Intertemporal Changes in the Riskiness of REITs

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***Abstract*. This study investigates the variability in the risk components of REITs over the 1973–1989 period using the cusum test, the cusum of squares test, and the Quandt's log-likelihood ratio method. Four REIT portfolios were formed: an all-REIT portfolio, an equity REIT portfolio, a hybrid REIT portfolio, and a mortgage REIT portfolio. The two-index model was employed and the results indicated that both the market *beta* and the interest-rate *beta* of the portfolios were time-varying. In addition, significant shifts in return-generating regimes over time were detected for all four portfolios.**

Introduction

REITs are pooled real estate funds that provide individual investors, as well as institutional investors, the opportunity to invest in securitized real properties and mortgages. REITs can be classified into three basic groups: equity REITs, mortgage REITs and hybrid REITs. Equity REITs acquire equity interests in real property, while mortgage REITs purchase mortgage obligations. Hybrid REITs do both. Historically, equity REITs invested heavily in commercial properties, such as retail centers, office buildings, industrial complexes, and healthcare facilities, while mortgage REITs invested heavily in residential mortgages (e.g., 69.2% in 1990, according to the *REIT Sourcebook*, 1990).

The inability of institutional real estate investors to get their money out of commingled real estate funds in recent years has focused attention on liquidity. Since many REIT stocks are publicly traded, they provide a relatively liquid mechanism for investing in real estate. However, as with all risky assets, the level of risk, the determinants of risk, and the changes in risk over time are important matters. It is often desirable to know whether or not a risky asset's *beta* has changed and, if so, at what point in time the change occurred. This knowledge is of obvious importance to *beta*-using security analysts and portfolio managers. In addition, tests are frequently performed on the effects of specific events on the residuals of the market model or the two-index model and such tests require the assumption of *beta* stability. For these, and possible other reasons, it is useful to know if a change in *beta* took place and to identify the point in time at which the change occurred. This study examines market *beta* and interest-rate *beta* behaviors of REITs (equity, mortgage and hybrid) to determine if they vary over time and if so, when risk levels changed.

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Date Revised—November 1994; Accepted—January 1995.

Literature

A REIT does not pay corporate taxes if it meets four separate tests on a yearly basis. These tests concern organizational structure sources of income, nature of assets, and distribution of income. For example, a tax-qualified REIT has to distribute at least 95% of its net income to its shareholders in the form of dividends. Because of this pass-through feature, REITs generally have high dividend yields. Existing research indicates that other high-dividend-yield stocks, such as utilities, are sensitive to interest-rate changes (Sweeney and Warga, 1986). Consequently, REITs may also possess a high degree of sensitivity to interest-rate fluctuations (Mengden, 1988); Hartzell, Shulman, Langetieg and Liebowitz, 1987). Mortgage REITs may be more sensitive to interest-rate changes than REITs in general, since they primarily hold mortgages, some of which have long durations.

Chen and Tzang (1988) addressed the issue of whether REITs are sensitive to changes in short-term and long-term interest rates for the period 1973–1985. REITs were found to be interest-rate sensitive and the sources and magnitude of interest-rate sensitivity were found to be different for equity versus mortgage REITs. In addition, REIT interest-rate sensitivities were found to be different for different time periods. Titman and Warga (1986) analyzed the risk-adjusted performance of a sample of REITs using both single-index and multiple-index models. One of the two-index models had an interest-rate factor. Their results indicate that the estimated performances using different models differ substantially. Recently, Chan, Hendershott and Sanders (1990) found that three factors, in addition to the percentage change in the discount on closed-end stock funds, consistently drive equity REIT returns. The three factors are: unexpected inflation, changes in risk, and the term structure of interest rates.

Apparently, the performance of REITs, especially mortgage REITs, is sensitive to interest-rate changes. However, the interest-rate sensitivities appear to change over time. Before the Federal Reserve changed its operating procedures in October 1979, shifting from interest-rate targeting toward money-supply targeting, interest rates were relatively stable (Kane and Unal, 1988). In the stable interest-rate period, residential mortgages held by mortgage REITs were primarily long-term fixed-rate mortgages and many of the commercial mortgages were intermediate-term. Adjustable-rate mortgages became popular in the 1980s because of volatile interest rates and consequently mortgage REITs could hold a large portion of their assets in adjustable-rate mortgages for the first time (Clauretie and Webb, 1993). Of course, the shorter the duration of the REIT mortgage portfolio, the less sensitive the REIT should be to interest-rate changes. The 1976 Tax Reform Act (TRA) and the 1986 TRA contain many changes that influence the real estate industry (Sanger, Sirmans and Turnbull, 1990; Allen, 1977; Fisher and Lentz, 1986). Some of these changes severely reduce the attractiveness of real estate as an investment vehicle relative to other assets, e.g., the passive loss limitations, the at-risk limitations, and the change in the capital gains tax rate. The REIT industry also experienced numerous changes during the 1970s. The change of investors' sentiment, the changes in Federal Reserve policy, the creation of new financial instruments, and the TRAs are major underlying factors that could change the return-generating process of REITs.

Glascock (1991) examined the return behavior of a portfolio of publicly traded real estate firms including a subset of REITs. He found that the *beta* of these firms shifted procyclically. Khoo, Hartzell and Hoesli (1993) found that *betas* on equity REITs underwent a structural shift in the past twenty years. They showed that this was the result of the lower variability of equity REIT returns and argued that the decrease in the standard deviation of equity REITs could be attributed to the increasing levels of information about equity REITs. This study employs a switching regression technique developed by Brown, Durbin and Evans (BDE) (1975) to identify the specific regimes of the return-generating process for REITs over the 1973–1989 period. We use the two-index model and focus on tax-qualified equity REITs, hybrid REITs and mortgage REITs.

Methodology

The assumed return-generating process for this study is the two-index model. This asset pricing model expands the familiar single-index model of asset returns by adding an interest-rate index as a quasi-industry factor.

Previous research results have indicated that long-term interest rates have a significant effect on bank returns (Flannery and James, 1984). Sweeney and Warga (1986) showed that high-dividend payout stocks such as utility companies are very sensitive to the change in long-term interest rates. Chen and Tzang (1988) found that REITs were sensitive to changes in long-term interest rates for their whole study period (1973–1985) and that only in the second half of the sample period were REITs found to be sensitive to changes in short-term rates. In this study, the unadjusted monthly holding period returns on long-term government bonds are used to proxy the unanticipated changes in interest rates. Since holding period returns are negatively correlated with changes in the levels of interest rates, a positive value for the interest rate *beta* implies that the firm's market value declines when interest rates rise.

The two-index regression model used in this study is:

$$R_t = a + b_{M,t}R_{M,t} + b_{I,t}R_{I,t} + u_t,\ t = 1, \ldots, T \ , \tag{1}$$

where at time t, R_t is the REIT portfolio return, $R_{M,t}$ is the market return, and $R_{I,t}$ is the long-term government bond holding period return.[1] T is the total number of observations. $b_{M,t}$ and $b_{I,t}$ are the market *beta* and the interest-rate *beta,* respectively, and are written with the subscript t to indicate that they may vary over time. The error terms, u_t, are assumed independent and normally distributed with mean zero and variances σ_t^2, $t=1, \ldots, T$. The number of regressors is 3 and is denoted by k ($k=3$). The null hypothesis of constancy over time, H_0, is:

$$b_{M,1} = b_{M,2} = \ldots = b_{M,T} = b_M \tag{2}$$

$$b_{I,1} = b_{I,2} = \ldots = b_{I,T} = b_I \tag{3}$$

$$\sigma_1^{\,2} = \sigma_2^{\,2} = \ldots = \sigma_T^{\,2} = \sigma^2 \ . \tag{4}$$

It is customary to examine the residuals in order to investigate departures from model specification. Both the cusum test and the cusum of squares test developed by BDE

(1975) are based upon recursive residual behaviors. The recursive residuals are denoted by w_r, $r=k+1, \ldots, T$, and are defined (BDE, 1975, p. 151) as:

$$w_r(y_r - x_{r'}b_{r-1})/(1 + x_{r'}(X'_{r-1}X_{r-1})^{-1}x_r)^{1/2}, \tag{5}$$

where:

y_r = the observation on the dependent variable,
x_r = the column vector of observations on the k regressor,
X'_{r-1} = $(x_1, \ldots, x_{r-1})$,
b_r = $(X_{r'}X_r)^{-1}X_{r'}Y_r$, and
$Y_{r'}$ = $(y_1, \ldots, y_r)$.

The numerator of equation (5) may be interpreted as a one-period prediction error. BDE (1975) show that under the null hypothesis of stationarity, recursive residuals are uncorrelated with zero mean and constant variance and, therefore, are independent under the normality assumption. Recursive residuals are preferable to OLS residuals for detecting structural changes because until such a change takes place, the recursive residuals behave exactly as specified by the null hypothesis.

Cusum (W_r) is defined as:

$$W_r = \frac{1}{s}\sum_{j=k+1}^{r} w_j, \tag{6}$$

where s denotes the estimated standard deviation (the ratio of the residual sum of squares to $(T-k)$ when the regression is fitted to the T observations). From the properties of the w_r's under H_0, the sequence $W_{k+1}, \ldots, W_r$ is a sequence of approximately normal variables such that the expected value and variance of W_r are zero and $(r-k)$, respectively. W_r is plotted against r for $r=k+1, \ldots, T$. In addition, two symmetric significance lines that pass through the two points $\{k, \pm c(T\text{-}k)^{1/2}\}$, $\{T, \pm 3c(T\text{-}k)^{1/2}\}$, are plotted, where c is a parameter. Parameter c is related to the significance level. Useful values of c and the significance levels are: $c=1.143$ for 1% significance, $c=.948$ for 5% significance, and $c=.850$ for 10% significance. If the cusum path travels outside the region between the two lines, the null hypothesis of constancy (H_0) will be rejected at the significance level indicated by the appropriate c parameter.

Cusum of squares (S_r) is defined as:

$$S_r = \left(\sum_{j=k+1}^{r} w_j^2\right) / \left(\sum_{j=k+1}^{T} w_j^2\right), \tag{7}$$

where $S_r(r=k+1, \ldots, T)$ is a monotonically increasing sequence of positive numbers with $S_T=1$. Under the null hypothesis of stationarity, S_r follows a *beta* distribution with a mean of $(r-k)/(T-k)$. The cusum of squares test is performed by plotting S_r against r for $r=k+1, \ldots, T$. The two significance lines will be plotted on the same graph: $\pm c^2 + (r-k)/(T-k)$, where $r=k+1, \ldots, T$. If S_r travels outside of the two lines, the null hypothesis will be rejected at the significance level indicated by the c^2 parameter. The relationship between the significance level, the degrees of freedom and c^2 has been tabulated by Durbin (1969) (Table 1, p. 4). For example, for the two-tailed test with d.f.=201, c^2=.155 for 1% significance, c^2=.128 for 5% significance, and c^2=.115 for 10% significance.

Besides the graphic approach, two test statistics can be derived from the significance lines. The cusum test statistic (C) and the cusum of squares test statistic (C^2) are defined as:

$$C = \text{Max}(C_{k+1,\ldots,} C_T), \tag{8}$$

$$C^2 = \text{Max}({C^2}_{k+1,\ldots,} {C_T}^2), \tag{9}$$

where

$$C_r = \left| W_r(T-k)^{1/2} / (T + 2r - 3k) \right|, r = k+1, \ldots, T \tag{10}$$

$$C_r^{\ 2} = \left| S_r - (r-k)/(T-k) \right|, r = k+1, \ldots, T\,. \tag{11}$$

| | is the absolute value notation. The critical values of C are given by parameter c and the critical values of C^2 are given by parameter c^2.

Since recursive residuals can be calculated forward as well as backward, the cusum test and the cusum of squares test are performed using both forward and backward recursive residuals. This study uses both the cusum test and the cusum of squares test (forward and backward) to test the parameters of the regression for stability. If the tests reject the hypothesis that the parameters are stable over the regression period, and if an assumption is made that any change over time may be concentrated at a single, unknown point, the Quandt's log-likelihood ratio can be used to determine the point of change. The Quandt's method involves calculating for each r from $r=k+1$ to $r=T-(k+1)$ the ratio (for details of this matter, see Quandt, 1958, 1960):

$$L_r = \text{Log}_{10}\left\{\frac{\text{Maximum Likelihood of the Observations Given } H_0}{\text{Maximum Likelihood of the Observations Given } H_1}\right\}, \tag{12}$$

where H_0 is the null hypothesis of parameter stationarity, and H_1 is the alternative hypothesis of a structure change at point r. The statistic L_r is a standard likelihood ratio for deciding between the two hypotheses, H_0 and H_1, and it can be shown that:

$$L_r = \tfrac{1}{2} r \log(s_1^2) + \tfrac{1}{2}(T-r)\log(s_2^2) - \tfrac{1}{2} T \log(s^2), \tag{13}$$

where $s_1{}^2$, $s_2{}^2$, and s^2 are the ratios of the residual sums of squares to the number of observations when the regression is fitted to the first r observations, the remaining ($T-r$) observations, and the T observations, respectively. When L_r attains its minimum value, the return-generating process experiences its peak change. Unfortunately, no test of significance has been devised yet for minimum L_r since its distribution under H_0 is unknown. However, if a structural change is indicated by the cusum or the cusum of squares test, the minimum L_r provides useful information about the timing of the peak structural change.

Since there might be more than one switching point or more than two return-generating regimes for our sample period (1973–1989), the following procedure is used to exhaust all possible switching points or to identify all possible return-generating regimes. First, the cusum test and the cusum of squares test are applied to the whole sample period. If one or both of the tests reject the null hypothesis of stationarity, then the point with the minimum Quandt's log-likelihood ratio will be chosen as the first switching point. Hence, the two return-generating regimes separated by this switching point are identified. Second, the cusum and the cusum of squares tests are separately applied to the two regimes already identified. If one or both of the tests reject the stationarity hypothesis, then Quandt's log-likelihood ratio is again used to locate switching points within each of the two regimes. Third, the above procedure is repeated until both of the cusum and the cusum of squares tests fail to reject the null hypothesis of stationarity within each regime previously identified. The cusum and the cusum of squares test are used to determine the significance and Quandt's log-likelihood ratios are used to locate the switching point. Since the exact distribution of the L_r under the null hypothesis is unknown, we cannot attach significance levels to likelihood ratios. However, the term "significant" regime means that the regime is identified by the significance tests of the cusum and the cusum of squares.

Please note that the cusum and the cusum of squares test may give different results because departures from constancy may show themselves in different ways. The power of the tests depends upon the specific situations encountered. For example, a run of large recursive residuals with alternating signs may cause the cusum of squares test to show significant results, but not the cusum test. In a relatively long time period, as it is the case in this study, the cusum of squares test should be more powerful in detecting structural shifts. Also, effects of serial correlation in the OLS residuals on the performance of cusum and cusum of squares tests are not considered.[2] This study uses the TIMVAR program developed by the Economist Support Group in the Data Processing Division of the International Monetary Fund.

In addition to the above, this study also estimates the moving regression coefficients for each of the four portfolios. Over the sample period, January 1973 to December 1989, the first five-years' monthly data is used to obtain the market and interest-rate *beta* in that five-year interval. To obtain the market *beta* and interest-rate *beta* for the second five-year interval, the first observation is dropped and the 61st observation is added. This procedure is repeated until the end of the sample period. With this process, the market and interest-rate *beta*s for each five-year interval are obtained. The *betas* (market *beta* and interest-rate *beta*) are the average risks of the portfolio during each five-year interval. The monthly moving *betas* may provide some insights into the shifting of the return-generating process for the REIT portfolios.

Data

A list of tax-qualified REITs and their type (equity, hybrid, or mortgage) from 1973 to 1989 were supplied by the National Association of Real Estate Investment Trusts. The return information for the sample REITs is from the daily data tapes prepared by the Center for Research in Security Prices (CRSP) at the University of Chicago. The sample period is 1973–1989. Since the CRSP NASDAQ data start at the middle of 1972 and some of the REITs in the sample are listed on the NASDAQ, 1973 was the first year used in this study. Daily returns were compounded into monthly returns. Four equally weighted portfolios were constructed: an all-REIT portfolio, an equity REIT portfolio, a hybrid REIT portfolio, and a mortgage REIT portfolio. An equally weighted monthly return index is calculated for each portfolio.

The market index in the two-index model is the equally weighted market return index, including dividends, from the NYSE/ASE CRSP tape.[3] The interest-rate index is the monthly holding period return index of the long-term government bonds, as given by Ibbotson Associates and published in *Stocks, Bonds, Bills, and Inflation – 1990 Yearbook.*

Empirical Results

Regime Identification

Exhibit 1 gives the regression results for the two-index model over the entire study period (1973–1989). The market *betas* of the four portfolios are smaller than 1, indicating that the average market risk of REITs is below market average. Over the sample period, mortgage REITs have the highest market risk (.77) and equity REITs have the least market risk (.54).[4] Since the all-REIT portfolio and the hybrid REIT portfolio can be viewed as combinations of equity REITs and mortgage REITs, the markets *betas* of the two portfolios are logically between those for equity REITs and mortgage REITs. The mortgage REIT portfolio has the highest interest-rate *beta* and residual risk (σ) while the equity REIT portfolio has the lowest interest-rate *beta* and residual risk. The equity REIT portfolio also has an insignificant interest-rate *beta.* In short, mortgage REITs are considerably riskier than equity REITs in terms of systematic risk (market *beta* and interest-rate *beta*) and unsystematic risk (residual risk).

The cusum test and the cusum of squares test results for the all-REIT portfolio are presented in Exhibit 2 and Exhibit 3, respectively. Both the cusum test and the cusum of squares test rely upon transformation of forward recursive residuals or backward recur-

Exhibit 1
Estimated Market and Interest-Rate *Betas* for REIT Portfolios (1973–1989)

REIT Portfolio	b_M	b_I	σ	R^2
All	.697***	.088*	.031	.67
	(19.41)	(1.35)		
Equity	.544***	-.005	.026	.65
	(18.81)	(-.10)		
Hybrid	.735***	.131*	.042	.57
	(15.49)	(1.50)		
Mortgage	.767***	.200**	.045	.56
	(15.05)	(2.14)		

σ is the residual risk of the portfolio.
t-statistics are in parentheses.

*significance at the 10 % level (one-tailed test)
**significance at the 5% level (one-tailed test)
***significance at the 1% level (one-tailed test)

Exhibit 2
Cusum of Forward Recursive Residuals
(All-REIT Portfolio)

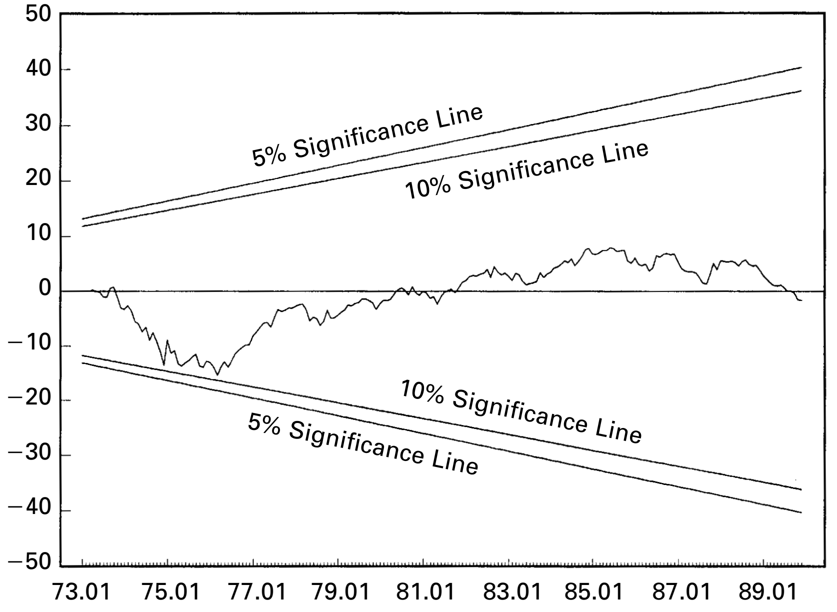
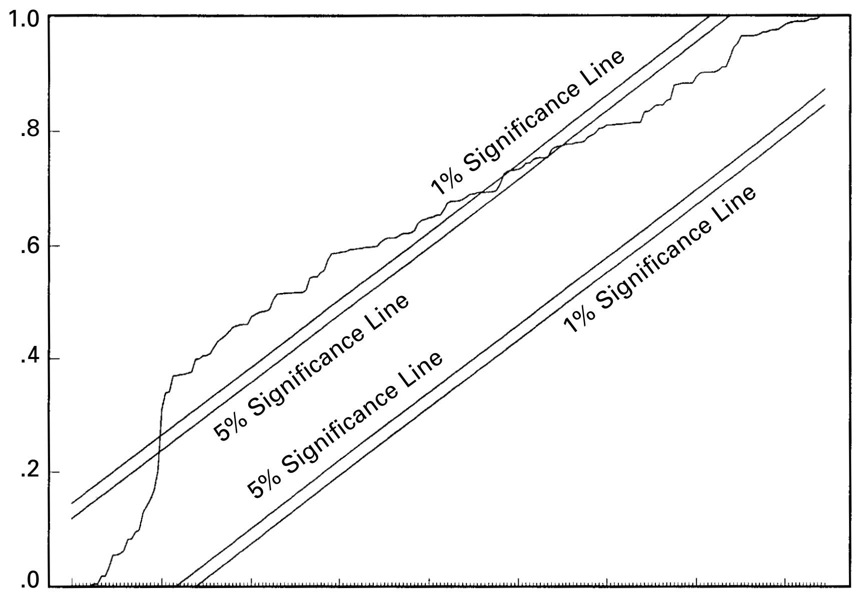


Exhibit 3
Cusum of Squares of Forward Recursive Residuals
(All-REIT Portfolio)

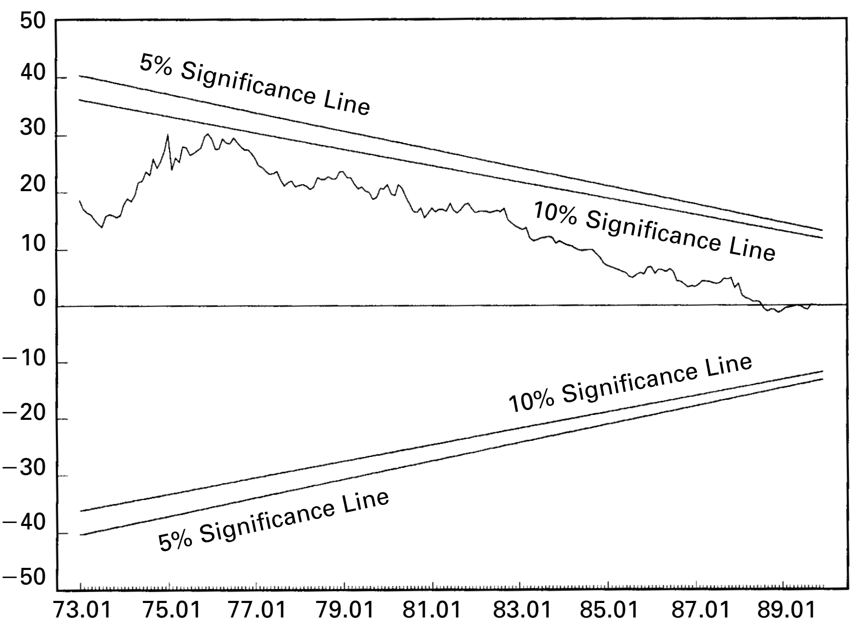


sive residuals. The results shown in Exhibit 2 and Exhibit 3 are obtained from the cusum of the forward recursive residuals and the cusum of squares of the forward recursive residuals, respectively. As Exhibit 2 shows, the W_r (cusum quantity) fails to cross either the 5% significance line or the 10% significance line for the all-REIT portfolio. Hence the cusum test fails to reject the null hypothesis for that portfolio. As a matter of fact, only the W_r for the equity REIT portfolio crosses the 10% significance line and the W_r's for all four portfolios fail to cross the 5% significance line. However, the cusum of squares test rejects the hypothesis at the 5% and at the 1% significance levels (Exhibit 3). The cusum of squares tests reject the null hypothesis of constancy over the sample period for all four REIT portfolios at the 1% level. These results indicate that the return-generating process for all four REIT portfolios changed over the time period concerned.

Exhibits 4 and 5 show the cusum and cusum of squares test using the backward recursive residuals for the all-REIT portfolio. Again, the cusum quantities (W_r's) fail to cross either the 5% or the 10% significance lines and S_r's cross both the 5% significance line and the 1% significance line. As a matter of fact, none of the W_r's crosses the 10% significance lines for all four portfolios. However, all the S_r's cross the 1% significance lines for all four portfolios. As mentioned before, the cusum of squares test should be more powerful than the cusum test due to the long period concerned.

Exhibit 6 presents the test results in an alternative form. The cusum test fails to reject the null hypothesis at the 5% level for all four portfolios, using either the forward or backward recursive residuals. The critical values for C are given by parameter c. The critical values of C^2 are given by parameter c^2. The cusum of squares test statistic (C^2)

Exhibit 4
Cusum of Backward Recursive Residuals
(All-REIT Portfolio)



rejects the constancy hypothesis at the 1% level for all four REIT portfolios, using either the forward or backward recursive residuals.

Next, the Quandt's log-likelihood ratios are used to ascertain the points of change. The point with the lowest likelihood ratio is the most likely point at which the return-generating process changed. Exhibit 7 demonstrates that the first most likely switching point for the all-REIT portfolio is March 1976. The first most likely switching points for

Exhibit 5
Cusum of Squares of Backward Recursive Residuals
(All-REIT Portfolio)

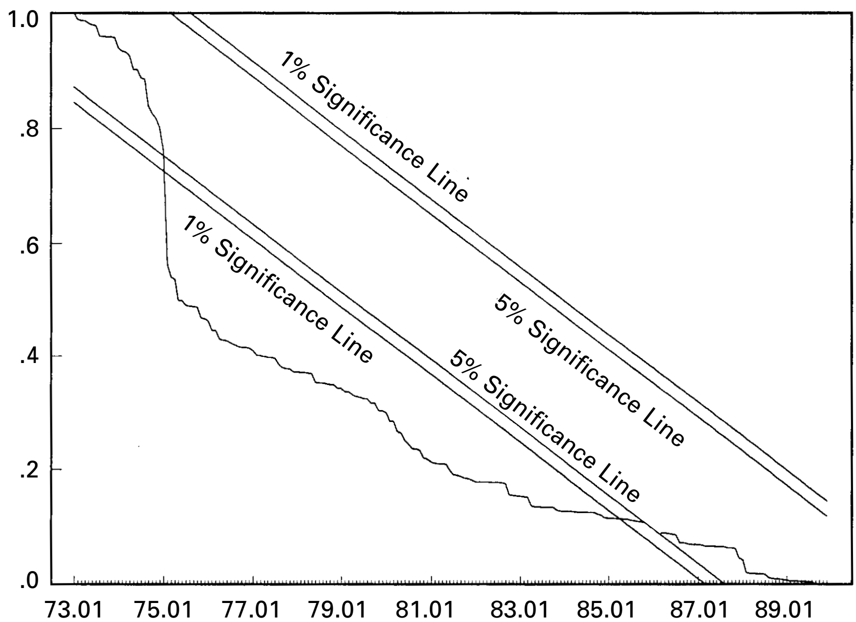


Exhibit 6
The Cusum Test and the Cusum of Squares Test Results
(1973–1989)

	Backward Recursion		Forward Recursion	
REIT Portfolio	C	C^2	C	C^2
All	.8064	.3758***	.7995	.2514***
Equity	.7054	.2023***	.8850*	.1976***
Hybrid	.6892	.2711***	.6952	.2241***
Mortgage	.7732	.3970***	.5841	.2361***

C is the cusum test statistic: C^2 is the cusum of squares test statistic. C and C^2 can be calculated using either forward recursive residuals or backward recursive residuals.

*significance at the 10 % level (two-tailed test)
**significance at the 5% level (two-tailed test)
***significance at the 1% level (two-tailed test)

the equity REIT portfolio, the hybrid REIT portfolio, and the mortgage REIT portfolio are March 1983, September 1981 and June 1980, respectively. In addition, the magnitude of Quandt's log-likelihood ratio for the mortgage REIT portfolio is much larger than for the equity REIT portfolio, which indicates that the return-generating process for the mortgage REIT portfolio is considerably more time-varying than the equity REIT portfolio. The all-REIT portfolio and the hybrid REIT portfolio experienced moderate instability, relative to the equity and mortgage REIT portfolios.

The above procedure was repeated separately over the two return-generating regimes already identified for each portfolio. As a matter of fact, the procedure was repeated until both the cusum and the cusum of squares tests fail to reject the null hypothesis of stationarity within each regime previously identified. The switching points that separate

Exhibit 7
Quandt's Log-Likelihood Ratios

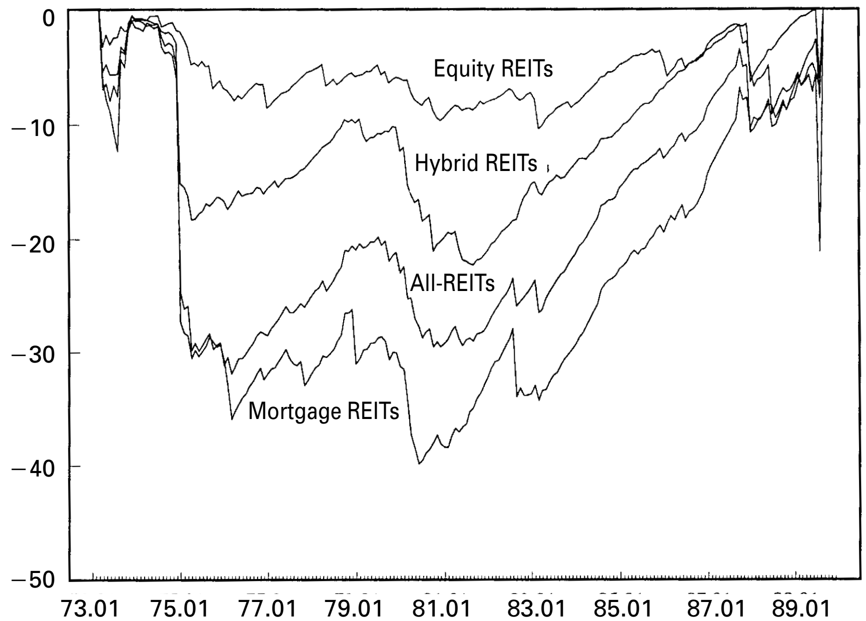


Exhibit 8
Switch Points That Separate the Return-Generating Regimes

	Switching Points			
Portfolio	1 (1976)	2 (1980)	3 (1983)	4 (1986)
All	03/76	10/80	04/83	07/85
Equity	n/a	n/a	03/83	n/a
Hybrid	04/75	09/81	n/a	09/87
Mortgage	03/76	06/80	03/83	n/a

the significant regimes for the four portfolios are reported in Exhibit 8. The results indicate that switching points most likely occurred in the neighborhood of the following years: 1976, 1980, 1983, and 1986. There are four switching points (five-regime) for the all-REIT portfolio, three switching points (four-regime) for the hybrid REIT portfolio and for the mortgage REIT portfolio. However, only one switching point (two-regime) was identified for the equity REIT portfolio.

The parameter estimates for the two-index model over different regimes are reported in Exhibit 9. For the all-REIT portfolio, the market *beta* dropped from .87 to .33 and then came back to .41 recently. REITs are interest-rate sensitive in three out of the five regimes. The equity REIT portfolio has much smaller and more stable markets *betas*. The average market risk for equity REITs was .58 before 1983 and .45 after 1983. The market risk for hybrid REITs declined first (from .97 to .28) and then increased recently (from .28 to .57). Hybrid REITs were interest-rate sensitive for most of the 1980s. Mortgage REITs experienced the most reduction in market risk during the seventeen years concerned, dropping from 1.08 to .34. The interest-rate sensitivity of mortgage REITs is smaller in the 1980s (the last two regimes) than in the 1970s (the first two regimes).

To confirm that structural changes indeed occurred over different regimes, the Chow test was used for all four portfolios. The F-statistics were all significant at the 1% level for all paired adjacent regimes. The changing return-generating process for REIT securities seems to be largely driven by mortgage REITs. Equity REIT risk remained relatively stable and was not sensitive to changes in interest rates.

The Moving Regression Results

The moving market *betas* for the four portfolios are presented in Exhibits 10 and 11. Each point *beta* is calculated using the previous five-year's monthly information and hence should be interpreted as the average market risk during the previous five years. The market *beta* for the mortgage REIT portfolio was the highest in the 1970s, declined dramatically in late 1970s and early 1980s, and gradually declined in the 1980s. The market risk for the equity REIT portfolio was relatively stable in the 1970s and early 1980s and declined a little in the late 1980s. Exhibit 10 confirms the previous results that the market *beta* for the equity REIT portfolio is relatively stable compared to the market *beta* for the mortgage REIT portfolio. The market *beta* behaviors for the all-REIT portfolio and the hybrid REIT portfolio are similar, as Exhibit 11 shows.

The moving interest-rate *betas* for the all-REIT portfolio and the mortgage REIT portfolio are presented in Exhibit 12. The moving interest-rate *betas* for the equity REIT portfolio are omitted because of the lack of significance. The moving interest-rate *betas* for the hybrid REIT portfolio are not presented because they are essentially the same as those for the all-REIT portfolio. The three REIT portfolios (especially the mortgage REIT portfolio) reached the highest levels of interest-rate sensitivity approximately in 1978.

Some Implications

The observed pattern of coefficient changes indicates that the riskiness of REIT securities changed significantly over time. The switch points found in this study may be attributed to changes in the operating environment for the REIT industry. The 1976

Exhibit 9
Return-Generating Regimes for the REIT Portfolios

REIT Portfolio	Regime	Time Period	b_M	b_I	σ	R^2
All	1	01/73–02/76	.870***	.384	.048	.77
			(10.72)	(1.11)		
	2	03/76–09/80	.678***	.149*	.025	.74
			(10.90)	(1.37)		
	3	10/80–03/83	.555***	.025	.025	.59
			(5.49)	(.23)		
	4	04/83–06/85	.326***	.173***	.011	.73
			(6.91)	(2.85)		
	5	07/85–12/89	.413***	.119*	.021	.56
			(7.65)	(1.40)		
Equity	1	01/73–02/83	.581•••	−.052	.029	.67
			(15.40)	(−.68)		
	2	03/83–12/89	.446***	.058	.025	.65
			(10.11)	(.88)		
Hybrid	1	01/73–03/76	.972***	.423	.067	.71
			(7.57)	(.73)		
	2	04/76–08/81	.770***	.091	.040	.58
			(9.38)	(.59)		
	3	09/81–08/87	.284***	.333***	.023	.48
			(4.45)	(4.57)		
	4	09/87–12/89	.570***	.122	.038	.48
			(4.77)	(.13)		
Mortgage	1	01/73–02/76	1.084***	.526	.067	.73
			(9.51)	(1.08)		
	2	03/76–05/80	.697***	.506***	.039	.63
			(6.77)	(2.72)		
	3	06/80–02/83	.423***	.158	.033	.38
			(3.47)	(1.22)		
	4	03/83–12/89	.338***	.184**	.024	.40
			(6.34)	(2.32)		

t-statistics are in parentheses.
*significance at the 10% level (one-tailed test)
**significance at the 5% level (one-tailed test)
***significance at the 1% level (one-tailed test)

switch was likely driven in large part by the TRA of 1976. The 1976 tax act contained many changes that influenced the real estate industry (Halpern, 1978; Sanger, Sirmans and Turnbull, 1990). The major goal of legislators in drafting the 1976 TRA was to limit or eliminate the availability of various tax shelters that were considered to be abusive. The major changes affecting real estate in general dealt with the requirement to capitalize construction period interest, implementation of depreciation recapture on residential income properties, tightening of the minimum tax requirements, extension of the capital

Exhibit 10
Moving Market *Betas* for Equity REITs and Mortgage REITs

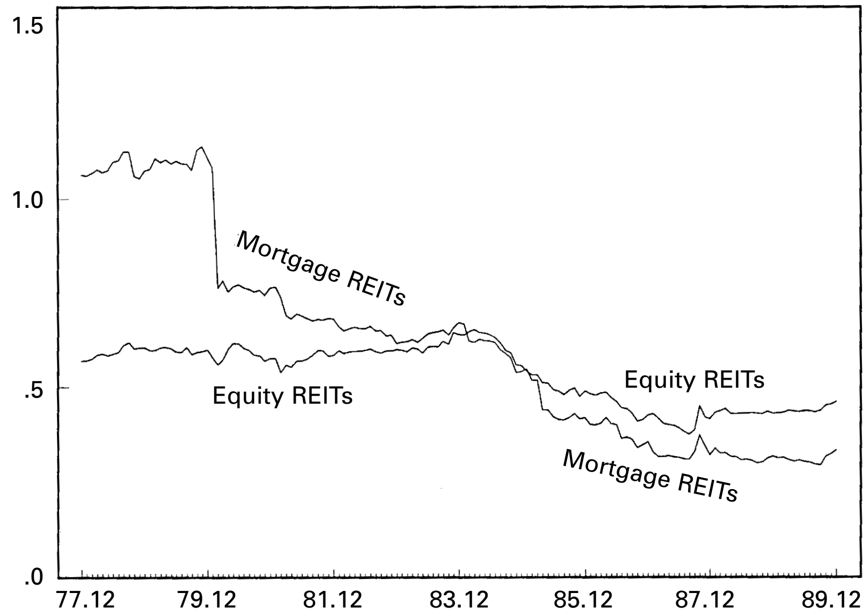


Exhibit 11
Moving Market *Betas* for All-REITs and Hybrid REITs

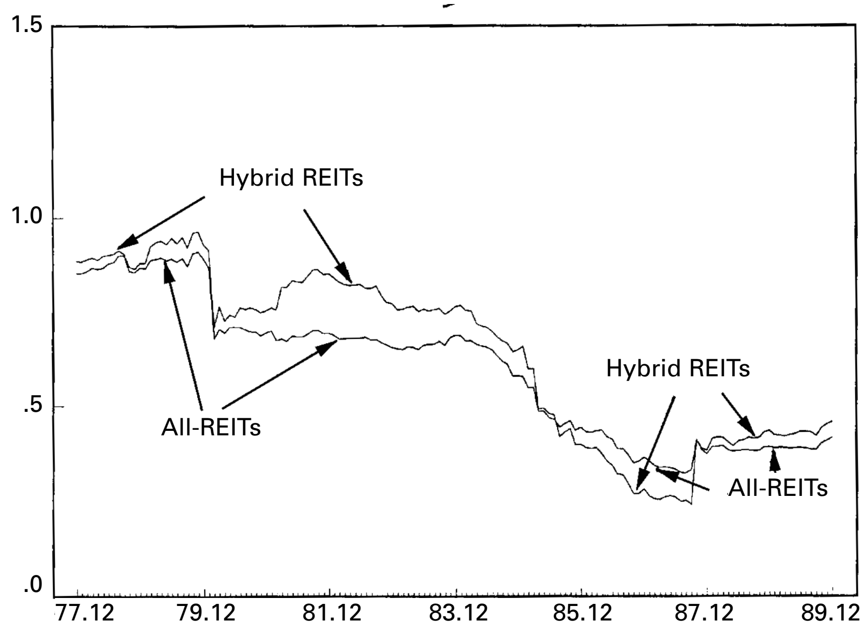
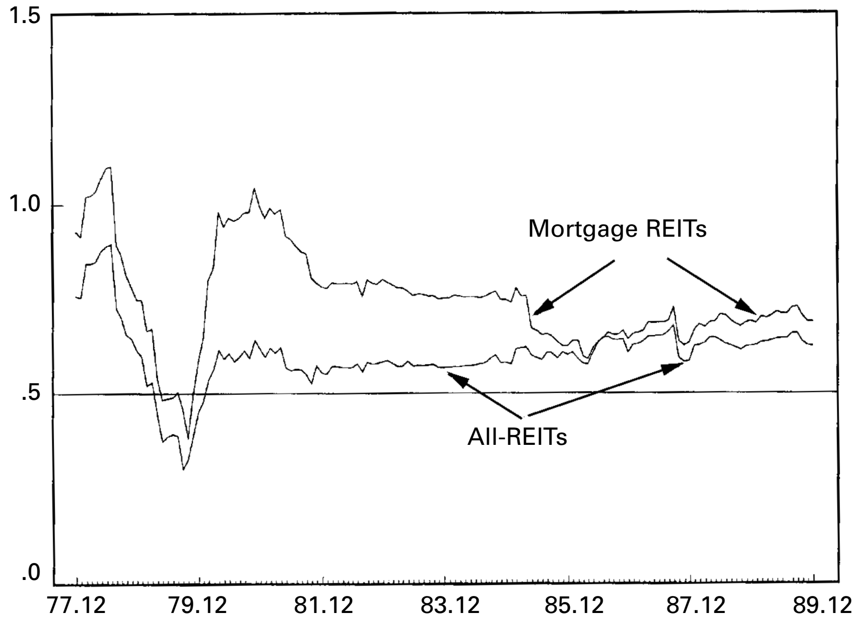


Exhibit 12
Moving Interest-Rate *Betas* for All-REITs and Mortgage REITs



gains holding period, and further tightening of the investment interest limitations. There were several provisions in the act that applied specifically to REITs. The 1976 TRA was the first major tax reform to affect REITs since 1960 by making structural modifications in existing REIT tax provisions.

The 1986 switch may be associated with the most comprehensive revision of the tax code since its adoption in the 1950s. The real estate industry was affected by the 1986 Tax Reform Act in the following ways: the depreciation deduction was reduced; loss offset limitations and at-risk restrictions were imposed: marginal tax rates were lowered and capital gains were taxed as ordinary income (higher than previously). The 1986 TRA was the only major tax reform to significantly affect REITs since the 1976 act. The primary purpose of the REIT provisions was to make it easier for an entity to qualify for REIT status and to improve the flexibility of REIT operations.

Furthermore, the Federal Reserve announced a switch from interest rates to unborrowed reserves as its short-run operating target for monetary policy on October 6, 1979. This switch had significant impact on the variability and the level of interest rates. Therefore, the 1980 switch for REITs may be a result of the Fed policy change. Because of the marked changes in operative, regulatory and monetary policy frameworks, other interest-rate-sensitive institutions, such as banks and S&Ls, also experienced a 1980 switch in their return-generating processes (Kane and Unal, 1988). In addition, some of the provisions in the 1981 Tax Reform Act altered the real estate investment environment. The TRA of 1981 might be one of the factors that contributed to the 1980 switch.

Close to the time of this change in monetary policy, there were two back-to-back recessions in the early 1980s, one in 1980, the other in 1982/1983. The year 1982 was a year of considerable financial and regulatory turmoil. The 1983 switch may be a result of the joint forces produced by those factors. Again, financial institutions experienced a similar switch in the vicinity of 1983.

Finally, the evolution of alternative mortgage instruments, especially the widespread use of the adjustable-rate mortgages, and the development of the secondary markets for residential mortgages should also have influenced the interest-rate sensitivity of mortgage REITs. When fixed-rate mortgages (FRM) were the dominant mortgage form, mortgage REITs had to hold primarily FRMs with long durations. When adjustable-rate mortgages became a popular alternative, mortgage REITs had the choice of holding mortgages with much shorter durations. This and the development of mortgage securitization may have contributed to the reduction of interest-rate sensitivity for mortgage REITs in later years.

The results have some implications for research based on the two-index model. In ex post application, nonstationarity can cause a confounding of systematic and nonsystematic risk, and biased, inefficient estimators. Ex ante, nonstationarity makes prediction more difficult. Doubt is cast on studies that have relied on parameter stability, such as the studies of market efficiency and the event studies in which events took place around the identified switching points. The problem of nonstationarity can be reduced by using more refined models/techniques such as models with time-dependent parameters. Also, government regulation of the REIT industry, including changes in tax codes, can have a profound effect on the return-generating process of REITs and the valuation of REIT securities.

Conclusions

Substantial evidence regarding the stability of risk components for REIT securities over time has been developed. Using all tax-qualified REITs listed on the NYSE, the ASE and the NASDAQ, four equally weighted REIT portfolios were constructed: an all-REIT portfolio, an equity REIT portfolio, a hybrid REIT portfolio, and a mortgage REIT portfolio. Significant return-generating regimes were found during the 1973–1989 period for all four portfolios. The systematic risk for equity REITs was relatively stable. The risk components for mortgage REITs varied considerably more than those for equity REITs over the sample period. The market risk and the interest-rate risk of REITs, especially of mortgage REITs, were much larger in the 1970s than in the 1980s. All four portfolios experienced significant shifts in their return-generating processes. The switching points that separate the return-generating regimes are in the vicinities of 1976, 1980, 1983, and 1986, coinciding with important events such as the tax reform acts of 1976, 1981 and 1986, and the monetary regime change in 1979.

Notes

[1]An alternative way to estimate the *betas* would be to orthogonalize $R_{I,t}$ and $R_{M,t}$ first. Giliberto (1985) shows that if equation (1) is the return-generating process, then the orthogonalization of $R_{I,t}$ against $R_{M,t}$ will produce a biased estimate for the market *beta*, but it will not affect the estimate for interest-rate *beta* and vice versa. Because of the potential bias associated with orthogonalization of the model, the market *beta* and interest-rate *beta* are estimated based on the unorthogonalized version of (1).

[2]There is evidence that supports the contrary. See Schwert and Seguin (1990).

[3]The results were not significantly changed if we had used the CRSP equally weighted index for the NASDAQ.

[4]The results may look counterintuitive. However, equity REITs on average are much larger than mortgage REITs. The larger market *beta* for mortgage REITs than for equity REITs was caused by the size differential.

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