The Role of Systematic Covariance and Coskewness in the Pricing of Real Estate: Evidence from Equity REITs

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Abstract. **This study explores the impact of systematic risk (*beta*) and systematic coskewness on EREIT returns. The test uses the Skewness Preference CAPM, which includes the impact of the third moment on returns. The findings are that systematic risk impacts return in the predicted manner. However, there is no evidence that systematic coskewness is a determinant of EREIT return, which is contrary to prior findings using other financial instruments. Also, the problem of multicollinearity noted in earlier tests of the model does not occur herein.**

Introduction

Much of the evidence financial economists have gathered regarding risk premia depends on a single-factor return-generating process, such as the Capital Asset Pricing Model (CAPM). Despite the popularity of this approach, several empirical and theoretical flaws have been noted. Difficulties with the slope and intercept of the Security Market Line are well established.[1] An alternative to the traditional theory is to use multifactor pricing models, such as the Skewness Preference CAPM (SPCAPM). Although the single-factor models should be sufficient if the distribution of security returns is completely described by the first two moments, many assets do not meet this qualification. One asset that seems to violate the two-moment assumption is real estate.[2]

The development of SPCAPM can be traced to Arditti (1967), who expands the traditional portfolio selection model to include the third moment, or skewness. Three-moment theory shows that right skewness, the greater likelihood of obtaining a return above the mean than below the mean, is preferred by investors. This preference must then be paid for by the investor, typically in the form of lower returns. Kraus and Litzenberger (1976) extend the CAPM to include the potential impact of systematic coskewness on valuation. The Kraus and Litzenberger (K-L) model is supported by several empirical results although a multicollinearity problem exists in the regression analyses. Liu, Hartzell and Grissom (1992) present evidence that may support the conclusion that coskewness aids in the explanation of real estate returns.

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The present study examines the explanatory power of systematic coskewness on equity real estate invest trust (EREIT) returns. The original version of the K-L model is employed. Two important findings are obtained. First, there is no evidence that suggests systematic coskewness affects EREIT returns. Second, the econometric difficulties noted in earlier tests of the Kraus-Litzenberger model do not occur using the current data set. This decreases the possibility that these results are contaminated by methodological difficulties found in other SPCAPM tests. The following section of this paper presents and discusses the K-L model used in the tests. Alternatives to K-L are also described. The data and the empirical methods are described in section three. Sections four and five detail the results and conclusions of the tests.

The SPCAPM and Real Estate Returns

Arditti (1967) attempts to explain equity returns by using variance, skewness and covariance with the market and industry indices. Although he finds some support for the use of the third moment, the development and acceptance of equilibrium pricing models (for example, CAPM) that account for the effects of systematic factors on security returns changed the empirical approach to investigating return-generating functions. As noted earlier, to avoid the empirical difficulties with the CAPM, several alternatives are commonly used in the literature. Kraus and Litzenberger (1976) include the coskewness variable in their pricing model as specified in the following:

$$\bar{R}_i - R_f = b_1 \beta_i + b_2 \gamma_i \,. \tag{1}$$

The dependent variable is the expected excess return from the ith asset, β_i is the *beta* of the ith asset with the market, γ_i is the systematic coskewness of the ith asset with the market, and the b's represent the impact of each independent variable on return. The addition of the systematic coskewness term,

$$\gamma_i = \frac{m_{iMM}}{m_M{}^3} \,, \tag{2}$$

provides the difference between the Kraus-Litzenberger model and CAPM. This variable is interpreted as a measure of the tendency for an asset to follow the asymmetry of the market. The numerator is the coskewness of the asset with the market. The denominator is the third moment of the market. In periods when the market is skewed to the right, a positive coskewness asset would also likely display right skewness, which should lower the desired return. On the other hand, a negative coskewness asset would likely be skewed to the left, which increases required return. Therefore, the K-L model predicts that in periods of right market skewness, the sign of b_2 should be negative.

When the market is skewed to the left, investors with positive coskewness assets must be compensated with a higher return, while investors with negative coskewness assets would be willing to accept a lower return. Therefore the K-L model predicts that in periods of left market skewness, the sign of b_2 should be positive.[3] The *beta* coefficient, b_1, should be consistently positive.

These hypotheses are supported by the tests of Kraus and Litzenberger (1976) using stock portfolios and, to a lesser extent, by Friend and Westerfield (1980), who include bonds as well as equity securities. However, each of these works indicates a high degree of collinearity between the systematic covariance and systematic coskewness that calls the results into question. At least in part, this uncertainty has led to the development of alternative methodologies designed to investigate the possible impact of the third moment on asset returns.

Barone-Adesi (1985) relates the K-L model to an arbitrage equilibrium model based on Ross (1976). Errors-in-variables caused by the use of estimators in the multivariate regression, in addition to collinearity, can perhaps be avoided in this fashion. However, Barone-Adesi does not find strong support for the impact of higher moments on stock returns. Lim (1989) tests the K-L using the generalized method-of-moments technique and finds some evidence that coskewness is priced over various time periods.

The K-L model has been used in attempts to explain the returns of several other types of assets. Cotner (1991) finds evidence to support the hypothesis that both systematic covariance and systematic coskewness affect returns for equity index call options. Junkus (1991) is unable to find support for either measure as explanatory variables for commodity and financial futures returns.

Only one test of the skewness preference pricing model on real estate assets exists. Using samples of commingled real estate funds (CREFs), Liu et al. (1992) examine the impact of the third moment on real estate returns. Their results suggest that systematic coskewness may play a role in the pricing of real estate, although they do not completely reject various forms of the traditional CAPM. One important aspect of these results that must be considered is the use of appraisal-based CREFs as a proxy for real estate returns. In addition, their test uses only ten years of quarterly returns on only five CREFs. An alternative to the use of appraisal-based returns is to use transactions-based EREIT returns.

Gyourko and Keim (1992) and Myer and Webb (1993) discuss the relationships between appraisal-based and EREIT returns. Both papers find evidence that REIT returns provide information that is later reflected in unsecuritized real estate returns as exemplified by appraisal-based data. In particular, Myer and Webb find that REIT returns are closely related to common stock returns from a time series perspective, but are more closely associated with unsecuritized real estate on a cross-sectional basis. The data and the methodology for the current study are described below.

Data and Methodology

To expand the evidence provided in the prior test of SPCAPM, this study uses EREIT returns[4] as an alternative to CREFs. According to National Association of Real Estate Investment Trusts (NAREIT), equity REITs are those with at least 75% of their assets in estate equity; mortgage REITs hold at least 75% of their assets in mortgages, and hybrid REITs hold both equities and mortgages. The sources of REITs are NAREIT and *Moody's Banking and Financial Intermediaries*. The REIT type for each REIT in the sample is identified by either NAREIT or the authors by following the same rule. Data from EREITs was chosen for the current study because of ready availability, the desire to contrast results with previous studies, and the statistical benefits of a relatively large sample for the real estate industry.

Monthly returns for the EREITs are obtained for the period 1971–1991 from the Center for Research in Security Prices (CRSP). Due to the estimation process chosen for this study, only those securities with at least twenty-five consecutive observations are utilized. The sample of EREITs contains a total of 8,277 monthly returns (an average of about thirty-three per month). These returns are converted to deflated excess returns:

$$r_{it}=\frac{(1+R_{it})-(1+f_t)}{(1+f_t)}, \tag{3}$$

where the i subscript represents the individual asset and the t subscript the observation month. The R_{it} indicates the raw asset return directly from the data source, and the f_t is the bond equivalent yield on the Treasury bill closest to one-month maturity. The use of deflated excess returns follows convention[5] and serves to provide a serially independent, identically distributed database.

The previous twenty-four months are used to estimate the *beta* and systematic coskewness of each EREIT for a given observation month. Because a large number of EREITs are short-lived, an estimation period longer than twenty-four months would substantially reduce the sample size. The average excess returns over this twenty-four-month estimation period are taken as the expected excess returns for each EREIT, i, and the market, M, respectively.[6] These expected excess returns are used to calculate the deviations needed for *beta*,

$$\frac{\sum (r_{it}-Er_i)(r_{Mt}-Er_M)}{\sum (r_{Mt}-Er_M)^2} \tag{4}$$

and the systematic coskewness, γ,

$$\frac{\sum (r_{it}-Er_i)(r_{Mt}-Er_M)^2}{\sum (r_{Mt}-Er_M)^3}. \tag{5}$$

Thus, in each case, t ranges from month -24 to month -1. These estimates are then used to segment the securities into one of nine portfolios of EREITs with as wide a range of systematic covariance and systematic coskewness as possible. These nine portfolios are formed based on a two-stage screening process. Initially, the *beta* is used to segment the securities available for each month into three groups; either high, medium, or low *beta*. Within each of these three classifications, the securities are again sorted by systematic coskewness into three groups; high, medium and low. The use of an independent estimation period (twenty-four months) for *beta* and systematic coskewness follows the two-stage practice initiated by Black, Jensen and Scholes (1972), as well as Miller and Scholes (1972). The sequential segmentation into portfolios by *beta*, then systematic coskewness, follows Friend and Westerfield (1980). After the portfolios are formed, their excess returns for month 25 are calculated. The portfolio excess return is the average of excess returns of the EREITs in the portfolio.[7]

For each successive month the entire procedure is repeated and the assets are regrouped based on their relative *beta*s and systematic coskewness parameters.

Because the first portfolio *beta* and *gamma* are found using portfolio excess returns from month 25 through month 48, the first usable portfolio excess returns are from month 49 (January 1975). The excess returns, *beta*s, and systematic coskewness for the nine portfolios are used in the regression model,

$$r_{pt} = b_0 + b_1(\beta_{pt}) + b_2(\gamma_{pt}) + u_{pt}, \tag{6}$$

where β_{pt} is the portfolio *beta* in month t, γ_{pt} is the systematic coskewness in month t, and r_{pt} is the portfolio excess return in month t. This regression covers nine portfolios for 204 months from January 1975 to December 1991. Exhibit 1 presents the summary statistics for the nine groupings of portfolios. Since tests are later repeated on only four portfolios, these are presented in Exhibit 2. The market index displays positive raw skewness (.1345). An equal-weighted EREIT index is constructed using all EREITs in the sample in order to calculate the raw skewness of EREIT returns. The raw skewness is 1.01. The positive raw skewness of both the market index and the EREIT index leads to predominantly positive average systematic coskewnesses for both the set of nine and four portfolios (see Exhibits 1 and 2).

Exhibit 1
Summary Statistics of Nine Portfolios

Portfolio	Average Return	Standard Deviation	*Beta*	Systematic Coskewness
One	.0074	.0662	.4459	.2793
Two	.0058	.0732	.6135	.5226
Three	.0053	.0914	.8548	1.0224
Four	.0119	.0632	.6710	1.4630
Five	.0101	.0598	.6967	1.1938
Six	.0083	.0647	.6760	1.0333
Seven	.0102	.0615	.7001	.5271
Eight	.0124	.0799	.7775	.8779
Nine	.0078	.0878	.9598	1.0445

Exhibit 2
Summary Statistics of Four Portfolios

Portfolio	Average Return	Standard Deviation	*Beta*	Systematic Coskewness
One	.0077	.0548	.5715	.7365
Two	.0091	.0709	.8164	1.2647
Three	.0115	.0550	.6813	.8019
Four	.0075	.0673	.7937	.8725

Exhibit 3
Ordinary Least Squares Regression Results for the Nine Portfolios

$$r_{pt} = b_0 + b_1(\beta_{pt}) + b_2(\gamma_{pt}) + u_{pt}$$

Model	b_0	b_1	b_2	F-value
6.1	.000562 (.162)	.011002[a] (2.517)	.000490 (.825)	4.298[a]
6.2	.000354 (.103)	.011904[b] (2.814)	—	7.917[b]
6.3	—	.011611[b] (5.200)	.000483 (.816)	17.836[b]

[a]significant at 95% level
[b]significant at 99% level

Results

The results of the regression in equation (6) are shown in Exhibit 3. There are three models in Exhibit 3. Model 6.1 is identical to equation (6). Model 6.2 is the traditional capital asset pricing model with systematic covariance as the only independent variable. Model 6.3 is equation (6) without the intercept.

In Model 6.1 the coefficient (b_1) for systematic covariance (*beta*) is significant and positive, which coincides with the theory. The intercept is not found to be significantly different from zero. This coincides with the theoretical prediction, although previous tests of SPCAPM have not achieved this result.[8] In contrast to the findings of Liu et al. (1992), the coefficient for systematic coskewness (b_2) is also not different from zero. These results are strengthened by the collinearity diagnostics.[9] The smallest eigenvalue is .12440. The highest condition number of 4.0816 is below the threshold of 5 suggested by Belsley, Kuh and Welsch (1980). The proportion of variance shared by the principal components of the *beta* and *gamma* is negligible. These results suggest an absence of the collinearity found by Kraus and Litzenberger (1976) and Friend and Westerfield (1980). However, there is a high degree of common variance shared between the intercept and the *beta*.

Model 6.2 in Exhibit 3 shows the results obtained with a traditional one-factor pricing model. Note the increase in the F-value and the improvement in the significance of the *beta* coefficient. Although the condition numbers are still low and the eigenvalues do not indicate a serious problem, there is still a high degree of common variance between the intercept and the *beta*. To investigate the possibility that this is altering the results, the regression is repeated with the intercept forced to zero (Model 6.3). The removal of the intercept increases the F-value to 17.836. In addition, the b_1 coefficient is still significant and positive, while the b_2 coefficient is still not different from zero.

Previous investigations, most notably Friend and Westerfield (1980), suggest a possible sample dependence of results. Thus the tests described above are repeated

Exhibit 4
Ordinary Least Squares Regression Results for the Four Portfolios

$$r_{pt} = b_0 + b_1(\beta_{pt}) + b_2(\gamma_{pt}) + u_{pt}$$

Model	b_0	b_1	b_2	F-value
6.1	.000807 (−.164)	.012782[c] (1.913)	.000715 (.557)	2.529[c]
6.2	−.001247 (−.256)	.014314[a] (2.353)	—	5.534[a]
6.3	—	.011830[b] (3.600)	.000748 (.591)	11.455[b]

[a]significant at 95% level
[b]significant at 99% level
[c]significant at 90% level

using only four portfolios. The individual REITs are sorted into two groups based on systematic covariance. Each is then divided into two systematic coskewness groups. The systematic covariance and coskewness for these four portfolios are then generated in the same fashion as the nine portfolio tests, and regression (6) is estimated. The results (see Exhibit 4) further reinforce this study's findings. Under Model 6.1, the intercept is again zero. Systematic coskewness is again rejected as an influence on real estate returns. The coefficient for systematic covariance (b_1) again is the only result that supports the K-L theory. The smallest eigenvalue is .0943 and the condition number is less than 5.0, which suggest the absence of multicollinearity, although there is still a high degree of common variance between the *beta* and the intercept. The results from Model 6.2 and Model 6.3 are consistent with the findings of the nine-portfolio tests.

Conclusions

The results presented here show that systematic coskewness does not explain EREIT returns. This is in contrast to most two-stage tests of the K-L model using non-real estate assets (see, for example, Kraus and Litzenberger, 1976, Friend and Westerfield, 1980 and Cotner, 1991). These results are obtained under conditions that eliminate some of the questions previously raised concerning research using SPCAPM. The intercept is not found to deviate significantly from zero, as in previous studies of CAPM and SPCAPM. There is also no evidence of multicollinearity between the *beta* and systematic coskewness independent variables. These outcomes are consistent between tests which use different market indices and different number of portfolios.

The results here also differ substantially from Liu et al. (1992), who use appraisal-based CREFs. The present data is composed solely of transaction-based EREITs. Gyourko and Keim (1992) note the effect of lags and seasonality in the appraisal process. Transaction-based EREIT price data may be subject to market effects. In addition, Liu et al. use ten years of quarterly data compared to this study's twenty-one (nineteen used for regressions) years of monthly observations. These differences in data may account for the different results between Liu et al. and this study.

Differences in methodology might also account for differing results. Liu et al. (1992) use Barone-Adesi (1985) to estimate the impacts of covariance and coskewness. The primary benefit of that methodology is a possible reduction in any errors-in-variables problems, reducing potential bias in estimates of regression coefficients.[10] It is impossible to verify whether or not the current results are biased in this fashion. However, it is interesting to note that the multicollinearity found in previous studies is not obtained in these tests.

Notes

[1]Black, Jensen and Scholes (1972), Miller and Scholes (1972), as well as Fama and MacBeth (1977), provide the definitive testing of the CAPM.

[2]See Ibbotson and Siegel (1983, 1984) or McCue (1984). Liu, Hartzell and Grissom (1992) also find asymmetric returns.

[3]This interpretation assumes that the marginal rate of substitution between skewness and *beta* is non-zero, as is the risk-adjusted market skewness. See Sears and Wei (1985).

[4]These returns include hybrid REITs.

[5]See for example, Kraus and Litzenberger (1976) and Friend and Westerfield (1980).

[6]Both the equal-weighted and value-weighted CRSP indices are used as proxies. Since the results are virtually identical, the equal weighted findings are presented.

[7]This procedure thus excludes EREITs without at least twenty-five consecutive monthly returns.

[8]All previous tests of SPCAPM indicate that the intercept is too high.

[9]SAS Proc Reg generates eigenvalues and variance commonality percentages to investigate possible linkages among the independent variables.

[10]Barone-Adesi explains that his results may have been subject to heteroskedasticity. If this is the case, the newer methodology appears to have traded one econometric difficulty for another.

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