The Predictability of REIT Returns and Market Segmentation

*Yuming Li**
*Ko Wang***

***Abstract*. Recent research suggests that real estate returns are more predictable than the returns of other assets and that the real estate market is segmented from the general stock market. This study examines these two issues empirically using a multifactor asset pricing model that allows for time-varying risk premiums. The results indicate that, in a general two-factor asset pricing framework, the REIT market is integrated with the general stock market. Furthermore, no evidence can be found that REIT returns are more predictable than the returns of other stocks.**

Introduction

One of the most interesting, and perhaps the most controversial, topics in the real estate literature is the pricing and performance of real estate securities. Depending upon the methodologies, data and sample periods used, researchers derive different conclusions. Some studies conclude that real estate securities outperform the stock market, while several other studies report that real estate securities perform no better or worse than the stock market.[1] Similarly, the literature on the predictability of returns of real estate securities and segmentation of a real estate securities market is also filled with conflicting evidence.

The purpose of this study is to examine the second issue (predictability and segmentation) empirically. It differs from previous studies in three important ways. First, it uses a new multifactor asset pricing model that specifies the risk premiums as functions of the conditional variances and covariances of the factors. In this method, the cross-sectional differences between expected returns on REITs and other assets are tested jointly based on the pricing errors of the model. In addition, not only are the predictability of excess returns being compared as in some other earlier studies, but the part of the excess returns that are unexplained by the time-varying risk premiums specified in the model are also examined. It should be noted that previous studies use their unconditional factor models or a conditional model that specifies risk premiums as linear functions of the instrumental variables.

Second, the samples used in previous studies are either quite limited in size or include only equity REITs. This study uses all REITs identified by the National Association of Real Estate Investment Trusts Inc. (NAREIT) that are available on the Center for Research in Security Prices (CRSP) tapes. This means that results for this study will be free of survivorship bias. Third and most importantly, this study not only compares

*School of Business Administration, University of Michigan, Ann Arbor, Michigan 48109, and Department of Finance, California State University-Fullerton, Fullerton, California 92634.
**Department of Finance, The Chinese University of Hong Kong, Shatin NT, Hong Kong, and Department of Finance, California State University-Fullerton, Fullerton, California 92634.
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REIT returns to the general stock market, but also to the returns of other industries. Within the REIT industry, the returns for both mortgage REITs and equity REITs are analyzed. In this regard, more direct and diversified evidence on the issues of market segmentation and return predictability is provided.

This paper is organized as follows. The following section provides a brief literature review. The third section discusses the methodology. (A detailed description of the methodology and estimation procedure is included in the Appendix.) Section four reports our sample procedure and summary statistics; section five presents our empirical results and the last section contains our conclusions.

Literature Review

Liu, Hartzell, Greig, and Grissom (1990) document that segmentation between the real estate market and the capital market does exist. The implication of their finding is that there is a separate pricing paradigm for financial and real estate assets. However, Ambrose, Ancel and Griffiths (1992), by studying the nonlinear long-term dependence of returns on Real Estate Investment Trusts (REITs) and the stock market, conclude that segmentation does not exist between different real estate markets or between the real estate and the stock market.[2] Given these conflicting findings, more research in this area seems warranted.

Liu and Mei (1992) were the first to study the predictability of returns for equity REITs. Using a multifactor latent variable model with time-varying risk premiums, they demonstrate that expected excess returns for equity REITs are more predictable than those for large cap stocks, small cap stocks, and bonds. Recently, using a similar multifactor asset pricing model framework, Mei and Lee (1994) report that they cannot find evidence to support market segmentation and that there is a need to include a real estate factor in asset pricing. Their finding implies that the real estate premium found in Liu, et al. (1992) does not compensate for real estate market imperfections, but does compensate for the systematic risk in the real estate market. However, it should be noted that Mei and Lee's conclusion assumes the existence of a real estate factor premium in the economy. There seems to be a need to examine the predictability issue without this unique assumption.

Research Design

The methodology adopted in this study is a variant of Li (1992). In the model, the state variables are described by a first-order vector autoregressive process (VAR (1)). This process is used to remove any possible anticipated movements of the state variables $\mathbf{Y_t}$,

$$\mathbf{Y_t} = \mathbf{A} + \mathbf{B}(\mathbf{Y_{t-1}} - \mathbf{A}) + \mathbf{e_t}\,, \tag{1}$$

where $\mathbf{Y_t}$ is the 2×1 vector of the state variables and $\mathbf{A}$ is a vector of the unconditional means of the state variables. $\mathbf{B}$ is a 2×2 constant matrix and $\mathbf{e_t}$ is a vector of residuals with the conditional variance-covariance matrix $\mathbf{H_t}$.

Let r_{it} be the excess return on asset i in period t. The multifactor asset pricing model implies

$$E[r_{it}|\boldsymbol{I}_{t-1}] = \mathbf{b_i}\lambda_\mathbf{t}, \tag{2}$$

where $\boldsymbol{I}_{t-1}$ is the set of information available as of time $t-1$, $\mathbf{b_i}$ is a 2×1 vector of conditional factor loadings of asset *i* on the state variables and $\lambda_\mathbf{t}=\mathbf{H_t q}$ is a 2×1 vector of conditional factor risk premiums where $\mathbf{q}$ is a constant vector of risk prices. The factor loadings are conditional regression coefficients

$$\mathbf{b_i} = \mathrm{var}^{-1}(\boldsymbol{Y}_t|\boldsymbol{I}_{t-1})\mathrm{cov}(r_{it},\boldsymbol{Y_t}|\boldsymbol{I_{t-1}}). \tag{3}$$

Let the first state variable $\boldsymbol{Y_{1t}}$ denote the return on the market portfolio and q_l be interpreted as the relative risk-aversion coefficient.

In this model, the cross-sectional differences between expected returns on REITs and other assets are captured by the factor loadings. The time-varying expected returns are captured by the time-varying risk premiums (of the state variables $\boldsymbol{Y_t}$), which are related to the time-varying conditional variances and covariances of the state variables.

The Generalized Method of Moments (GMM) developed by Hansen (1982) provides a natural way to estimate the parameters of the state variables. Following this methodology, orthogonality conditions from equations (1) to (3) are formed to jointly estimate all parameters and test the implications of the pricing model (equation (2)) for REITs and other assets. (See the Appendix for a detailed description of the estimation procedure.)

The pricing errors for REITs and other assets are examined individually or jointly. If the real estate market is integrated with the general stock market, the cross-sectional differences between the expected returns on REITs and other assets should be explained by the same two-factor model. As a result, the average pricing errors for REITs and other assets from the two-factor model should all be zero. The *t*-statistic is used to test the hypothesis that the average pricing error for each portfolio is zero. The m_t-statistic distributed as χ^2, is used to test the joint hypothesis that the pricing errors for REITs and other assets are jointly zero.[3]

If the real estate market is integrated with the general stock market, the predictability of REIT returns should be similar to the predictability of the returns on the other stock portfolios (including different industry and size portfolios). When the two-factor model is correctly specified, the pricing errors for REITs or other assets should be uncorrelated with certain forecasting variables. (There are several forecasting variables that are commonly used in the literature.) If the real estate market and the stock market are integrated and if the two-factor model does not capture all of the predictable variation in the expected returns, the correlations between REITs and the forecasting variables should be similar to that between other assets and the same forecasting variables. The *t*-statistic can be used to test for the significance of the correlation of returns between a portfolio and a forecasting variable. The hypothesis that the correlations between all portfolios, including REITs, and a forecasting variable are zero, is jointly tested using the m_t-statistic. The joint hypothesis that all the pricing errors are zero and uncorrelated with all forecasting variables is tested using the J_t-statistic.

Sample and Summary Statistics

The asset return data used in this study consist of monthly nominal rates-of-return on a portfolio of equity REITs, a portfolio of mortgage REITs, two size-based portfolios (smallest and largest), and three industry portfolios (durables, construction and utilities). The one-month Treasury bill rate (TB), obtained from the CRSP government bond file, is used to calculate excess returns. All portfolio returns are value-weighted.[4]

All stock return data were obtained from the Center for Research in Security Prices (CRSP). The two size portfolios are the smallest and the largest deciles of common stocks, ranked by the market value of equity outstanding at the beginning of each year. The three industry portfolios are grouped by the two-digit standard industry classification (SIC) code in the same way as in Breeden, Gibbons and Litzenberger (1989), Ferson and Harvey (1991), and others.[5]

To identify REITs and their asset types, the information published by the National Association of Real Estate Investment Trusts (NAREIT) is used. It should be noted that there are several years for which the NAREIT publications do not report information on non-member REITs or on the tax qualification status and asset composition of individual REITs. In addition, there are a significant number of firms that are classified as REITs by the Compustat and CRSP tapes, but are not listed as REITs by the NAREIT publications. For the non-listed years and non-listed firms, the firms' annual reports, Standard and Poor's Stock Reports, and the LEXIS-NEXIS database were examined in order to determine a REIT's status and its asset composition.[6]

For the period 1971–1991, 140 equity REITs and 74 mortgage REITs were identified.[7] The number of REITs used to calculate monthly returns on the portfolio of equity REITs ranges from 14 to 58. For the mortgage REIT portfolio, the number of REITs in the portfolio ranges from 4 to 41. This sample is larger than samples used in previous studies and is free of the survivorship bias.

The state variables (or the pricing factors) used in this study include the real return on the value-weighted portfolio of all NYSE stocks (*RVW*) and the difference between the return on the long-term corporate bond portfolio and the return on the long-term government bond portfolio (*PREM*).[8] The real return is calculated as the nominal return deflated by the Consumer Inflation Index (CPI). The variable *PREM* captures premium for default risk. Chan, Chen and Hsieh (1985), among others, document that this variable is one of the most important variables for explaining the cross-sectional difference between returns on small and large firms. Ferson and Harvey (1991) find that this variable is useful for capturing the predictability of returns. Returns on the bond portfolios and the short-term T-bill, as well as the inflation rate, are also obtained from the CRSP tapes.

The forecasting variables used in the model include a constant, the first lag of the real market return (*RVW*), the inflation rate (*INF*), the growth rate of the industrial production (*IP*), the dividend yield on the NYSE value-weighted portfolio (*DIV*), the term spread (*TERM*), the default spread (*DEF*), and a dummy variable for the month of January (*JAN*). The dividend yield (*DIV*) is defined as the ratio of total dividends on the NYSE value-weighted portfolio paid in the last twelve months to the current value of the portfolio. The term spread (*TERM*) is the difference between the average yield on corporate bonds rated Aaa by Moody's Investor Services and the one-month Treasury bill rate. The default spread (*DEF*) is the difference between the yield on Baa-rated corporate bonds and the Aaa corporate bond yield. The Aaa and Baa corporate bond yields are obtained from Ibbotson Associates for the period before the end of 1987 and from the Federal Reserve Board thereafter.[9]

The variables *DIV, TERM* and *DEF* are selected because it is well documented that they can predict stock returns (see Keim and Stambaugh, 1986; Campbell, 1987; Fama and French, 1988, 1989). The variable *PREM* is not included as a forecasting variable because it is similar to the *DEF* variable but has less predictive power for stock returns. The January dummy variable is included in the forecasting variable set because Keim (1983) documents that small stocks earn abnormal returns in the month of January. (Colwell and Park (1990) extend the evidence to real estate assets.) Unlike other non-constant forecasting variables that are stochastic, the January dummy variable is deterministic. The inclusion of this instrumental variable allows for a test of the January effect in stock returns.

Exhibit 1 presents the summary statistics for the state and forecasting variables for the period 1971 through 1991. The autocorrelations of the state variables, *RVW* and *PREM*, are noticeable at the first and second orders. These autocorrelations suggest that there might exist anticipated components in these two state variables. This underscores the importance of using a VAR(1) process. A review of the sample correlation coefficients

Exhibit 1
Summary Statistics for the State[a] and Forecasting Variables:[b] 1971–1991

Panel A: Means, Std Dev. and Autocorrelations

			Autocorrelations at					
Variable	Mean	Std Dev.	lag 1	lag 2	lag 3	lag 4	lag 12	lag 24
RVW	.0043	.0476	.0658	−.0435	.0226	−.0332	.0440	−.0269
PREM	.0005	.0121	−.1656	−.0833	−.0149	.0308	−.0389	−.0157
IP	.0024	.0088	.4482	.3067	.2275	.1178	.0125	−.1988
INF	.0050	.0035	.6337	.5336	.4618	.4084	.3898	.1114
DIV	.0412	.0080	.9612	.9203	.8846	.8461	.5665	.3354
TERM	.0281	.0164	.8492	.7527	.6569	.5949	.3109	.0692
DEF	.0121	.0062	.8210	.7418	.6588	.5913	.3232	−.0255

Panel B: Cross-Correlations

	RVW	*PREM*	*IP*	*INF*	*DIV*	*TERM*
PREM	.0120					
IP	−.0462	.1547				
INF	−.2744	.0586	−.0622			
DIV	−.1088	−.0036	−.2737	.3430		
TERM	.1504	.0645	.0760	−.5941	−.1757	
DEF	.0497	−.0440	−.2593	.0258	.5185	.0564

[a]The state variables are the real return on the value-weighted portfolio of all NYSE stocks (*RVW*), and the return on long-term corporate bonds less the return on long-term government bonds (*PREM*).
[b]The forecasting variables are: a constant, the real return on the VW portfolio (*RVW*), the inflation rate (*INF*), the seasonally adjusted growth rate of industrial production (*IP*), the dividend yield on the VW portfolio (*DIV*), and annualized Aaa yield less the one-month Treasury bill rate (*TERM*), the annualized Baa yield less the Aaa yield (*DEF*), and a dummy variable for January (*JAN*).

reported in Panel B of the same exhibit indicates that the state variables do not appear to be close substitutes for one another.

As expected, the forecasting variables *DIV, TERM* and *DEF* have larger and more persistent autocorrelations than the state variables. The variables *IP* and *INF* also exhibit larger autocorrelations. The largest correlation coefficient (=−.59) is between the *TERM* and *INF* forecasting variables. In general, the size of the correlations show that collinearity among the forecasting variables should not be a concern.

Exhibit 2 reports the average excess returns of the two REIT portfolios, the two size portfolios, the three industry portfolios, and the value-weighted market portfolio. The *t*-statistics are used to test for the correlations between the excess returns. The forecasting variables are also reported in the same exhibit. As shown in the first column, over the sample period the mean returns on REITs are smaller than the returns on other assets. The *t*-statistics also indicate that every forecasting variable has some predictive power for each of the eight portfolio returns.

It should be noted that, since the January dummy variable (*JAN*) takes a value of unity when excess returns are for the month of January and a value of zero otherwise, sample averages for the products of the excess returns with *JAN* should measure the difference between the average excess returns in January and the average monthly excess returns in

Exhibit 2
Average Excess Returns and *t*-Statistics for Coefficients of Regression of Excess Returns[a] on Forecasting Variables:[b] 1971–1991

		t-stat. for Coefficient of Regression on Variables Given by							
Portfolio	$\bar{r}_i$[c]	100	*RVW*	*INF*	*IP*	*DIV*	*TERM*	*DEF*	*JAN*
REIT									
Equity	.38	(1.10)	(2.02)	(−2.11)	(−2.20)	(2.51)	(3.24)	(1.70)	(4.05)
Mortgage	.03	(.09)	(.88)	(−1.57)	(−1.93)	(2.58)	(3.20)	(2.75)	(3.58)
Size									
Smallest	.82	(1.65)	(2.42)	(−1.30)	(−2.90)	(2.76)	(2.26)	(2.20)	(6.51)
Largest	.41	(1.41)	(.47)	(−2.64)	(−.90)	(1.60)	(3.59)	(.54)	(1.36)
Industry									
Durables	.43	(1.16)	(1.57)	(−2.40)	(−2.19)	(2.45)	(3.74)	(1.79)	(2.63)
Construction	.65	(1.57)	(2.01)	(−2.03)	(−2.15)	(1.70)	(3.32)	(.78)	(2.04)
Utilities	.48	(2.03)	(−1.27)	(−1.68)	(−1.51)	(2.23)	(3.03)	(.99)	(2.17)
All stocks									
VW	.47	(1.58)	(.71)	(−2.27)	(−1.38)	(2.14)	(3.52)	(1.00)	(1.81)

[a]All returns are monthly, simple compound rates of return in excess of the one-month Treasury bill rate. The assets include the two value-weighted portfolios of the smallest and largest deciles of NYSE stocks, three value-weighted industry portfolios, and the value-weighted portfolio of all NYSE stocks (*VW*).
[b]The forecasting variables are: a constant, the real return on the VW portfolio (*RVW*), the inflation rate (*INF*), the seasonally adjusted growth rate of industrial production (*IP*), the dividend yield on the VW portfolio (*DIV*), the annualized Aaa yield less the one-month Treasury bill rate (*TERM*), the annualized Baa yield less the Aaa yield (*DEF*), and a dummy variable for January (*JAN*). All forecasting variables except a constant are mean-adjusted and scaled beginning-of-month values.
[c]$\bar{r}_i$ is the average percentage excess return on portfolio *i*. The next column provides the *t*-statistics for the average excess return.

the remainder of the year. The results in the last column of Exhibit 2 show that the difference in returns is statistically significant for most of the portfolios, including REITs. This result indicates that, similar to other stocks in the market, the returns of REIT stocks also exhibit the well-known "January effect".

Results

Exhibit 3 shows that the estimate for the relative risk-aversion coefficient (or more precisely the elasticity of the marginal utility of wealth with respect to equity) is 3.26 with a standard error of 1.08. This result is consistent with French, Schwert and Stambaugh (1987) who document a positive relation between the expected excess stock return and the conditional volatility of the stock return.[10] The risk price for the variable *PREM* is −39.42 with a standard error of 12.33. This indicates that the conditional volatilities of the market return and the variable *PREM* both affect the market risk premium and the premium for default risk.

The test of joint significance for the risk prices produces a p-value of .006. This suggests that the market risk premium and the default risk premium are jointly significantly related to the conditional variance-covariance matrix of the state variables (or the pricing factors). The estimates of factor loadings appear to be in a reasonable range. The factor loadings on the market portfolio are significant for REITs as well as other assets. These loadings are smaller for REITs than for the other assets. However, the magnitudes of the differences in the loadings are consistent with the magnitudes of the

Exhibit 3
GMM Estimates from a Two-Factor Pricing Model for REITs and Other Assets

$$\begin{aligned} \boldsymbol{Y_t} &= \boldsymbol{A}+\boldsymbol{B}(\boldsymbol{Y_{t-1}}-\xi)+\mathbf{e}_t, \\ r_{it} &= \boldsymbol{b_i}\lambda_{\boldsymbol{t}}+u_{it} \end{aligned}$$

$\boldsymbol{Y_t}$ includes the real market return and the return on long-term corporate bonds minus the return on long-term government bonds. r_{it} represents excess returns on two REIT portfolios, five other stock portfolios and a value-weighted market portfolio. $\lambda_t = E_{t-1}[\boldsymbol{e}_t\boldsymbol{e}'_t]\boldsymbol{q}$ is a vector of factor risk premiums where $\boldsymbol{q}$ is a constant vector of risk prices. $\boldsymbol{b_i}$ are constant factor loadings. The system is estimated by the generalized method of moments (GMM).

		RVW ($j=1$)		*PREM* ($j=2$)		H_0: $\boldsymbol{q}=0$	
Portfolios	Parameter	Coeff.	Std Error	Coeff.	Std Error	χ^2	*P*-value
	q_j	3.2555	1.0840*	−39.419	12.33*	16.150	.006
Equity	b_{1j}	.5128	.0372*	.0557	.1624		
Mortgage	b_{2j}	.5132	.0492*	.2325	.2042		
Smallest	b_{3j}	.9088	.0510*	.4761	.1776*		
Largest	b_{4j}	.9954	.0254*	.0122	.0469		
Durables	b_{5j}	1.1024	.0247*	.0875	.0939		
Construction	b_{6j}	1.1597	.0344*	.0375	.1322		
Utilities	b_{7j}	.6427	.0340*	−.0085	.1000		

*significant at 5% level

differences in average returns. The factor loading on the *PREM* variable is significant only for the smallest stock portfolio. This result is consistent with the finding reported by Chan, Chen and Hsieh (1985) that the *PREM* variable is important for explaining small stock returns.

Exhibit 4 presents the implied average pricing errors and *t*-statistics for the correlations of the pricing errors with the forecasting variables. The m_T-statistics (that follow the *t*-statistics) are multivariate tests of the hypothesis that the pricing errors for all asset returns are zero or uncorrelated with each of the seven forcasting variables.

The result of the GMM tests of overall fitness is also given. In the GMM system, there are sixty-four orthogonality conditions implied by the asset pricing model and two risk prices as additional parameters. This leaves sixty-two over-identifying restrictions. The J_T-statistic is 103.2 (the associated *p*-value is .0008). Thus the evidence strongly rejects the hypothesis that the two-factor asset pricing model can fully explain both the cross-sectional and intertemporal variation of returns on REITs and other assets.

As is evident in the first column of Exhibit 4, the average pricing error for each of the portfolios is smaller than the average excess return reported in Exhibit 2. The *t*-statistics for the average pricing errors are all insignificant. The m_T-statistic is 13.07 with 8 degrees of freedom (the *p*-value is .109). This test indicates that the average pricing errors for

Exhibit 4
GMM Tests of Integration and Predictability of REITs and Other Assets

		t-stat. for Correlations of Pricing Errors with Forecasting Variables[a]							
Portfolio	$\bar{u}_i$[b]	100	*RVW*	*INF*	*IP*	*DIV*	*TERM*	*DEF*	*JAN*
REIT									
Equity	.02	.07	1.72	−1.36	−1.03	2.35	2.80	1.56	1.97
Mortgage	−.23	−.60	.52	−1.02	−1.05	2.33	2.63	2.42	1.90
Size									
Smallest	.37	.67	1.96	−.86	−1.26	2.55	2.19	2.00	2.45
Largest	−.29	−.79	.01	−1.08	−1.07	1.72	2.74	1.11	.73
Industry									
Durables	−.40	−.90	.87	−1.14	−1.53	2.35	2.90	1.97	1.36
Construction	−.17	−.34	1.32	−.96	−1.67	1.78	2.59	1.20	1.14
Utilities	.01	.03	−1.14	−.67	−1.17	2.17	2.43	1.36	1.03
All stocks									
VW	−.24	−.64	1.53	−.88	−1.24	2.05	2.67	1.40	.94
m_T-stat.		13.07	18.51	16.54	9.09	17.98	17.07	12.50	12.01
P-value[c]		.109	.018	.035	.335	.021	.029	.130	.151
J_T-stat.		103.20							
P-value[d]		.0008							

[a]See note to Exhibit 2 for definitions of the forecasting variables. All of the variables, except a constant, are mean-adjusted and scaled.
[b]$\bar{u}_i$ represents the average percentage pricing error for portfolio *i*. The *t*-statistics in the next column are for tests of the significance of the average pricing errors.
[c]The m_T-statistics, distributed χ^2 with 8 degrees of freedom, are for tests of the joint hypotheses that pricing errors for all eight portfolios are zero or uncorrelated with a forecasting variable.
[d]The J_T-statistic, distributed χ^2 with 62 degrees of freedom, is for the test of the overall fitness of the model.

REITs and other assets are not significantly different from zero. The result also implies that the two-factor model can explain the cross-sectional differences in the expected returns between REITs and other assets, and provides evidence against the existence of a segmented real estate market.

The *t*-statistics and m_T-statistics for the average correlations between the pricing errors and the forecasting variables indicate that the pricing errors are correlated with the lagged observations of *RVW, DIV* and *TERM.* This result implies that the pricing errors are still predictable (using the forecasting variables). However, it should be noted that, as reported in Exhibit 4, the magnitudes and significance levels of the *t*-statistics for each forecasting variable are similar for all REIT portfolios and other asset portfolios. This implies that the predictability of the eight forecasting variables should be the same for both the REIT returns and the returns of other assets. In other words, the results indicate that the returns of REIT stocks are not more (or less) predictable than the returns of other stocks, and provides for further evidence against market segmentation.

Conclusions

This study uses a multifactor asset pricing model to evaluate the predictability of REIT returns and the returns of other common stocks. In this model, the risk premiums of the two pricing factors (stocks and bonds) are related to the conditional variances and covariances of the factors. The cross-sectional and time-series variations of returns on REITs and other assets are examined jointly, based on the pricing errors of the model. Using return data for the 1971 through 1991 period, the results of this study show that the cross-sectional variation in expected returns on REITs and other assets can be captured for the most part by the differences in their sensitivities to market risk and default risk.

The predictability of returns on REITs and other assets is found to be very similar in the model framework used in this study. The three most important forecasting variables (dividend yield, term premium and default premium) predict REIT returns in the same way that they predict the returns of other stocks. Based on a two-factor asset pricing model with time-varying risk premiums, the unexplained part of the predictability of the returns on REITs is not significantly different from that of other assets.

This study also documents that the time-varying conditional volatilities of the market return and the default premium variables do not explain much of the predictability. This result is in contrast to earlier findings reported by Liu and Mei (1992) that the predictability of the returns on REITs and other assets can be captured by a multifactor latent-variable model. However, the result is consistent with that reported by Mei and Lee (1994).

Mei and Lee (1994) also report that they cannot find evidence to support market segmentation. However, it should be noted that Mei and Lee (1994) use a three-factor model (stocks, bonds and real estate) to derive their result. In Mei and Lee's model, the returns of financial assets are also specified as a function of a real estate factor. The model employed by this study derives a similar conclusion without assuming the existence of a real estate factor premium in the economy, which provides further evidence that REIT stocks are integrated with the general stock market.

Appendix

If VAR residuals satisfy that $E_{t-1}[\boldsymbol{e_t}]=0$, the law of iterated expectations implies

$$E[\boldsymbol{e_t} * \boldsymbol{Y_{t-1}}] = \mathbf{0}\,, \tag{4}$$

where * represents the element-by-element multiplication.

From (3), the conditional factor loadings are

$$\boldsymbol{b_i} = (E[\boldsymbol{e_t}\boldsymbol{e_t}'])^{-1}\ E[r_{it}\boldsymbol{e_t}]\,. \tag{5}$$

This implies that the following system of equations holds when the factor loadings are constant:

$$E[r_{it}\boldsymbol{e_t} - \boldsymbol{e_t}\boldsymbol{e_t}'\boldsymbol{b_i}] = \mathbf{0}\,. \tag{6}$$

Since $\boldsymbol{H_t}=E_{t-1}[\boldsymbol{e_t}\boldsymbol{e_t}']$, we can write the factor risk premiums as $\boldsymbol{\lambda_t}=E_{t-1}[\boldsymbol{e_t}\boldsymbol{e_t}']\boldsymbol{q}$. Substituting this expression into the asset pricing model (2), we have

$$E[(r_{it} - \boldsymbol{b_i}[\boldsymbol{e_t}\boldsymbol{e_t}']\boldsymbol{q})\boldsymbol{Z_{t-1}} = \mathbf{0}\,, \tag{7}$$

where $\mathbf{Z_{t-1}}$ is a vector of forecasting variables contained in the information set $\boldsymbol{I_{t-1}}$. This shows that while the factor risk premiums are functions of the conditional variance-covariance matrix, the asset pricing model can be estimated and tested without a parametric specification of the conditional second moments.

Equations (4), (6) and (7) are used to form orthogonality conditions that are estimated jointly by the generalized method of moments (GMM). The GMM procedure minimizes the weighted sum of squared residuals of the equations. Hansen (1982) outlines a form of the weighting matrix that guarantees that the GMM estimator is consistent and asymptotically normal. The weighted sum of squared residuals provides a J_T-statistic that can be used to test the overall fitness of the model. A high value of the statistic would provide evidence against the model.

Notes

[1]For a review of the literature on this issue, see Wang et al. (1995).

[2]Other related studies include Miles, Cole and Guilkey (1990) and Chan et al. (1990).

[3]This test performs a function similar to that of an F-test.

[4]Because the number of stocks in the REIT portfolios can be quite small in certain periods, the returns on the value-weighted portfolios are less likely to contain spurious autocorrelation and predictability caused by nonsynchronous and infrequent trading than the equally weighted portfolios (Scholes and Williams, 1977).

[5]We are grateful to Raymond Kan for providing the data on industry portfolios.

[6]For each month, a REIT is classified as an equity (or mortgage) REIT when at least 75% of its assets is comprised of real properties (or mortgages).

[7]The post-1971 data are used because few REITs are available prior to 1971.

[8]The long-term corporate bond portfolio is used instead of the Baa-rated bond portfolio because the latter is not available after 1987.

[9]Time-series plots from 1947–1987 indicate that the yields compiled from the two sources are very similar.
[10]Also see Campbell (1987), Glosten, Jagannathan and Runkle (1993), and Whitelaw (1994).

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