuilding in most office markets. The result is lower appraisal values for office buildings and higher appraised values for industrial properties. The fundamental determinants of value used in this study suggest that the values of office properties should have fallen prior to 1982 and that, starting from a lower base, office performance during the 1982–86 period would be much improved.

Interestingly, the skewness in all the transaction-based series except office were negative where they had been positive in the appraisal series. While the sample period is far too short to suggest that real estate return distributions are characterized by a negative third moment, this downside exposure is certainly consistent with press accounts of real estate-related problems over the sample period.

The volatilities of the transaction-based returns relative to those of the corresponding appraisal series also are of interest. When volatility is measured by the coefficient of variation, the transaction-based return series, overall and for every property type, exhibit greater volatility than do the corresponding appraisal return series. This finding bolsters the "smoothing" criticism that so often has been aimed at appraisal-based real estate research.

Also of interest are comparisons of the volatilities of transaction-based returns across property types, which show office ($CV=2.82$), retail ($CV=1.47$), and industrial R&D ($CV=1.36$)

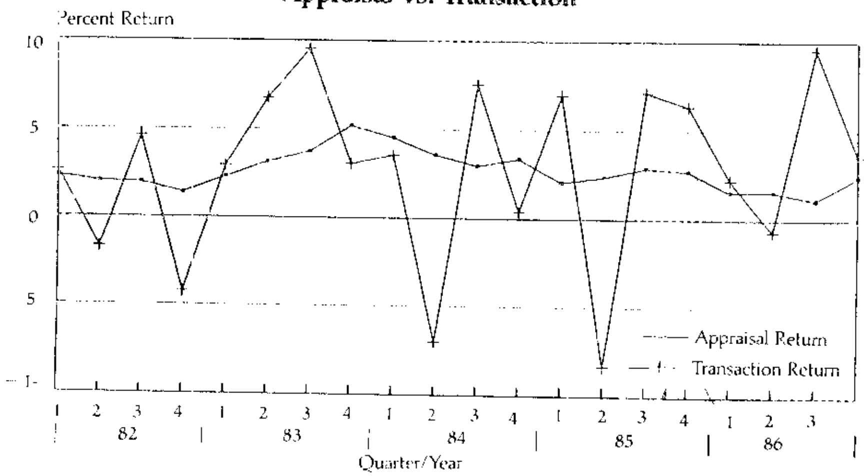
returns to be seven, four and three times more variable than industrial warehouse ($CV=0.39$) returns. Given the fact that the industrial warehouse properties were more likely to be long-term *net* leased and less subject to long vacancies, their returns would be expected to be more stable than those of other property types.

While industrial warehouse properties once again show up at the low risk/low return end of the spectrum, at the opposite end of the spectrum office properties exhibit unusually low risk-adjusted returns as a consequence of their standard deviation being more than double that of retail, the next most volatile property type. To a considerable extent this result is probably period-specific, with wide swings in stabilized income and vacancy rates attributable to the well-documented overbuilding and subsequent glut of office space in major metropolitan markets during the early and mid-1980s.

Transaction-based returns exhibit behavior that is more representative of common beliefs, relative to stock, bond, and bill returns, than do appraisal-based returns. No longer do all real estate returns dominate stocks and bonds on a risk-adjusted basis. Office returns are the most volatile and actually show a much higher coefficient of variation than do stocks. This is an intuitively pleasing period-specific result, given the comparison of a relatively poor real estate market and a booming stock market over the sample period.

Figure 1

Composite Property Returns Appraisal vs. Transaction



In Figure 1, both the composite real estate transaction-based and appraisal-based sets of quarterly value-weighted return series are plotted over time. This plot of the appraisal-based versus the transaction-based return series reveals little comovement, with the transaction-based series exhibiting much greater swings from quarter to quarter. It graphically demonstrates what was evidenced by the coefficients of variation discussed above, i.e., that the transaction-based returns are much more volatile than the appraisal returns.

Table 5 presents Pearson product-moment correlations for the appraisal-based and transaction-based total returns series for office buildings and for the composite real estate series with stocks (total return on the *Standard and Poor's 500 Index*), bonds (total returns on Ibbotson's Investment Grade Bond Index), and Treasury bills (three-month Treasury bill auction average). Office property *appraisal* returns are shown to be negatively correlated with both common stock (*rho* = − 0.29) and corporate bond (*rho* = −0.45, significant at 0.05) returns, indicative of significant benefits from diversifying a stock and bond portfolio into office properties. Office *transaction-based* returns present a somewhat different picture. This return series is essentially uncorrelated with both stocks (*rho* = −0.076) and bonds (*rho* = −0.038); still suggestive of diversification benefits, but of lesser magnitude. Similar results hold for the composite real estate series.

TABLE 5

Asset Return Correlations

	Office		Composite Real Estate	
	Appraisal	Transaction	Appraisal	Transaction
Appraisal	1.000	· 0.0789	1.000	0.084
	(0.000)	(0.742)	(0.000)	(0.724)
Transaction	−0.0789	1.000	0.084	1.000
	(0.0742)	(0.000)	(0.724)	(0.000)
SP500	− 0.292	0.076	−0.311	0.080
	(0.212)	(0.750)	(0.183)	)0.736)
Corp. Bond	−0.451	−0.038	0.393	−0.048
	(0.046)	(0.873)	(0.087)	(0.840)
T-Bill	0.338	· 0.211	0.313	−0.170
	(0.145)	(0.373)	(0.180)	(0.473)

The numbers in the parentheses are significance levels.

CONCLUSIONS

This study has dealt with problems inherent in the use of real estate return series as inputs for mixed-asset portfolio allocation models. These issues are of great practical importance because institutional investors move billions of dollars in and out of real estate investments based, in part, on reported appraisal-based returns. Whether investors' decisions are based on a straightforward Sharpe allocation model or on more complex consumption-based dynamic models such as that of Breeden [1], accurate covariance measures are critical for successful implementation. Using sales from the NCREIF/FRC Property Index, a multifactor asset pricing model was developed which, when applied to a control sample of investment properties, produced results that offer insights into the covariance of real estate with stocks and bonds, and, hence, insights into asset allocation decisions.

For four types of commercial real property and for commercial real estate as a general asset class, transaction-based returns were found to be considerably more variable than corresponding appraisal returns, lending support to the widespread criticism that the appraisal process smooths real estate returns so as to understate the true underlying variability and bias measures of correlation with other asset returns.

Overall, the results from analyzing the transaction-based return series suggest that (1) risk-adjusted real estate returns of the transaction-based series are more consistent with other asset classes than are previously reported appraisal-based returns, (2) real estate investment presents an attractive diversification opportunity for stock, bond and bill portfolios, and (3) real estate is not a particularly homogeneous asset class, suggesting the need for further research on the performance of subcategories within this broad asset class.

The period of study used in this research (twenty quarters) does not permit sweeping generalizations. However, the combination of these data sources and methodologies offers considerable potential for dealing with questions relating to the role of real estate in the mixed-asset portfolio. Real estate competes with stocks and bonds for investment dollars yet trades so infrequently that comparisons using standard performance evaluation techniques may be unreliable. The authors do not claim that the reported covariances are perfectly analogous to their stock and bond counterparts; yet, they are surely more useful in a mixed-asset context than those previously reported in the literature.

APPENDIX

Data

Data included in this study relate to each property sold from the NCREIF/FRC Index between 1982 and 1986 plus a control sample of unsold properties for a total of 573 income-producing properties.[11] The NCREIF/FRC Index has become the standard for evaluation of institutionally owned real estate and is widely quoted in the *Wall Street Journal* and various investment banking publications. To qualify for inclusion, a property must be held in a tax-exempt portfolio and must not be levered.

The sold property sample consists of the 347 NCREIF/FRC properties sold from the inception of the index in January 1978 through December 1986. The control sample consists of 226 NCREIF/FRC properties contained in the NCREIF/FRC Property Index in December 1985.

In the course of the data collection process, it was determined that 70 properties from the sold sample and 34 properties from the unsold sample were unsuitable for use in this study. These 104 properties were deleted from the database, leaving 277 and 192 properties in the sold and control samples, respectively. (See Guilkey et al. [3], for more detail on these deletions.) Both of these samples and the NCREIF/FRC Property Index in total are well diversified across a number of dimensions, such as property type, location, investment manager, and size.

For each sample property, data on observable indicators of the five essences of value were collected. The urban (county) variables came from the Bureau of Labor Statistics and the Bureau of Economic Analysis. Quarterly performance data were collected from NCREIF/FRC Property Index records on each property for the variables: net income, capital improvements, partial sales, and appraised value. Property-specific "fixed" data such as number of stories, distance to major transportation arteries and physical age were collected from the detailed internal records of the individual investment managers.

For each property, the data span the entire period for which the property entered into NCREIF/FRC Property Index calculations. Each of these observations were confirmed both by the investment manager and by the researchers during personal

[11]The final database consists of over 300,000 unique pieces of information making it easily the largest "no missing cells," property-specific, commercial real estate database in existence.

visits to each fund manager. As a last precaution, printouts of these data were sent back to fund managers for final confirmation.

The appraisal-based return series were constructed from the data reported by individual fund managers (members of the National Council of Real Estate Investment Fiduciaries) to the Frank Russell Company for construction of the NCREIF/FRC Property Index. The Index is a value-weighted index where each property's weight in each quarter is determined by the proportion of total portfolio value for which it accounts. The NCREIF/FRC Property Index return formula is:

$$[(EMV - BMV + PS - CI) + NI] \;/\; [BMV - 0.5PS + 0.5CI - 0.33NI]$$

where: EMV = *Ending Market Value*
BMV = Beginning Market Value
NI = Net Income
PS = Partial Sales
CI = Capital Improvements

This formulation assumes that capital improvements and partial sales occur at the midpoint of each quarter, while net income is received monthly (as is the case for most index properties). Returns were calculated according to this formula for each property in each quarter. These individual property returns were then weighted according to their market value to produce a value-weighted return index.

For each property type, total-, income-, and appreciation-return series were compared with their NCREIF/FRC Property Index counterparts. This comparison of the value-weighted appraisal returns from the unsold sample to the NCREIF/FRC overall returns showed that the value-weighted returns for all four property types closely followed the corresponding NCREIF/FRC returns. Thus, one can conclude that the control sample used in this study is broadly representative of the NCREIF/FRC property database in general.

Problems encountered at the complex accounting, financial, and real estate valuation interface, and the related corrections made in this research, are listed below. In 1987, the NCREIF/FRC Property Index was restated with the new formula used here and adjusted for many of the items shown below.

Issue	Resulting Biases Return	Risk	Correction
A. Property included in index before lease-up resulting in a major capital improvement caused by earn-out payment	DOWN	UP	Remove property from index until quarter after last earn-out and do not accrue earn-outs. This is consistent with the Index's stated inclusion policy
B. Partial quarter for income	DOWN	UP	Include with first full quarter of income and, upon sales, treat sales price as market value at end of the last full quarter of income. Disregard income from partial quarter.
C. Subsequent adjustments for over- and under-accruals	NONE	UP	Ongoing corrections to previous quarters only when managers' books are restated in previous quarters. This is consistent with the actual investor realized returns. Historically, correct only major items on the same basis.
D. Negative capital improvements	DOWN	UP	Same as above
E. Major capital improvements for acquisition of surrounding property or construction of new property	DOWN	UP	Remove property from Index prior to acquisition or construction. Return property to Index after first appraisal subsequent to acquisition or construction.

F.	Tenant improvements and leasing commissions sometimes in lump sums and sometimes on an accrual basis.	DOWN	UP	Leave them. Corrections cause more problems than they solve.
G.	Free rent problem similar to F above	DOWN	UP	No change in numbers. Acknowledge in publication footnote the differences among investment managers in accrual policies.

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