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Interest Rate Sensitivities of REIT Returns

Ling T. He
Department of Economics & Finance, University of Central Arkansas, Conway, AR 72035 or linghe@mail.uca.edu

James. R. Webb
Department of Finance, James J. Nance College of Business, Cleveland State, University, Cleveland, OH 44115

F.C. Neil Myer
Department of Finance, James J. Nance College of Business, Cleveland State University, Cleveland, OH 44115

In order to identify effective interest rate proxies for equity and mortgage REITs, this study analyzes seven different interest rate proxies that have been widely used in the REIT literature. They are the monthly holding period returns on long-term U.S. government bonds and high-grade corporate bonds, the percentage changes in yields for long-term U.S. government bonds and high-yield (Baa) corporate bonds, the difference between returns on long-term U.S. government bonds and T-bill rates, the spread between yields on high-yield (Baa) corporate bonds and returns on long-term U.S. government bonds, and the spread between returns on high-grade corporate bonds and returns on long-term U.S. government bonds. The overall OLS results suggest that mortgage REITs are sensitive to all proxies, while equity REITs are significantly affected by only changes in yields on long-term U.S. government bonds and high-yield corporate bonds. The time variation paths for sensitivities indicate that all interest rate sensitivities are time specific. Overall, the changes in yields on high-yield corporate bonds (Baa) has the strongest explanatory power for returns of equity and mortgage REITs for most of the 27-year sample period (1972 through 1998).

Introduction

The risk and return characteristics of real estate investment trusts (REITs) have generated a considerable amount of research. Evidence from some REIT studies, Ross and Zisler (1987a, 1987b, 1991), Mengden and Hartzell (1986), Ennis and Burik (1991), and Gyourko and Keim (1992), indicate that returns on REITs are highly correlated with stock market returns. Other studies find that returns on REITs, particularly mortgage REITs, are also related to changes in interest rates. Giliberto (1990) reports that stock and bond market returns explain 60 percent of REIT return variability. Thus, a two-factor market model is needed in order to correctly evaluate REIT performance (Liang and Webb, 1995b).[1]

Some studies on the interest rate sensitivity of equity REITs are conflicting. For example, Chen and Tzang (1988) report significant sensitivity of equity REITs to changes in yields of long-term government bonds, while Liang, McIntosh and Webb (1995a) (LMW hereafter) find only the insignificant sensitivity of equity REITs to changes in monthly holding period returns on long-term government bonds. It would seem that different proxies for interest rates are causing the conflicting results. In addition, Sanders (1996, 1998) reports that returns on high yield (Baa) corporate bonds and sometimes high grade long-term corporate bonds, have significant explanatory power for REIT returns. Fama and French (1993) use two bond market factors in their five-factor model, the spreads between returns on long-term government bonds and T-bill rates and spreads between high grade long-term corporate and long-term government bonds. These factors are also found to be useful in REIT return analyses (Chan, Hendershott, and Sanders (1990), Peterson and Hsieh (1997), and Sanders (1998)).

Other studies suggest that both risk premiums and sensitivities of REIT returns to changes in the stock and bond market returns vary over time. Because of changes in pricing processes, risk premiums for REITs display a time-varying nature (Karolyi and Sanders, 1996) and sensitivities of REIT returns to risk factors are sometimes different in different sub-periods (Sanders, 1998). Chen and Tzang (1988) also indicate that their results suggest that interest rate sensitivities of REIT returns are different for different time periods. In their recent study, LMW (1995a) find that the market beta and the interest-rate beta for equity and mortgage REITs are time varying by performing the Cusum and Cusum of Squares tests to examine the forward/backward recursive residuals

1 More recently, other factors, such as the unsecuritized real estate market, size, and book-to-market equity, have been found to be important in explaining REIT returns (Peterson and Hsieh (1997), Chen et al (1998), and He (1999)). However, in order to compare with previous findings about interest rate sensitivities of REIT returns, the focus of this study is on results from the two-factor model which has been used widely in the REIT literature.

from the two-index model. The results of the Quandt=s log-likelihood ratio method suggest one switching point (two-regime), March of 1983, for the equity REITs and three switching points (four-regime), March of 1976, June of 1980 and March of 1983, for mortgage REITs. Return-generating regimes are essentially sub-sample periods in which coefficients of both factors have undergone significant changes. The merit of LMW=s methodology lies in the method used to classify sub-sample periods. That is, the sub-sample periods are no longer subjectively determined by researchers, but objectively detected by results of statistical tests. Nevertheless, this method focuses only on the residuals of the OLS regression model, rules out any possibilities to observe and analyze changes in individual coefficients over time, and therefore fails to find the factor which is mainly responsible for causing the switching points in the return-generating regimes.

The Flexible Least Squares (FLS) method developed by Kalaba and Tesfatsion (1988, 1989, 1990) and used in this study allows the analysis of changes that affect each factor of the return-generating process. The FLS technique can be used to analyze the relative stability of regression coefficients by showing the smooth changes of the coefficients over time. Unlike the OLS method, the FLS method does not impose a time-constant restriction on coefficient estimates. Instead, it recursively estimates the time paths of the coefficients of a regression model with time-varying coefficients. The FLS solution represents the collection of all coefficient sequence estimates that yield vector-minimal sums of squared residual measurements (squared regression errors) and squared dynamic errors (squared coefficient variations) for the given observations. The FLS solution exhibits the efficient attainable trade-offs between residual measurement error and residual dynamic error. The time paths traced out by the FLS estimates not only illuminate the instability for each coefficient, but also display unanticipated qualitative movements in individual coefficients at dispersed points in time. Therefore, it is easy to detect significant shifts in return-generating regimes, namely coefficients of both stock and bond market factors, over time, by directly observing the time variation paths of the coefficients. More importantly, since the FLS estimates display a time variation path for each coefficient, changes in each coefficient can be observed independently. It means that it is feasible to examine changes in the sensitivities of REIT returns to each factor (the stock market and interest rates) separately.

Studies on the sensitivities of REIT returns to major risk factors are also relevant to some Asian countries. For example, He (2001) finds that both Hong Kong and South Korea stock markets are very sensitive to changes in U.S. long-term interest rates. Moreover, in a study about the price discovery in the Hong Kong security markets (real estate, financial institutions, utilities, and commerce and industry), He (1997) provides evidence that price changes in one sub-market have significant impacts on other three sub-markets. Therefore, U.S. long-term interest rates may be a risk factor for real estate investment companies in Asia.

Going one step further, the purpose of this study is two-fold. First, this study uses different interest rate proxies reported in the REIT literature and analyzes relationships between different proxies. This is useful in identifying effective interest rate proxies for REITs. Second, given the time-varying nature of interest-rate sensitivities for REITs, this study tries to depict the detailed and visible time variation paths of interest-rate sensitivities by using the FLS approach. The switching points in the interest-rate sensitivities suggested by the FLS results will be verified by OLS results for the corresponding sub-periods. The time variation paths of coefficients not only display major turning points, but also the relative importance each factor has on the returns of REITs. For example, the stock market is, generally speaking, a predominant factor affecting REIT returns. However, in some years, the interest-rate sensitivity of mortgage REITs plays a similarly important role. In addition, changes in the interest-rate sensitivities of REIT returns are not necessarily limited to changes in the levels or magnitudes of sensitivities, they can also be changes in the directions of sensitivities. That is, returns for REITs exhibit negative sensitivities to changes in interest rates in some periods, and positive sensitivities in other periods. The time variation paths of interest rate sensitivities for REIT returns provided by this study will deepen the understanding of the instability of sensitivities for REIT returns due to changes in interest rates. The knowledge about time varying sensitivities and/or insensitivities of REIT returns to interest rate changes is obviously of increasing concern to institutional investors, such as pension funds, insurance companies, and others as they significantly increase their REIT exposure in investment portfolios.

The remainder of this study is organized as follows. Section 2 describes the data and methodology. Section 3 presents the empirical results, and Section 4 contains the conclusions.

Data and Methodology

This study uses time series data over the period of January, 1972 through December, 1998. The data set includes the following monthly indices:

BOND = the monthly returns on long-term U.S. government bonds (Ibbotson Associates);

CORP = the monthly returns on long-term high-grade corporate bonds (Ibbotson Associates);

LONG = the changes of monthly yields on long-term U.S. government bonds (Economic Database, St. Louis Federal Reserve Bank);

HIGH = the changes of monthly yields on high-yield (Baa) corporate bonds (The Federal Reserve Bank);

T-bill = the one monthly treasury bill rate observed at the beginning of the month.

TERM = BOND minus T-bill (a measure of unexpected returns on long-term government bonds);

DEF = yields on high-yield (Baa) corporate bonds minus BOND (a default risk measure);

DEFL = CORP minus BOND (a measure of default risk (Fama and French, 1993));

MKT = the monthly returns on the NYSE/ASE/NASDAQ value weighted index (CRSP);

MKTE = MKT minus T-bill (a measure of the overall stock market risk);

EREIT = the monthly returns for equity REITs (National Association of Real Estate Investment Trusts (NAREIT));

MREIT = the monthly returns for mortgage REITs (National Association of Real Estate Investment Trusts (NAREIT));

EREITE = EREIT minus T-bill (the monthly excess returns for equity REITs);

MREITE = MREIT minus T-bill (the monthly excess returns for mortgage REITs).

Previous research provided empirical evidence that the stock market and the bond market (long-term interest rates) play an important role in pricing common stocks, such as bank stocks (Flannery and James, 1984), utility stocks (Sweeney and Warga, 1986), REIT stocks (Mengden, 1988), etc. In order to compare with findings in the previous studies, this study uses a two-index model to examine the sensitivity of REIT returns to interest rates.

The time paths of the coefficients in the two-index model are detected by using the FLS approach. In order to illustrate the FLS method, assume the following general regression model with time-varying coefficients:

$$Y_t = X_t\, b_t + e_t\, ,\ t = 1, \ldots, T, \qquad (1)$$

where $X_t = (X_{t1}, ..., X_{tk})$ and b_t are (K x 1) vectors. The FLS approach specifies the time paths $b_1, ...b_T$ of the coefficient vectors which minimize the incompatibility loss function (the sum of squared residual measurement error plus the sum of squared residual dynamic error):

$$C(b;\mu,T) = \sum_{t=1}^{T}(Y_t - 'X_t b_t)^2 + \mu \sum_{t=1}^{T-1}(b_{t+1} - b_t)' D(b_{t+1} - b_t) , \qquad (2)$$

where μ is a pre-chosen positive constant and D is a fixed dynamic scaling (K x K) matrix. Like Tesfatsion and Veitch (1990), this study defines D as a diagonal matrix with ith diagonal term $d_{ii} = (X_{1i}^2 + ... + X_{Ti}^2)/T$, $t = 1, ..., T$. Therefore, multiplication of a regressor by a constant cannot cause any changes in the shape of the time path of the corresponding coefficients. In order to set the smoothing weight between zero and one, that is, $\mu \in (0,1)$, the incompatibility function can be rewritten as follows:

$$C(b;\mu,T) = \frac{1}{1-\mu}[(1-\mu)\sum_{t=1}^{T}(Y_t - 'X_t b_t)^2 + \mu \sum_{t=1}^{T-1}(b_{t+1} - b_t)' D(b_{t+1} - b_t)] . \qquad (3)$$

The size of μ plays an important role in the coefficient variation. As μ approaches zero, no weight is put on the dynamic specification. Thus, the squared residual movement error can generally be reduced to zero and the corresponding value for the squared residual dynamic error will be relatively large. Therefore, b_t tends to become more volatile as the value of μ decreases. On the other hand, when μ becomes arbitrarily large, the squared residual measurement error is minimized (subject to the squared residual dynamic error equal to zero). Thus, the b_t becomes constant and approaches the OLS solution with a single time-invariant coefficient vector. In order to get a clear time variation curve, different values for μ may be tried. The appropriate μ should generate FLS results consistent with OLS results for subperiods suggested by the time variation curves. That is, the final FLS results must be verified by the OLS estimates.

For the FLS approach, no stochastic assumptions are necessary. The approach is essentially descriptive. Nevertheless, Lutkepohl (1993) proves the potential stochastic framework for the FLS method.

Empirical Results

Interest-rate proxies

The descriptive statistics in Table 1 show that both equity and mortgage REITs underperformed the stock and bond markets during the entire sample period of

January 1972 through December 1998. The mean monthly return for mortgage REITs (MREIT) was 0.55%. For equity REITs (EREIT), the mean monthly return was 1.08%, still below the mean monthly stock market return (1.14%). Equity REITs have similar correlations with mortgage REITs (0.64 with a t-value of 14.95) and the general stock market (MKT) (0.63 with a t-value of 14.56) and lower correlations with four interest rate proxies: monthly returns on long-term U.S. government bonds (BOND) (0.20 with a t-value of 3.66) and high-grade corporate bonds (CORP) (0.25 with a t-value of 4.63), and changes of yields on long-term U.S. government bonds (LONG) (-0.31 with a t-value of -5.85) and high-yield (Baa) corporate bonds (HIGH) (-0.37 with a t-value of -7.15). Compared with equity REITs, mortgage REITs have a similar relationship with MKT (0.56) and higher correlations with BOND (0.33), CORP (0.44), and LONG (-0.32). Nevertheless, the correlation between MREIT and HIGH (-0.32 with a t-value of -6.06) is close to the correlation between EREIT and HIGH (-0.37 with a t-value of -7.15). Turning to the explanatory variables, BOND has the highest correlation with CORP (0.94 with a t-value of 49.44) and the lowest correlation with HIGH (-0.48 with a t-value of -9.82). MKT has quite low correlations with LONG and HIGH. The coefficients of correlation are -0.28 and -0.29, respectively. LONG and HIGH have a high correlation (0.82). All correlations have the expected signs that reflect the inverse relationship between returns and changes in interest rates. That is, negative signs for the correlations between the five return indices (EREIT/MREIT/MKT/BOND/CORP) and the two interest rate changes (LONG/HIGH); and positive signs for the correlations among the return indices and the correlation between interest rate changes (Table 1).

When excess returns are used, equity and mortgage REITs keep similar relationships with the market (Table 1). The correlation between themselves is virtually unchanged. As expected, a perfect negative correlation (-1.00) exists between TERM (BOND minus T-bill) and DEF (yields on Baa bonds minus BOND). In addition, BOND is perfectly correlated with TERM (1.00), and CORP is highly correlated with TERM (0.93) and highly negatively correlated with DEF (-0.93). Compared with DEF, the second default risk measure,

Table 1: Summary Statistics for the Monthly Returns in Percent (January 1972 through December 1998)

Variable	Mean	Std. Dev.	Correlations EREIT	MREIT	MKT	BOND	CORP	LONG	HIGH
EREIT	1.08	3.96	1.00						
MREIT	0.55	5.67	0.64 (14.95)*	1.00					
MKT	1.14	4.53	0.63 (14.56)*	0.56 (12.13)*	1.00				
BOND	0.80	3.07	0.20 (3.66)*	0.33 (6.27)*	0.33 (6.27)*	1.00			
CORP	0.79	2.73	0.25 (4.63)*	0.44 (8.79)*	0.38 (7.37)*	0.94 (49.44)*	1.00		
LONG	-0.03	3.25	-0.31 (-5.85)*	-0.32 (-6.06)*	-0.28 (-5.23)*	-0.66 (-15.76)*	-0.68 (-16.64)*	1.00	
HIGH	-0.02	2.18	-0.37 (-7.15)*	-0.32 (-6.06)*	-0.29 (-5.44)*	-0.48 (-9.82)*	-0.52 (-12.79)	0.82 (34.68)*	1.00

Variable	Mean	Std. Dev.	Correlations EREITE	MREITE	MKTE	TERM	DEF	DEFL
EREIT	0.52	3.98	1.00					
MREITE	-0.003	5.67	0.64 (19.45)*	1.00				
MKTE	0.59	4.56	0.64 (19.45)*	0.56 (12.13)*	1.00			
TERM	0.24	3.07	0.21 (3.85)*	0.33 (6.27)*	0.33 (6.27)*	1.00		
DEF	0.07	3.06	-0.20 (-3.66)*	-0.33 (-6.27)*	-0.33 (-6.27)*	-1.00	1.00	
DEFL	-0.003	1.09	0.06 (1.08)	0.18 (3.34)*	0.03 (0.54)	-0.47 (-9.55)*	0.48 (9.82)*	1.00

Variable	Mean	Std. Dev	Correlations BOND	CORP	LONG	HIGH	TERM	DEF	DEFL
BOND	0.80	3.07	1.00						
CORP	0.79	2.73		1.00					
LONG	-0.03	3.25			1.00				
HIGH	-0.02	2.18				1.00			
TERM	0.24	3.07	1.00	0.93 (45.40)*	-0.66 (-15.76)*	-0.49 (-10.09)*	1.00		
DEF	0.07	3.06	-1.00	-0.93 (-45.40)*	0.66 (15.76)*	0.48 (9.82)*	-1.00	1.00	
DEFL	-0.003	1.09	-0.48 (-9.82)*	-0.14 (-2.56)*	0.16 (2.95)*	0.06 (1.08)	-0.47 (-9.55)*	0.48 (9.82)*	1.00

EREIT=Monthly returns for equity REITs.
MREIT=Monthly returns for mortgage REITs.
MKT=NYSE/ASE/NASDAQ monthly value-weighted returns.
BOND=Monthly returns on long-term government bonds.
CORP=Monthly returns on long-term corporate bonds.
LONG=Percentage changes in long-term government bond yields.
HIGH=Percentage changes in Baa corporate bond yields.
EREITE=Monthly returns for equity REITs minus Treasury-bill rate.
MREITE=Monthly returns for mortgage REITs minus Treasury-bill rate.
MKTE=NYSE/ASE/NASDAQ monthly value-weighted returns minus Treasury-bill rate.
TERM=Monthly returns on long-term government bonds minus Treasury-bill rate.
DEF=Monthly yields on Baa corporate bonds minus BOND.
DEFL=Monthly returns on long-term corporate bonds minus BOND.
*represents the significance at the one percent level.
t-values are in parentheses.

DEFL (CORP minus BOND), has much lower correlations with other interest-rate proxies (the bottom of the Table 1). Therefore, DEFL is used to replace DEF, which has perfectly negative correlations with BOND and TERM, in the OLS regression analysis. As expected, BOND and TERM are perfectly negatively correlated, BOND represents returns and TERM represents excess returns, therefore both are kept in the OLS regression analysis: BOND is used as an independent variable for analyzing returns of equity and mortgage REITs, while TERM is used for analyzing excess returns of REITs.

Table 2: OLS Regression Results (January, 1972 through December, 1998)

CONST	MKT	BOND	CORP	LONG	HIGH	MKTE	TERM	DEFL	R^2
Dependent Variable is EREIT									
0.45	0.56	-0.01							0.40
(2.49)**	(13.95)*	(-0.10)							
0.43	0.55		0.02						0.40
(2.41)**	(13.52)*		(0.27)						
0.48	0.52			-0.18					0.42
(2.77)*	(13.43)*			(-3.36)*					
0.49	0.50				-0.37				0.44
(2.89)*	(13.20)*				(-4.47)*				
Dependent Variable is MREIT									
-0.42	0.63	0.31							0.34
(-1.55)	(10.54)*	(3.49)*							
-0.55	0.57		0.56						0.37
(-2.09)**	(9.62)*		(5.69)*						
-0.19	0.64			-0.3					0.34
(-0.71)	(10.85)*			(-3.67)*					
-0.19	0.64				-0.45				0.34
(-0.71)	(10.78)*				(-3.68)*				
Dependent Variable is EREITE									
0.19						0.56	-0.01		0.40
(1.12)**						(14.06)*	(-0.10)		
0.19						0.56		0.14	0.41
(1.13)						(14.86)*		0.92	
Dependent Variable is MREITE									
-0.45						0.63	0.31		0.34
(-1.73)***						(10.57)*	(3.45)*		
-0.41						0.70		0.83	0.34
(-1.58)						(12.32)*		(-3.53)*	

EREIT=Monthly returns for equity REITs.
MREIT=Monthly returns for mortgage REITs.
MKT=NYSE/ASE/NASDAQ monthly value-weighted returns.
BOND=Monthly returns on long-term government bonds.
CORP=Monthly returns on long-term corporate bonds.
LONG=Percentage changes in long-term government bond yields.
HIGH=Percentage changes in Baa corporate bond yields.
EREITE=Monthly returns for equity REITs minus Treasury-bill rate.
MREITE=Monthly returns for mortgage REITs minus Treasury-bill rate.
MKTE=NYSE/ASE/NASDAQ monthly value-weighted returns minus Treasury-bill rate.
TERM=Monthly returns on long-term government bonds minus Treasury-bill rate.
DEFL=Monthly returns on long-term corporate bonds minus BOND.
***represents the significance at the ten percent level.
**represents the significance at the five percent level.
*represents the significance at the one percent level. t-values are in parentheses.

The OLS estimates generally confirm the above correlations between EREIT/MREIT and BOND/CORP/LONG/HIGH. The results suggest that equity REITs are insensitive to changes in BOND (the monthly returns on long-term government bonds) (Table 2). This is consistent with the finding of LMW (1995a). But the coefficient of BOND for EREIT has a negative sign. However, it may be ignored due to its small magnitude (-0.01) and a low t-value (-0.10). Similar to Chen and Tzang (1988) and Sanders (1998), the OLS results clearly indicate that changes in bond yields (HIGH in particular) have significant impacts on EREIT. Both HIGH and LONG have significant coefficients and increased R-square values. When more direct proxies of interest rates (HIGH and LONG) are used, not only are the interest rate sensitivities of EREIT detected, but the explanatory power of the model is also increased.

With the correct signs, coefficients for the four interest rate proxies, BOND, CORP, HIGH and LONG, are statistically significant (at the one percent level) for mortgage REITs. The larger size of the coefficients, compared with equity REITs, suggests that mortgage REITs are more sensitive to changes in interest rates. As fixed-income securities, both mortgages and bonds share many similar fundamentals in the return-generating process. This may be the reason why MREIT, unlike EREIT, has significant coefficients for BOND and CORP. In addition, both MREIT and EREIT are sensitive to HIGH and LONG. Chen and Tzang (1988) used Athe effective duration of real estate@ to explain the difference in interest rate sensitivities between equity and mortgage REITs. According to Hartzell, Hekman and Miles (1987), the effective duration of real estate is a function of the lease structures for equity REITs and maturities of mortgages for mortgage REITs. For most equity REITs, lease terms are renegotiated every three to five years to reflect changes in the market. On the other hand, for mortgage REITs the maturities of underlying mortgages are usually ten years or longer. Therefore, mortgage REITs should be more sensitive to changes in interest rates. Both equity and mortgage REITs use long-term liabilities (debentures, notes, etc.) as financing sources. Therefore, the duration of long-term liabilities may be a factor which can explain the sensitivities of REITs to changes in LONG, because interest rates on long-term government bonds (LONG) do not contain risk premiums. The longer duration of long-term liabilities, the higher is the sensitivity to LONG for equity and mortgage REITs.

There are no major changes in REIT interest rate sensitivities when excess returns are used. Excess returns on equity REITs (EREITE) are insensitive to excess returns on two bond factors, TERM and DEFL. However, sensitivities of MREITE to TERM and DEFL are very significant (at the one percent level) for the entire sample period.

Time variation paths of interest rate sensitivities of equity REITs

Given the high correlations between BOND and CORP (0.94), LONG and HIGH (0.82), and TERM and DEF (-1.00), only BOND, HIGH, TERM, and DEFL are kept in the time variation analysis. The return series of BOND and HIGH, along with MKT, are used as independent variables for EREIT and MREIT; the excess return series of TERM, DEFL and MKTE are used to explain changes in EREITE and MREITE. A smoothing weight of 0.999 is used for all FLS estimations, in order to test the OLS verifications.

Table 3: FLS Estimates (January, 1972 through December, 1998)

CONSTANT	MKT	BOND	HIGH	MKTE	TERM	DEFL
			Dependent Variable is EREIT/EREITE			
0.50[a]	0.52	0.003				
(0.27)[b]	(0.18)	(0.15)				
[0.54][c]	[0.34]	[48.76]				
0.59	0.45		-0.44			
(0.30)	(0.18)		(0.11)			
[0.52]	[0.40]		[-0.24]			
0.24				0.52	0.01	
(0.23)				(0.18)	(0.16)	
[0.97]				[0.35]	[23.75]	
0.29				0.52		0.22
(0.20)				(0.18)		(0.24)
[0.70]				[0.35]		[1.09]
			Dependent Variable is MREIT/MREITE			
-0.28a	0.59	0.36				
(0.31)b	(0.23)	(0.25)				
[-1.13]c	[0.39]	[0.69]				
-0.01	0.59		-0.50			
(0.39)	(0.27)		(0.20)			
[27.13]	[0.45]		[-0.40]			
-0.31				0.59	0.36	
(0.35)				(0.23)	(0.25)	
[-1.13]				[0.39]	[0.69]	
-0.31				0.67		0.77
(0.25)				(0.26)		(0.47)
[-0.79]				[0.39]		[0.61]

EREIT=Monthly returns for equity REITs.
MREIT=Monthly returns for mortgage REITs.
MKT=NYSE/ASE/NASDAQ monthly value-weighted returns.
BOND=Monthly returns on long-term government bonds.
HIGH=Percentage changes in Baa corporate bond yields.
EREITE=Monthly returns for equity REITs minus Treasury-bill rate.
MREITE=Monthly returns for mortgage REITs minus Treasury-bill rate.
MKTE=NYSE/ASE/NASDAQ monthly value-weighted returns minus Treasury-bill rate.
TERM=Monthly returns on long-term government bonds minus Treasury-bill rate.
DEFL=Monthly returns on long-term corporate bonds minus BOND.
[a] Mean of coefficient. [b] Standard deviation. [c] Coefficient of variation.

Results of the FLS estimations provide similar pictures about interest rate sensitivities for equity and mortgage REITs (Table 3) as did the OLS results. That is, the averages of BOND/HIGH/TERM/DEFL coefficients for MREIT/MREITE are larger than that for EREIT/EREITE. Nevertheless, the FLS results also indicate that interest rate sensitivities for MREIT/MREITE are more unstable than those for EREIT/EREITE, since MREIT/MREITE have higher standard deviations for all four sets of coefficients. This result is consistent with previous findings, for example LMW(1995a) and Chen and Tzang (1988).

The time variation paths of interest rate sensitivities for both EREIT/EREITE and MREIT/MREITE traced by the FLS method indicate that these sensitivities are unstable. However, they are not volatile for EREIT/EREITE. Equity REITs do not have significant sensitivities to BOND in any time period (Figure 1). This is similar to the results of LMW (1995a). However, the coefficients of BOND do change over time (from negative to positive). The turning point for BOND is approximately at the end of 1983. That is, in the period from January 1972 through December 1983 returns of equity REITs responded negatively to changes in monthly holding period returns on long-term U.S. government bonds. Since January, 1984 the sensitivity has been positive. The OLS regression results verify these two different kinds (negative vs. positive) of sensitivities in the two periods (Table 4).

Figure 1: Time variation paths (EREIT vs. MKT & BOND)

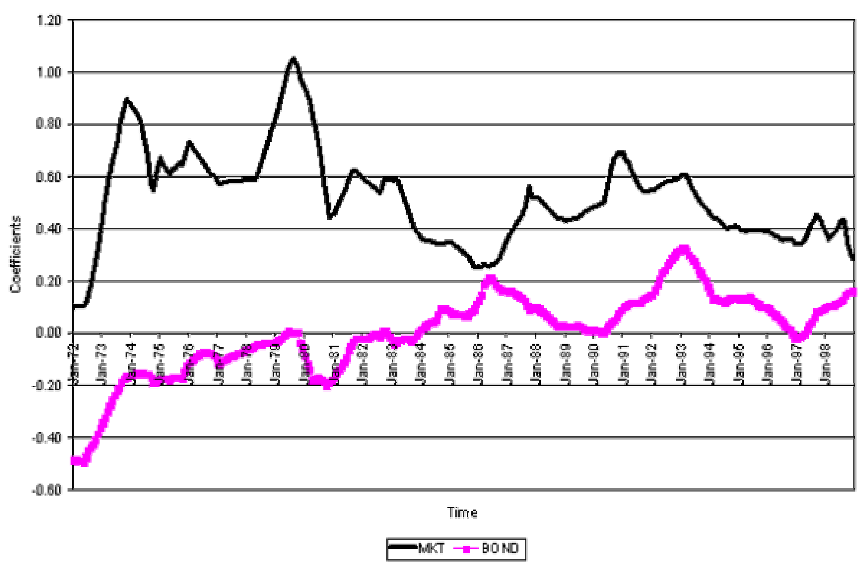
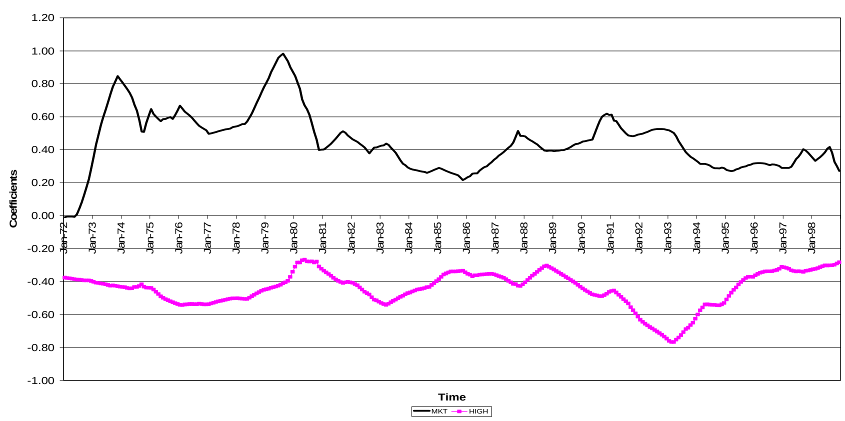


Table 4: OLS Regression Results for EREIT/EREITE in Subperiods

CONSTANT	MKT	BOND	HIGH	MKTE	TERM	R^2
			Jan. 1972 - Dec. 1983 (144 months)			
0.67	0.68	-0.11				0.47
(2.35) **	(10.91) ***	(-1.23)				
			Jan. 1984 - Dec. 1998 (180 months)			
0.26	0.44	0.10				0.34
(1.18)	(8.92)***	(1.32)				
			Jan. 1972 - Dec. 1975 (48 months)			
-0.11	0.58		-0.20			0.36
(-0.18)	(5.16)***		(-0.47)			
			Jan. 1976 - Dec. 1996 (252 months)			
0.76	0.49		-0.38			0.46
(4.31)***	(11.65)***		(-4.89)***			
			Jan. 1997 - Dec. 1998 (24 months)			
-1.03	0.43		-0.46			0.39
(-1.55)	(3.72)***		(-1.30)			
			Jan. 1972 - Dec. 1974 (36 months)			
-0.52				0.58	0.39	0.28
(-0.70)				(3.96)***	(0.76)	
			Jan. 1975 - Jun. 1984 (114 months)			
0.61				0.66	0.75	0.54
(0.71)				(11.16)***	(2.83)***	
			Jul. 1984 - Dec. 1998 (174 months)			
0.05				0.47	-0.13	0.35
(0.22)				(9.55)***	(-0.65)	

EREIT=Monthly returns for equity REITs.
MKT=NYSE/ASE/NASDAQ monthly value-weighted returns.
BOND=Monthly returns on long-term government bonds.
HIGH=Percentage changes in Baa corporate bond yields.
EREITE=Monthly returns for equity REITs minus Treasury-bill rate.
MKTE=NYSE/ASE/NASDAQ monthly value-weighted returns minus Treasury-bill rate.
TERM=Monthly returns on long-term government bonds minus Treasury-bill rate.
DEFL=Monthly returns on long-term corporate bonds minus BOND.
** represents the significance at the five percent level.
*** represents the significance at the one percent level.
t-values are in parentheses.

Figure 2: Time variation paths (EREIT vs. MKT & HIGH)



The time variation path of HIGH coefficients for EREITs (Figure 2) suggests that for a period of twenty-one years (from January 1976 through December 1996) equity REITs had a significant interest rate sensitivity, except for two brief periods from January 1972 through December 1975 and January 1997 through December 1998. When the interest rate sensitivity is significant, the R-squared is high (Table 4). The standard deviations of earnings for the two brief periods are 0.50% and 0.15%, respectively, and 0.86% for the period of 1976 through 1996 (NAREIT) in which EREIT has a significant HIGH sensitivity.

Figure 3: Time variation paths (EREITE vs. TERM & DEFL)

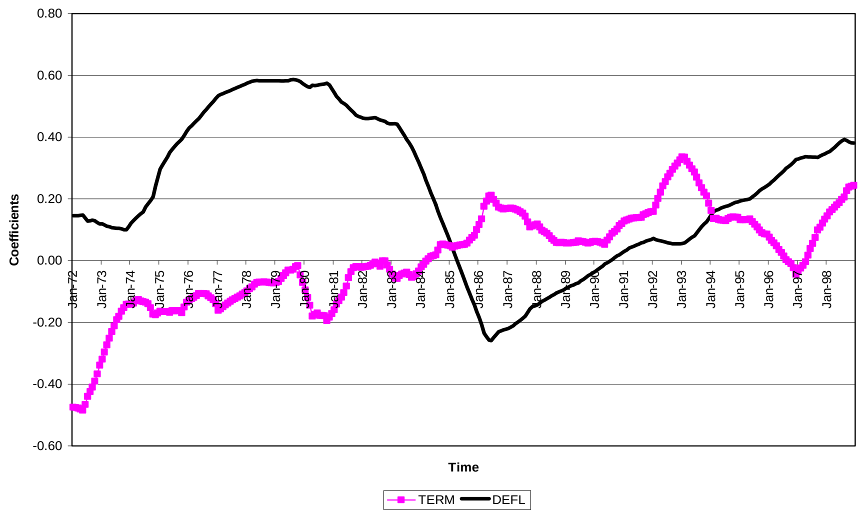


Figure 3 displays sensitivities of EREITE to TERM and DEFL. The time variation path of TERM is virtually the same as that of BOND, as would be expected, since the correlation between BOND and TERM is 1.00 (Figure 1). The time variation path of DEFL shows only two structural switches, one in 1974 and the other in 1986. However, it indicates that EREITE is very sensitive (significant) to DEFL during the period of January 1975 through June 1984. This result is not consistent with the OLS result for the entire 27-year sample period. This suggests insignificant DEFL sensitivity for EREITE (Figure 2). The OLS results in Table 4 verified the three sub-periods suggested by the time variation path. During the period of 1975 through 1984, the coefficient of DEFL is 0.75 which is larger than that for MKTE (0.66) and the R-square is as high as 0.54. This indicates that DEFL was the predominant factor in explaining excess returns for equity REITs in the period (Table 4). DEFL is a default risk measure which is more vigorous than HIGH. EREIT has a significant HIGH sensitivity over the period of 1976 through 1996. Meanwhile, the standard deviation of earnings for equity REITs is extremely high (1.15%) (NAREIT), during the period of January 1975 through June 1984.

Time variation paths of interest rate sensitivities for mortgage REITs

The time variation path of coefficients for monthly holding period returns on long-term U.S. government bonds (BOND) in Figure 4 suggests similar structural switches for mortgage REITs. However, overall, mortgage REITs are much more sensitive to changes in interest rates than equity REITs. The time variation curve indicates that during the period of January 1972 through September 1982 (the first sub-period) MREIT had significant coefficients for BOND. BOND lost this significant impact in the second sub-period (October 1982 through January 1993) and regained it for the period of February 1993 through December 1995 (the third sub-period). These changes are verified by the OLS regression results presented in Table 5. The results reflect dramatic changes in the return pattern for mortgage REITs. The mean monthly return rate in the first period was 0.59% but deteriorated to 0.36% in the second period. The monthly return rate for BOND increased from 0.432% to 1.153% during the same period. The correlation between these two series decreased from 40.36% (t-value of 4.97) to 24.01% (t-value of 2.72). It clearly indicates that the relation between these two series was weakening during the second period. In the third period the two series moved closer again. The correlation increased to 32.44% (t-value of 2.87). This reflects the improvement of returns for mortgage REITs to 0.79% per month in the third sub-period. The monthly return rate for BOND was 0.90% in the same period.

The time variation path of HIGH in Figure 5 indicates structural switches in 1974 and 1986 only. The curve suggests two sub-periods: one before 1986 and the other since 1986. MREIT is more sensitive to HIGH in the first period than the second period. The OLS coefficient of HIGH is -0.54 with a t-value of -3.09 in the first period and -0.36 with a t-value of -2.19 in the second period (Figure 5). The coefficients of HIGH in both periods are significant. The results indicate that HIGH, amongst the seven interest rate proxies, has the strongest explanatory power on returns of mortgage and equity REITs for the most time of the entire 27-year sample period.

Because of the almost identical time variation paths of TERM (Exhibt 9) and BOND (Figure 4), the focus of the analysis is on DEFL, not TERM. The 1974 and 1986 switches are displayed on the time variation curve of DEFL again (Figure 6). The results suggest three sub-periods for the default risk sensitivities of mortgage REITs: the significant sensitivity in the first period of January 1972 through December 1981; the insignificant sensitivity in the second period of January 1982 through December 1989; and a return to significant sensitivity in the third period of January 1990 through December

1998. The three sub-periods are verified by the OLS results in Figure 5. The results suggest that during the period of high inflation (1970s and early 1980s) the default risk (proxied by DEFL) was a major influence on mortgage REITs. Long-term fixed-rate mortgages (FRM) were the predominant type of mortgages in the period. Therefore, changes in DEFL have immediate impacts on the underlying assets (mortgages) of mortgage REITs. The rapid development of mortgage securitization and the secondary market of mortgage related securities in the 1980s greatly increased the liquidity for mortgage REITs and, therefore, significantly reduced the interest rate risk facing mortgage REITs. The default risk sensitivity becomes marginally significant in the 1990s.

Table 5: OLS Regression Results for MREIT/MREITE in Subperiods

CONSTANT	MKT	BOND	HIGH	MKTE	TERM	R^2
			Jan. 1972 - Sep. 1982 (129 months)			
-0.16	0.84	0.43				0.45
(-0.35)	(8.26)***	(2.90)***				
			Oct. 1982 - Dec. 1993 (135 months)			
-0.29	0.41	0.08				0.26
(-0.92)	(5.98)***	(0.84)				
			Jan. 1994 - Dec. 1998 (60 months)			
-0.73	0.65	0.56				0.26
(-1.13)	(4.14)***	(2.37)***				
			Jan. 1972 - Dec. 1985 (168 months)			
0.06	0.80		-0.54			0.44
(0.15)	(9.52)***		(-3.09)***			
			Jan. 1986 - Dec. 1998 (156 months)			
-0.30	0.44		-0.36			0.22
(-0.85)	(5.55)***		(-2.19)**			
			Jan. 1972 - Dec. 1981 (120 months)			
-0.25				0.91	1.13	0.43
(-0.50)				(8.87)***	(2.57)**	
			Jan. 1982 - Dec. 1989 (96 months)			
-0.48				0.49	0.31	0.36
(-1.50)				(7.38)***	(1.30)	
			Jan. 1990 -Dec. 1998 (108 months)			
-0.24				0.57	1.06	0.20
(-0.53)				(5.01)***	(1.82)*	

MREIT=Monthly returns for mortgage REITs.
MKT=NYSE/ASE/NASDAQ monthly value-weighted returns.
BOND=Monthly returns on long-term government bonds.
HIGH=Percentage changes in Baa corporate bond yields.
MREITE=Monthly returns for mortgage REITs minus Treasury-bill rate.
MKTE=NYSE/ASE/NASDAQ monthly value-weighted returns minus Treasury-bill rate.
TERM=Monthly returns on long-term government bonds minus Treasury-bill rate.
DEFL=Monthly returns on long-term corporate bonds minus BOND.
*represents the significance at the ten percent level.
**represents the significance at the five percent level.
***represents the significance at the one percent level. t-values are in parentheses.

Figure 4: Time variation paths (MREIT vs. MKT & BOND)

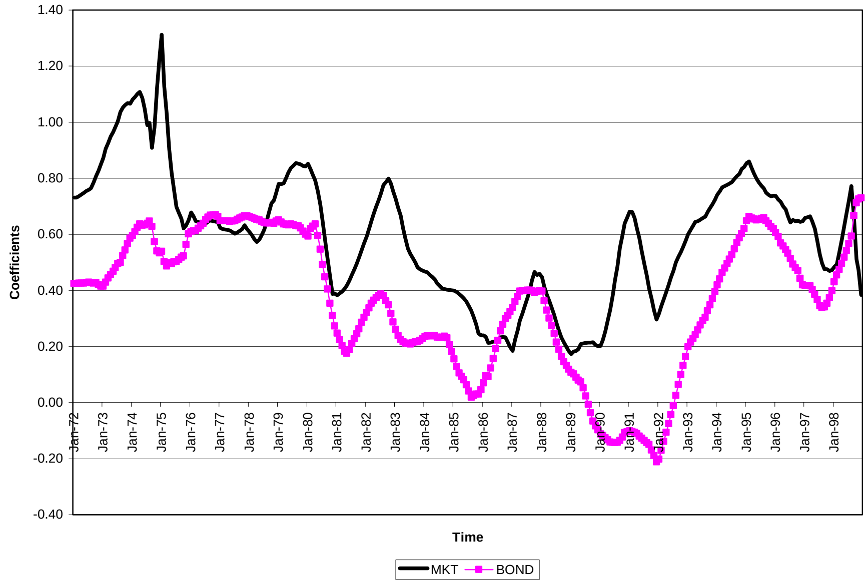


Figure 5: Time variation paths (MREIT vs. MKT & HIGH)

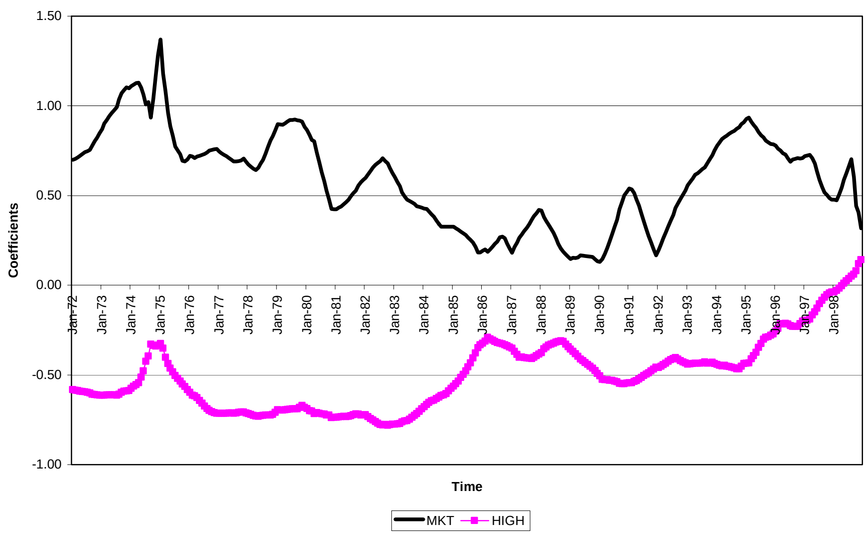
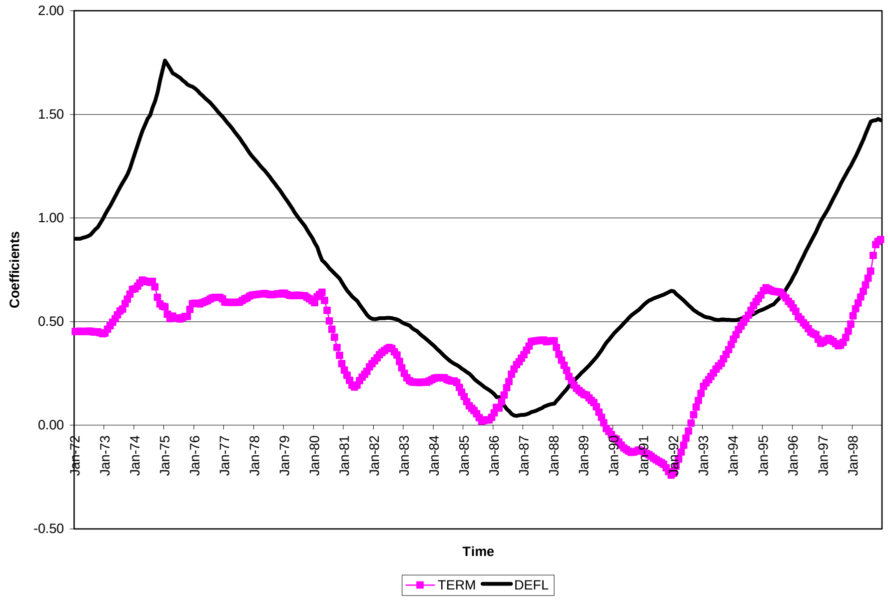


Figure 6: Time variation paths (MREITE vs. TERM & DEFL)



Conclusions

In order to identify effective interest rate proxies for equity and mortgage REITs, this study analyzes seven different interest rate proxies that have been widely used in previous studies: the monthly holding period returns on long-term U.S. government bonds (BOND) and high-grade corporate bonds (CORP), the percentage changes in yields for long-term U.S. government bonds (LONG) and high-yield (Baa) corporate bonds (HIGH), the difference between returns on long-term U.S. government bonds and T-bill rates (TERM), the spread between yields on high-yield (Baa) corporate bonds and BOND (DEF), and the spread between CORP and BOND (DEFL). Some proxies are substitutable for each other, due to perfect correlations (positive or negative). For example, TERM and DEF (-1.00), TERM and BOND (1.00), and DEF and BOND (-1.00). Other highly correlated series that should not be used at the same time are: CORP and BOND (0.94), TERM and CORP (0.93), DEF and CORP (-0.93), and LONG and HIGH (0.82).

The OLS results for the entire 27-year sample period suggest that only changes in bond yields (HIGH in particular) have a significant impact on the returns of equity REITs. Effects of all the other proxies were not significant. Unlike equity REITs, mortgage REITs were sensitive to all proxies.

The time variation paths for coefficients of interest rates reveals additional detailed information about interest rate sensitivities for equity and mortgage REITs. That is, all interest rate sensitivities are time specific. The overall OLS results indicate that equity REITs are insensitive to DEFL. However, the FLS results show a significant DEFL sensitivity for equity REITs during the period of January, 1975 through June, 1984. This is verified by the OLS results for this period. DEFL (the spread between returns on high-grade corporate bonds and long-term government bonds) is a better default risk measure than HIGH (the changes in yields on high-yield corporate bonds).

The FLS results indicate that interest rate sensitivities for mortgage REITs are not significant at all times. The BOND sensitivity for mortgage REITs is insignificant over the period of October 1982 through December 1993. It reflects the deteriorated returns for mortgage REITs and the increased returns for long-term U.S. government bonds. Generally speaking, changes in the BOND sensitivity are consistent with changes in total returns for mortgage REITs and long-term U.S. government bonds. As an interest proxy, HIGH has the strongest explanatory power among the seven proxies on returns of equity and mortgage REITs for most of the 27-year sample period.

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