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An Anatomy of the Interrelationship between Equity and Mortgage REITs

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We investigate the long- and short-term interrelationships between equity and mortgage real estate investment trusts (REITs) by focusing on decomposed income and appreciation components. We find that the previously documented long-term cointegration relation between equity and mortgage REIT prices stems exclusively from their income components and subsequently, the appreciation components contribute nothing to such a long-term relationship. We also find that the previously documented short-term causal relation between equity and mortgage REIT returns is due to the causality that runs from the appreciation returns of equity REITs to those of mortgage REITs while their income returns do not lead to causality. Lastly, we show that the income returns of both equity and mortgage REITs are influenced by the same equity market factor while their appreciation returns are responsive to different macroeconomic factors, which explain the heterogeneous performance between them.

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Keywords

Equity REITs, Mortgage REITs, Income Component, Appreciation Component, Cointegration, Causality

1. Introduction

A real estate investment trust (REIT) is a company that owns and typically operates income-producing real estate or real estate-related assets. REITs can be further demarcated into equity REITs (EREITs), which own and operate real estate assets, and mortgage REITs (MREITs), which invest in mortgages secured by real estate assets. Both EREITs and MREITs are traded on major stock exchanges.

Prior studies show that there is a *long-term cointegration relation* between EREITs and MREITs based on their price indices (i.e. price levels). In addition, researchers document a *short-term causal relation* between EREIT and MREIT returns. Long-term cointegration (short-term causality) could be different based on the type of price index (return series). To gain a better insight into portfolio balancing and diversification, we investigate long- and short-term interrelationships between EREITs and MREITs by decomposing their data series into income and appreciation components. In addition to two total return series, TEREIT and TMREIT, we have four decomposed data series: (1) the income returns of EREIT (IEREIT, hereafter), (2) the appreciation returns of EREIT (AEREIT, hereafter), (3) the income returns of MREIT (IMREIT, hereafter), and (4) the appreciation returns of MREIT (AMREIT, hereafter).

Our research offers three important findings to the existing literature. First, we find that the previously reported long-term cointegration relation between the total price of EREITs and that of MREITs stems from the income stream while the appreciation component does not contribute to this relation. Second, short-term unilateral causality runs from AEREIT to AMREIT while income return does not lead to causality. Third, IEREIT and IMREIT are determined by the same equity market factor, the S&P 500-index return, while AEREIT and AMREIT are affected by different macroeconomic factors that explain for their heterogeneous performance. In sum, income streams help to maintain the long-term cointegration relation between EREITs and MREITs while appreciation returns lead to short-term causality.

Investors care a lot about the return attributes (i.e. income and appreciation) and there is abundant literature in this area (see Hartzell, Hekman and Miles, 1986; Ziobrowski and Richard, 1991; Barkham and Geltner, 1995; Benjamin, Chinloy, Hardin and Wu, 2008). A study based on decomposed data series will help real estate investors and the academic communities to better understand the underlying mechanisms that drive the results in the existing literature. Our results on decomposed data analyses also yield implications for portfolio management. First, our findings indicate that the income component has little volatility and most of the serial autocorrelation and persistence in REIT returns are driven by an embedded income series that has substantial autocorrelation. Second, if separate trading of REIT appreciation and income securities becomes available, it would be sub-optimal to simultaneously hold both EREIT and MREIT income securities in a portfolio because of their cointegration relation. It would also be sub-optimal to hold both EREIT and MREIT appreciation securities simultaneously due to their causal relation. As the Granger component of EREIT appreciation causes MREIT appreciation, this makes EREIT appreciation securities (leader) more favorable than MREIT appreciation securities (follower) should separate trading of REIT appreciation and income securities become available. Collectively, the optimal strategies would be to either hold EREIT appreciation security and MREIT income security, or hold all EREIT appreciation plus income securities.

The paper is structured as follows: the literature review is presented in Section 2; Section 3 describes the theory and hypotheses; Section 4 discusses the data; Section 5 explains our methodology; Section 6 presents the empirical results; and Section 7 concludes our findings.

2. Literature Review

Researchers have found that there is large heterogeneity between EREITs and MREITs. For example, Peterson and Hsieh (1997) suggest that risk premiums on EREITs are significantly related to the three Fama-French factors that drive common stock returns, while MREIT risk premiums are significantly related to bond market factors as well as stock market factors. Downs (2000) analyzes EREITs, MREITs, bonds, and stocks, and concludes that MREIT portfolios are highly correlated with bond portfolios while EREIT portfolios are highly correlated with every portfolio except bonds. Glascock, Lu, and So (2000) argue that EREITs act more “stock-like” and MREITs continue to act “bond-like” after 1992. In an incremental daily return analysis, Swanson, Theis, and Casey (2002) find that the factors that drive EREIT returns do not differ from those that drive MREIT returns. Devos, Ong, and Spieler (2007) find that MREITs are more transparent than EREITs. Blau, Hill, and Wang (2011) support Devos, Ong, and Spieler (2007), and find that MREITs are short sold less than EREITs, which is consistent with traders who find fewer opportunities to exploit mispriced MREIT stocks. Recently, Hansz, Zhang, and Zhou (2016) find that EREITs and MREITs are not substitutable.

Some studies suggest that EREITs and MREITs play a similar role in portfolio construction and diversification. Kuhle (1987) investigates the effects of EREITs and MREITs on portfolio risk reduction, and suggests that no significant diversification benefits can be expected by adding MREITs to common stock portfolios. Danielsen and Harrison (2000) find that EREITs have increased liquidity, consistent with financial assets held by MREITs. Chen, Ho, Lu, and Wu (2005) examine the effects of including REITs in an investment portfolio from an asset allocation perspective and conclude that MREITs do not improve the mean-variance efficient frontiers. Lee and Chiang (2004) examine REIT returns from 1972 to 1999 and find that EREITs and MREITs are perfectly substitutable, which suggests that both can be treated as a single asset class in constructing a diversified portfolio. Lee and Chiang (2004) and Chen, Ho, Lu, and Wu (2005) suggest that investors are able to maximize performance benefits by adding only one class of REIT stocks, as the benefits of holding REITs primarily stem from their pass-through taxation, high dividend, resistance to inflation, and potential for nontaxable return of capital.

Cointegration methods have been widely employed in the real estate literature to discern long-horizon relationships between real estate and alternative asset classes or markets. Studies that adopt cointegration methods in the real estate literature include Tarbert (1998), Myer, Chaudhry and Webb (1997), Chaudhry, Christie-David and Sackley (1999), Glascock, Lu and So (2000), Kleiman, Payne and Sahu (2002), Yunus (2009), Gallo and Zhang (2010), Oikarinen, Hoesli and Serrano (2011), and Hansz, Zhang and Zhou (2016). On the other hand, Granger causality methods have also been widely used in the real estate literature to discern short-horizon relationships among security returns; see Barkham and Geltner (1995) and Okunev, Wilson, Zurbruegg (2000) among others.

Prior studies show that there is a long-term cointegration relation between the total price index of EREITs and that of MREITs (see He, 1998; Glascock, Lu and So, 2000; and Hansz, Zhang and Zhou, 2016). Other studies have also found a causality relation and one-way feedback that run from the total returns of EREITs to those of MREITs (see Glascock, Lu and So, 2000; and Hansz, Zhang and Zhou, 2016). However, prior studies have been unable to separate price changes or total returns into appreciation and income components. This study investigates the long and short-term relations between EREITs and MREITs by decomposing data series into income and appreciation components.

3. Theoretical foundation

It is well known that the stock price represents the present value of future income streams. The definition of the total return R on a tradable equity is as follows:

$$R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} - 1 = \frac{P_{t+1} - P_t + D_{t+1}}{P_t} \tag{1}$$

where P_t is the current stock price, P_{t+1} is the one-period future stock price and D_{t+1} is the one-period holding period of a stock dividend. P_t and P_{t+1} are dividend adjusted prices. We can further present the total return R as capital gain yield (Appreciation Return—AR) plus dividend yield (Income Return—IR) as follows:

$$R_{t+1} = \frac{P_{t+1} - P_t}{P_t} + \frac{D_{t+1}}{P_t} = AR_{t+1} + IR_{t+1} \tag{2}$$

Multiplying P_t on both sides of Equation (2), we have:

$$R_{t+1} \cdot P_t = (P_{t+1} - P_t) + D_t = A_{t+1} + I_{t+1} \tag{3}$$

where $R_{t+1} \cdot P_t$ is the total dollar gains while $(P_{t+1} - P_t)$ is the capital gains (or losses) component in dollars (appreciation component A) and D_{t+1} is the dividend component in dollars (income component I). Note that $(P_{t+1} - P_t)$ is the first difference in dividend-adjusted stock prices. Rearranging Equation (3), we have:

$$(P_{t+1} - P_t) = R_{t+1} \cdot P_t - D_{t+1} \tag{4}$$

The appreciation component, $A = R_{t+1} \cdot P_t - D_{t+1}$, is a linear combination of total dollar gains $R_{t+1} \cdot P_t$ and income stream D_{t+1}. Dividing both sides of Equation (4) by R_{t+1}, we have:

$$\frac{(P_{t+1} - P_t)}{R_{t+1}} = P_t - \frac{D_{t+1}}{R_{t+1}} \tag{5}$$

According to Campbell, Lo and MacKinlay (1997), the stock price P is generally not a martingale, but follows a linear process with a unit root (nonstationary) if the dividend D follows a linear process with a unit root (nonstationary). See Campbell and Shiller (1987) for this application of the concept. So, at any time t, we have:

$$P_t - \frac{D_{t+1}}{R_{t+1}} = (\frac{1}{R_{t+1}}) \cdot E[\sum_{i=0}^{\infty} (\frac{1}{1 + R_{t+1+i}})^i \Delta D_{t+1+i}] \tag{6}$$

Equation (6) relates the difference between the stock price P_t and $(\frac{1}{R})$ times the dividend D_t to the expectation of the discounted value of future changes in dividends. More importantly, $E[\sum_{i=0}^{\infty}(\frac{1}{1+R_{t+1+i}})^i \Delta D_{t+1+i}]$ is stationary if changes in dividends are stationary.[2] In this case, even though both the dividend and the price processes are nonstationary, there is a stationary linear combination of prices and dividends. Plugging Equation (5) into (6), we have:

$$(\frac{1}{R_{t+1}})\cdot(P_{t+1}-P_t)=(\frac{1}{R_{t+1}})\cdot E[\sum_{i=0}^{\infty}(\frac{1}{1+R_{t+1+i}})^i \Delta D_{t+1+i}] \tag{7}$$

Dividing both sides by $(\frac{1}{R_{t+1}})$, we have:

$$A_{t+1}=P_{t+1}-P_t=E[\sum_{i=0}^{\infty}(\frac{1}{1+R_{t+1+i}})^i \Delta D_{t+1+i}] \tag{8}$$

Equation (8) implies that the appreciation component A is stationary without unit root representation. Two nonstationary variables with unit root representation are cointegrated if some linear combination of the variables is stationary. See Engle and Granger (1987) for a general discussion. In this case, any nonstationary variable, including A_{t+1}, should not be a cointegration contributor. So, the appreciation component should not be a part of the cointegration relation. Given the significant long-term cointegration relation between the total price of EREITs and that of MREITs found in prior studies, according to the theory stated above, we hypothesize that such a cointegration relation is not produced by their appreciation components. Instead, we expect that the cointegration is a result of their income components.

From Equation (3), we know that the total dollar gains, $R_{t+1}\cdot P_t$, is the sum of the appreciation A_{t+1} and income I_{t+1}. P_t is set to be the dividend adjusted price of a stock at time t. By rearranging Equation (3), we have:

$$P_t+P_t\cdot R_{t+1}=(P_t+A_{t+1})+(P_t+I_{t+1})-P_t \tag{9}$$

where P_t+A_{t+1} is the equity price plus the appreciation component and P_t+I_{t+1} is the equity price plus the income component. According to Campbell and Shiller (1987), income I is expected to be nonstationary while appreciation A is expected to be stationary. Equation (9) can be further written as:

$$P_t(1+R_{t+1})=P_t(1+\frac{A_{t+1}}{P_t})+P_t(1+\frac{I_{t+1}}{P_t})-P_t \tag{10}$$

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[2] We run four unit root tests on changes in dividends for all REITs, EREITs, and MREITs. We find that changes in dividends are indeed stationary without the unit root. The results are available upon request.

in which $\frac{A_{t+1}}{P_t}$ is the appreciation return AR_{t+1} and $\frac{I_{t+1}}{P_t}$ is the income return IR_{t+1} at time $t+1$ and total return $R_{t+1} = \frac{A_{t+1}}{P_t} + \frac{I_{t+1}}{P_t}$. Equation (10) can then be further written as:

$$P_t(1+R_{t+1}) = P_t(1+AR_{t+1}) + P_t(1+IR_{t+1}) - P_t \tag{11}$$

where $P_t(1+R_{t+1})$ is the total price indices, $P_t(1+AR_{t+1})$ is the appreciation indices, $P_t(1+IR_{t+1})$ is the income indices.[3] Rearranging Equation (11), we have:

$$P_t(1+R_{t+1}) + P_t = P_t(1+AR_{t+1}) + P_t(1+IR_{t+1}) \tag{12}$$

where $P_t(1+R_{t+1}) = P_{t+1}$. More importantly, P_{t+1} and P_t are the same price process of the same stock which both follow a nonstationary process with a unit root. Equation (12) can also be written as:

$$P_t(2+R_{t+1}) = P_t(1+AR_{t+1}) + P_t(1+IR_{t+1}) \tag{13}$$

In the literature, $P_t(1+R_{t+1})$ between EREIT and MREIT proves to be cointegrated, as $P_t(2+R_{t+1})$. Based on the corollary of the theory presented above, we expect that the income price indices, $P_t(1+IR_{t+1})$, between EREIT and MREIT are cointegrated but appreciation price indices, $P_t(1+AR_{t+1})$, according to Equation (8), are noncointegrated.[4] With the decomposed data series used in this paper, we are able to examine whether the appreciation or the income component contributes to the long-term cointegration relation.

For the short-run causal relation, previous studies find that there is a one-way causality relation that runs from the total returns of EREITs to those of MREITs. The Granger-causality test identifies whether a variable improves the forecasting performance of another variable. Prior studies test if the lags of the total returns of EREITs impact those of MREITs or vice versa. Based on Toda and Yamamoto (1995), if the EREIT and MREIT price indices are found to be

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[3] Empirically, we set the threshold price $P_t = P_0 = 100$, so that we have a time series of total, appreciation, and income price indices for EREITs and MREITs respectively.

[4] Note that the cointegration method must be performed on nonstationary indices. Therefore, to investigate the cointegration relation between the appreciation components of EREIT and those of MREITs, we ought to convert appreciation returns to price indices by using the $P_{t+1} = P_t * (1+AR_{t+1})$ formula. The same applies to the income components.

cointegrated, an error correction term needs to be added into the regular Granger (1969) causality test as follows:

$$\Delta X_t = \upsilon + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_k \Delta X_{t-k} + \lambda e_{t-1} + \varepsilon_t \qquad \text{t} = 1,...,\text{T} \tag{14}$$

where ΔX_t is an (n x 1) matrix of the return variables (n=2 if the system contains only EREIT and MREIT returns). υ is an (n x 1) vector of constants, and Γ_i is an (n x n) matrix of beta coefficients. ΔX_{t-i} is an (n x 1) matrix of lagged endogenous variables and ε_t is an (n x 1) vector of equation residuals. More importantly, e_{t-1} is the error correction term at time *t-1* which measures the response to deviations from the cointegration equilibrium over the long-horizon between the EREIT and MREIT price series. As mentioned in Granger (1988), the causation of an endogenous variable with any exogenous variable within the error correction model could be caused by either the lagged values of the exogenous variables or error correction term, e_{t-1}. To test if EREIT returns Granger-causes MREIT returns in the short-run, we test if the coefficients on the lagged REIT returns are jointly significant as measured by *F*-statistics or if the coefficient of the e_{t-1} is significant as measured by *t*-statistics. We run separate causality tests on the total, appreciation, and income returns.

The revenues of EREITs primarily originate from rental income and appreciation of asset reversions while those of MREITs are primarily generated by interest earned from mortgage loans. In addition, we know that REITs must pay out at least 90% of their taxable income in the form of dividends to shareholders. As their income components (dividends) stem from different revenue sources, we hypothesize that EREIT income returns are independent from MREIT income returns. Therefore, there should not be any significant causality between EREIT and MREIT income returns. Given the fact that previous studies find a causal relation between EREIT and MREIT total returns, we expect that such causality is driven exclusively by appreciation returns and receives no contribution from income returns.

4. Data

We obtain monthly data for equally-weighted and value-weighted EREITs and MREITs from 1980 to 2014 from the Center for Research in Securities Prices (CRSP)/Ziman U.S. Real Estate Data Series.[5] The CRSP/Ziman database includes all REITs traded on the NYSE, AMEX, and NASDAQ exchanges

[5] Findings based on equally weighted indices are substantively similar so for brevity we report only the value-weighted results. Full results are available from the authors upon request.

since 1980. The CRSP/Ziman database provides a comprehensive REIT data at both the index and firm levels.[6] REIT indices are based on a universe of REITs which fits the selection criteria of CRSP/Ziman database.[7] It sets all REIT indices to $100 on December 30, 1994 and shows the cumulative values of the portfolios relative to the starting date. The CRSP/Ziman database demarcates total returns into appreciation and income returns. Price appreciation uses security returns without dividends. Income returns use the difference between the two.[8]

The CRSP/Ziman database also provides firm-level data which allow us to construct U.S. REIT-based risk factors. Based on the methodology in Hartzell, Mühlhofer, and Titman (2010) and Cici, Corgel, and Gibson (2011), we create Fama-French-Carhart four factors that are REIT-based from the universe of REITs. First, we use the value-weighted CRSP/Ziman REIT market index as the market portfolio (MKT). The other factors are return differentials between the small cap and large cap REITs (Size), high and low book-to-market REITs (Book-to-Market), and positive and negative prior year return-momentum REITs (Momentum). To ensure that accounting information is known sufficiently in advance of returns, we follow Fama and French (1992) by matching returns for the period between July of year y to June of year y+1 to annual accounting data of a REIT for the fiscal year that ends in calendar year y-1.

For the high minus low (HML) factor, we sort all REITs at the end of June of each year y into two groups of book-to-market equity for the last fiscal year that ends in calendar year y-1. Accordingly, we compute the value-weighted returns on the portfolios from July of year y to June of y+1, and rebalance the portfolios in June of y+1. The HML factor is the monthly difference between the returns on the high-BE/ME portfolios and the low-BE/ME portfolios.[9] Likewise, we

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[6] Combining data on stock prices and returns with carefully researched information regarding the population, characteristics, and history of REITs, the CRSP/Ziman database provides firm-specific information and indices essential to analyses that involve this important asset class. The CRSP/Ziman database has been widely used in recent REITs-related studies, such as Chiang (2010); Chen, Downs, and Patterson (2012); Ling, Naranjo, and Ryngaert (2012), among others.

[7] CRSP/Ziman Guide: http://www.crsp.com/files/CRSP_Ziman_Guide_0.pdf

[8] CRSP/Ziman monthly REIT indices are portfolio-based. Each index can be treated as a REIT portfolio. Certain REIT firms distribute their incomes quarterly or semiannually, but not all the firms distribute their incomes at the same time. Therefore, a portfolio of REITs consists of many REIT firms would have continuous income streams on a monthly basis. A similar situation applies to appreciation returns. CRSP/Ziman does not smooth incomes over multiple months.

[9] BE/ME is the natural log of the ratio of book-to-market equity. Book-to-market equity is the ratio of book equity for the fiscal year that ends in y−1 to market equity at the end of December in y−1. Book equity is the difference between assets (COMPUSTAT annual item AT) and liability (item LT) plus balance sheet deferred taxes (item TXDB if available) minus the book value of a preferred stock. Depending on data availability,

create the small minus big (SMB) factor as the return difference between two SIZE portfolios. The fourth factor is momentum (Carhart, 1997), denoted by UMD. We construct this factor by using two value-weighted portfolios sorted on prior returns (PRYR) for months -12 to -2. PRYR is the cumulated continuously compounded REIT return from month *t*-12 to month *t*-2, where *t* is the month of the forecasted return. At the beginning of each month *t*, we categorize all REITs into two groups based on prior returns. We then calculate the value-weighted portfolio returns for month *t*, and rebalance the portfolios in month *t*+1. UMD is the monthly difference between returns on a high prior returns portfolio and those on a low prior returns portfolio.

To further examine the determinants of REIT returns, we conduct vector autoregression (VAR) modeling with the seven macroeconomic factors in Lee and Chiang (2004), including four macroeconomic factors, two real estate related factors, and one stock market factor. In particular, we obtain four U.S. macroeconomic factors (from Liu and Zhang, 2008), and also use industrial production growth rate, unexpected inflation rate, term structure, and default risk premium from the website of Professor Laura Xiaolei Liu, along with 30-year conventional mortgage rates from the Federal Reserve Bank of St. Louis, the new privately owned housing units from the U.S. Census Bureau, and the S&P 500 returns from the Center for Research in Securities Prices.

According to Chan, Leung and Wang (2005), the tax law changes in 1986 allowed REITs to use internal advisors. However, the impact of those changes on the REIT market only became detectable in the early 1990s. Chan, Leung and Wang (2005) argue that REITs in the 1990s were more liquid, larger in size and more focused by property type in their investment portfolios when compared to previous decades. In addition, REITs in the 1990s had a significantly higher inside ownership and used different capital structures and management strategies.[10] As a result, we repeat all tests by using the data from 199301 to 201412 (modern REIT era) and find consistent results. To conserve space, we only report full sample results in this paper. Sub-sample test results are available upon request.

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we use liquidation (item PSTKL), redemption (item PSTKRV), or preferred stock at carrying value (item UPSTK), in this order, to represent the book value of the preferred stock. Book-to-market equity is the ratio of book equity for the fiscal year y-1 to market equity at the end of December year y-1. SIZE is the natural log of market capitalization (stock price multiplied by shares outstanding, in millions) at the end of June.

[10] In the 1990s, REITs moved away from their original fund-like structure and took on characteristics similar to other operating firms traded in the equity market. Chan, Leung and Wang (1998) also document that institutional investors did not participate actively in REITs prior to 1990, and focused more of their funds in stocks rather than REITs. After 1990, they invested more of their funds in REITs than in other stocks in the market.

5. Method

5.1 Risk and Return Profile

We adopt two measures to compare the risk-return characteristics between EREITs and MREITs. First, we examine whether portfolio excess return is significantly different from zero (H0: RET- Rf =0) based on *t*-statistics as rational investors would prefer a portfolio with a significantly positive excess return. Second, to discern risks associated with each asset, we examine the performance of the EREIT portfolio and compare the performance with that of the MREIT portfolio. Hartzell, Mühlhofer, and Titman (2010) and Cici, Corgel, and Gibson (2011) argue that the conventional Fama-French-Carhart equity factors are biased and REIT-specific factors are more pertinent. So, we construct the REIT-based Fama-French-Carhart four factors by using the universe of REITs over a 34-year period from 1980 to 2014. We examine both EREIT and MREIT abnormal returns and their risk exposures (factor loadings) to the REIT-based market, size, style, and momentum factors:

$$\begin{aligned} R_{pt} - R_{ft} &= a + b_1(R_{MKT} - R_{ft}) + b_2(ReitSMB_t) + b_3(ReitHML_r) \\ &\quad + b_4(ReitUMD_t) + e_{pt} \end{aligned} \tag{15}$$

where R_{pt} is the monthly REIT raw return, R_{ft} is the monthly Citigroup 3-month Treasury bill return, R_{MKT} is the value-weighted CRSP/Ziman REIT market returns, $ReitSMB$ is the REIT size factor, $ReitHML$ is the REIT style factor, and $ReitUMD$ is the REIT momentum factor. We test the abnormal return of each portfolio by examining the sign and significance of the coefficient estimates of the intercept (alpha). A significant positive (negative) *t*-statistic of the intercept estimate indicates superior (inferior) risk-adjusted performance. In addition, the coefficient of each factor variable shows the risk exposure to the broad REIT market, size, style, and momentum factors.

5.2 Johansen Cointegration Approach

The Johansen cointegration approach has been widely used in the real estate literature. Cointegration refers to a linear combination of nonstationary indices. To test for stationarity in our data series, we conduct the following four unit root tests on each index: Dickey-Fuller (1981) (DF), Phillips-Perron (1988) (PP), Kwiatkowski, Phillips, Schmidt, Shin (1992) (KPSS), and Zivot and Andrews (1992) (ZA).

We conduct three long-run cointegrative analyses. First, we use the Johansen cointegration test (Johansen 1988, 1991) to test for the rank of cointegrated vectors. The rank test identifies the number of significant cointegration vectors. Second, we use an exclusion test (Johansen, 1991; Johansen and Juselius, 1990) as an additional test for independence of cointegration relations. Insignificant statistics of the exclusion test support index independence from the cointegrative vector (CIV). Third, we perform the Johansen (1992) weak exogeniety test between REITs and LPCs in cointegration relations over the long-horizon.[11] According to Pesaran, Shin, and Smith (2000), a weakly exogenous variable in the CIV should have no statistically significant error correction coefficient and is considered the source of cointegration relations over the long-horizon because it is unresponsive to deviations from long-horizon equilibrium. An asset index with an insignificant likelihood ratio (L-R) statistic is considered weakly exogenous, and vice versa. See Tarbert (1998); Chaudhry, Christie-David, and Sackley (1999); and, Kleiman, Payne, and Sahu (2002) for tests of weak exogeneity.

To ensure the accuracy of our model specification, we complete five sets of tests. First, the Ljung-Box Q (L-B-Q) and multivariate Lagrange multiplier (LM) tests are used to identify the appropriate lag length needed to eliminate serial autocorrelation in the residuals. Second, the specification of deterministic components (such as constant, linear trend, and seasonal dummy variables, etc.) in the VAR system is tested by using the *G(r)* statistics derived in Johansen (1994). Third, structural breaks in the cointegrated vectors are monitored by the Johansen, Mosconi, and Nielsen (2000) likelihood-ratio tests and the Bayesian information criterion (BIC) in Bai and Perron (2003) and Schwarz criterion (LWZ) statistics.[12] Fourth, dummy variables are imposed as controls for large residual shocks that could induce non-normal distributed residuals.[13] Lastly, the Bartlett small sample correction test is included in the cointegration rank testing to mitigate potential small sample size bias (Johansen 2000, 2002). It should be noted that we focus on the Bartlett-corrected trace test because our sample contains 420 monthly observations of our statistics. Nevertheless, we report the results of both the Johansen trace and the Bartlett-corrected trace tests. In addition, we perform two diagnostic tests to ensure the rigor of our analyses: the recursive test based on "R-representation" and recursive likelihood-ratio test based on the "test of beta" from Hansen and Johansen (1999). To conserve space, all of the specification tests are served as robustness tests and not tabulated. The results are available from the authors upon request. We apply these cointegrative analyses on both the total price indices and decomposed income and appreciation return indices.

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[11] Engle, Hendry, and Richard (1983) provide a detailed explanation of exogeneity.

[12] The linear autoregressive Johansen results may be questionable if equity indices exhibit nonlinear dependencies. All data series are logarithmically transformed to mitigate any nonlinearity in the data series. Structural break and linear trend components are also tested in the data series also [see Johansen (1994); and, Johansen, Mosconi and Nielsen (2000)]. We find no evidence of nonlinear dependency in the equity indices thus implying that there is no need for nonlinear nonparametric ranking and cointegration testing in Bierens (1997a, 1997b) and Breitung (2002). In addition, we find no evidence of significant structure breaks in our cointegration tests.

[13] Large shocks are defined as residuals that are statistically significant at a 1% level (input threshold=2.576). Residual normality is monitored by the chi-square test.

5.3 Granger-Causality, Cholesky Variance Decomposition, and Impulse Response Function

We conduct Granger (1969) causality tests to examine the lead-lag causal relation in the short run. The Granger-causality test is used to identify if one variable improves the forecasting performance of another variable. According to Granger (1988), the specification of the Granger-causality test model is dependent on the result of the cointegration rank test. If price indices are found to be non-cointegrated, we investigate if the coefficients on the returns of a lagged exogenous variable are jointly significant as measured by the *F*-statistic, and vice versa. However, if price indices are cointegrated, an error correction term must be imposed in general in the Granger-causality relation. An error correction term that measures responses to deviations from long-horizon equilibrium is derived from the cointegration test. As mentioned in Granger (1988), the causation of the endogenous variable by exogenous variables within an error correction model can originate from either the lagged values of the exogenous variables and/or the error correction term. Given that price indices are cointegrated, we test if Granger causality exists in the short-run by examining whether the coefficient on the returns for the lagged exogenous variable is jointly significant as measured by the *F*-statistic and/or if the coefficient of the error correction term is significant as measured by the *t*-statistic, and vice versa.

In addition to the Granger-causality test, we conduct Cholesky variance decomposition (CVD) and impulse response function (IRF) tests to see if EREITs and MREITs affect each other equally. The CVD shows rich interaction between the EREIT and MREIT returns, especially in a longer forecast horizon (see, Kolari, Fraser, and Anari, 1998). We report the percentage of the forecast error variance of one variable explained by both itself and another variable, up to 12 steps (months) ahead. The IRF shows how the return of one index responses to a standard deviation shock to itself and the return of another index (see Wheaton, 2003). We report up to 12 periods (months) for the IRF after the shock. The IRF results help us to understand if shocks of one variable have a permanent or transitory effect on another variable in the system.

5.4 Responsiveness of Income and Appreciation Returns to Economic Factor Changes

We perform a VAR analysis based on the existing literature with the index return together with seven macroeconomic factors: (1) the industrial production growth rate (INDPRO); (2) the unexpected inflation rate (INFL); (3) the term structure (TS); (4) the default risk premium (DEF); (5) the changes in the 30-year conventional mortgage rate (MTGED); (6) the change in percentage of new private housing starts (HSTARTS), and (7) the S&P 500 index return (SP500R).

Chen, Roll, and Ross (1986) investigate the impact of different economic forces on stock prices and suggest that changes in the unexpected inflation rate affect cash flows and interest rates. More importantly, changes in industrial growth rates affect the real value of cash flows. As a result, we include the industrial production growth rate (INDPRO). Fama and French (1998) suggest that term premiums (default risk premiums) are closely related to short-term (long-term) business cycles. Chan, Hendershott, and Sanders (1990) find that REIT returns are affected by changes in term structures, default risk premiums, expected (unexpected) inflation, and industrial production. Chen and Tzang (1988) find that both EREITs and MREITs are sensitive to changes in interest rates. Mengden (1988) finds that MREITs are more sensitive to short-term interest rate changes than EREITs. We define the term structure (TS) as (20-yr)-(1-yr) yield, risk premium (DEF) as BAA-AAA yield, unexpected inflation rate (INFL) as the seasonally adjusted changes in the Consumer Price Index. In Seck (1996) and Ling, Naranjo and Ryngaert (2000), the S&P 500 returns (SP500R) and mortgage rates (MTGED, defined as the changes in 30-year conventional mortgage rate) are used to forecast REIT returns. Ling, Naranjo, and Ryngaert (2000) also use construction starts (HSTARTS) as a proxy for real estate market activities.

The eight-variable VAR system with 1-lag in a standard form is as follows:

$$X_t = B_0 + B_1(L)X_{t-1} + E_t \tag{16}$$

where X_t represents an (8x1) vector including one of the decomposed returns (IEREIT, IMREIT, AEREIT, or AMREIT) and the seven macroeconomic factors. Thus, we conduct four separate VAR analyses with four different return series. B_0 is an (8x1) vector that contains the intercept and B_1 is an (8x8) vector of the polynomials in the lag operator (L). The lag length of 1 is determined by using BIC criteria. E_t is an (8x1) vector of errors, which is stationary and serially uncorrelated. Equation (16) generates eight VAR outputs with each of the eight variables in turn as the dependent (left-hand-side) variable at time *t* and eight independent (right-hand-side) variables with their *t*-1 lag in the VAR system. As our interest is the model with REIT returns as the dependent variable, we only report the output with respect to REIT returns in the sensitivity tests. The significance of the coefficients on lagged economic factors is measured by *F*-statistics.

6. Results

Descriptive statistics for MKT, EREIT, and MREIT as well as their income and appreciation components are reported in Table 1. For each variable, we report its total returns, standard deviations (STD), Sharpe ratio (SHP), market capitalization (Mkt. Cap.) in billions, and number of REITs in the portfolio (Count).

Table 1 Descriptive Statistics 198001-201412

Variable (Monthly)	Entire REIT MKT	EREIT	MREIT
Total Return	1.03%	1.06%	0.71%
Income Return	0.59%	0.54%	0.88%
Appreciation Return	0.44%	0.52%	-0.17%
Total Excess Return STD	4.90%	5.08%	5.79%
Total Excess Return SHP	13.12%	13.32%	5.58%
T-stat (H0: RET-Rf)=0	2.69***	2.73***	1.14
Mkt. Cap. (in billions)	171.00	152.00	10.38
Count	161.35	123.88	24.33

Note: This table summarizes the monthly statistics of value-weighted REIT indices examined over the 198001-201412 period. The REIT Market Index (Entire REIT MKT) is the CRSP/Ziman value-weighted REIT market portfolio. EREIT (MREIT) is the CRSP/Ziman value-weighted EREIT (MREIT) portfolio. For each index, we report the total raw, income and appreciation returns, standard deviation of returns (STD), and Sharpe ratio (SHP). Mkt. Cap. represents the average market value of each REIT in billions. Count represents the average number of REITs eligible for inclusion in the index. We report whether portfolio excess return T-stat statistics is significantly different from zero (H0: RET- Rf =0). ***and ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

In Panel A, over a period of 420 months from January 1980 – December 2014, the total mean monthly raw return of the MKT equals 1.03%, which is higher than that of MREITs (0.71%) but lower than that of EREITs (1.06%). The income return of MREITs (0.88%) is higher than that of EREITs (0.54%). However, the appreciation return of MREITs (-0.17%) is much smaller than that of EREITs (0.52%). The difference in the income returns between these two groups is less than the difference of the appreciation returns so that the total average return of EREITs is 1.06% (0.54% + 0.52%) which is higher than the total average return of MREITs at 0.71% (0.88% - 0.17%). As a result, the outperformance of EREITs over MREITs solely comes from the appreciation component. The finding of a greater appreciation return of EREITs is not surprising because EREITs invest primarily in equity real estate, while MREITs invest primarily in real estate debt. Moreover, the standard deviation of EREITs is smaller than that of MREITs, although the total standard deviation of both EREITs (5.08%) and MREITs (5.79%) is higher than that of the MKT (4.90%). SHP measures the excess return per unit of total risk. A smaller standard deviation with higher total returns gives rise to a higher SHP in EREITs (13.32%) than MREITs (5.58%), thus indicating a better performance by EREITs than MREITs. Interestingly, the *t*-test reveals that both the MKT (*t*-stat=2.69) and EREIT indices (*t*-stat=2.73) have a significantly positive risk premia while the risk premium of the MREIT index is not statistically different from zero (*t*-stat=0.85).[14] A large proportion (88.89%) of the REIT market value comes from EREITs. Only 6.07% is from MREITs and 5.04% from hybrid REITs. The average number of firms in the entire REIT industry is 161 (124 of these firms are EREITs, only 24 firms are MREITs, and 13 firms are hybrid REITs).

We analyze the risk and return profile of EREITs and MREITs, see Table 2. Following Hartzell, Mühlhofer, and Titman (2010) and Cici, Corgel, and Gibson (2011), we run the risk premiums of each REIT portfolio against the four REIT-based factors to discern its risk and return characteristics. Consistent with the results reported in Table 1, we find that the abnormal return of EREITs (a_{EREIT} = 0.01%, t-stat = 0.22) is better than that of MREITs (a_{MREIT} = -0.26%, t-stat = -1.23) after controlling for the four REIT-based factors. In terms of risk related characteristics, EREITs ($b_{1,EREIT}$ = 1.0265, t-stat = 135.92) have a higher systematic market risk than MREITs ($b_{1,MREIT}$ = 0.8046, t-stat = 17.50). This is expected because the MKT portfolio contains many more EREITs than MREIT stocks (shown in Table 1).

In addition, the SMB coefficient is positive but insignificant for EREITs ($b_{2,EREIT}$ =0.0201, t-stat = 1.50) while significant for MREITs ($b_{2,MREIT}$ = 0.1868, t-stat = 2.28). This implies that MREITs contain smaller sized REITs. The HML coefficients are the opposite signs. This implies that EREIT portfolios comprise low BE/ME REIT stocks ($b_{3,EREIT}$ = -0.0860, t-stat = -6.47) while MREIT portfolios comprise high BE/ME REIT stocks ($b_{3,MREIT}$ = 0.5064, t-stat = 6.25). A low BE/ME means that the market equity exceeds its book equity while a high BE/ME is the opposite. Thus, the HML coefficients suggest that EREITs have more growth potential than MREITs. The negative momentum coefficient ($b_{4,EREIT}$ = -0.0059, t-stat = -0.54) suggests that EREITs tend to be last year's losers, while the positive coefficient for MREIT ($b_{4,MREIT}$ = 0.2418, t-stat = 3.65) implies that MREITs tend to be last year's winners. Our findings on the alpha and factor loadings of EREITs and MREITs are consistent with those of Chiang, Kozhevnikov, Lee, and Wisen (2006).

EREITs and MREITs collectively are largely different in factor loading coefficients. In Panels B and C of Table 2, this result still holds when we split the full period into 'before' and 'after' timeframes from before and after the 1993 REIT industry reform.[15] Consistent with prior studies, we conclude that the long documented outperformance of EREITs over MREITs comes from the appreciation component (0.52% vs. -0.17%) and not from income component (0.54% vs. 0.88%), (see Kuhle, Walther, and Wurtzebach 1986; Kuhle 1987;

[14] Our results are consistent with those in Kuhle, Walther, and Wurtzebach (1986) and Han and Liang (1995).
[15] We also split the full period into before and after the recent global financial crisis (GFC) periods, 198001-200808 (344 months) vs. 200809-201412 (76 months), and the results are consistent. To conserve space, these results are not provided here but available upon request.

He 1988; and Hansz, Zhang, and Zhou 2016). Although it is not surprising that the income returns of MREITs are higher than those of EREITs, the difference in income components between these two groups is not enough to offset their appreciation discrepancy which explains for the outperformance of EREITs over MREITs.

Table 2 Risk and Return Profile

Panel A: Full Period

Index	a	b_1	b_2	b_3	b_4	Adj R-Sqr
EREIT	0.0001	1.0265	0.0201	-0.0860	-0.0059	0.9811
t-stat	0.22	135.92***	1.50	-6.47***	-0.54	
MREIT	-0.0026	0.8064	0.1868	0.5064	0.2418	0.4596
t-stat	-1.23	17.50***	2.28**	6.25***	3.65***	

Panel B: Pre-1993 (198001-199212, 156 months)

Index	a	b_1	b_2	b_3	b_4	Adj R-Sqr
EREIT	-0.0006	0.9990	0.0178	-0.0699	0.0343	0.9332
t-stat	-0.68	45.83***	0.66	-2.37**	1.20	
MREIT	-0.0025	1.0147	0.1634	0.2851	0.2061	0.5665
t-stat	-0.85	13.70***	1.79*	2.84***	2.11**	

Panel C: Post-1993 (199301-201412, 264 months)

Index	a	b_1	b_2	b_3	b_4	Adj R-Sqr
EREIT	0.0004	1.0294	0.0074	-0.0678	-0.0242	0.9956
t-stat	1.69*	210.58***	0.67	-5.99***	-3.26***	
MREIT	-0.0032	0.7254	0.1279	0.7811	0.1430	0.4398
t-stat	-1.11	12.22***	0.95	5.68***	1.59	

Note: This table summarizes the results of a four-factor model regression for EREITs (a value-weighted equity-REIT portfolio) and MREITs (a value-weighted mortgage-REITs portfolio). The four-factor model regression for EREITs and MREITs is as follows:

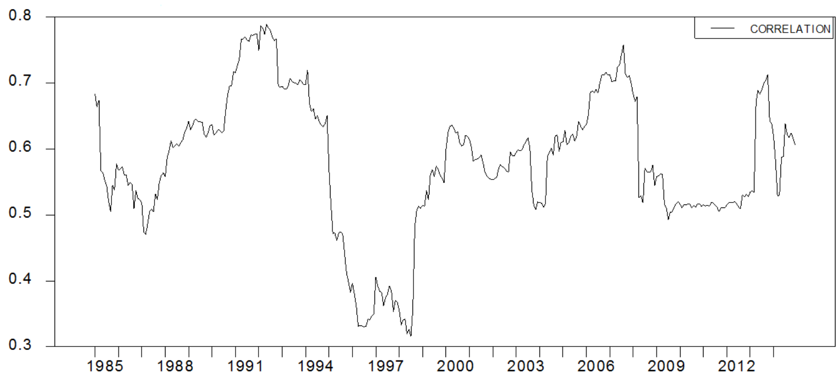
$$R_{pt} - R_{ft} = a + b_1(R_{MKT} - R_{ft}) + b_2(ReitSMB_t) + b_3(ReitHML_t) + b_4(ReitUMD_t) + e_{pt}$$

where R_{pt} is the monthly portfolio return of either EREITs or MIRET in separate regressions, R_{ft} is the monthly Citigroup 3-month Treasury bill return, R_{MKT} is value-weighted CRSP/Ziman REIT market index returns, *ReitSMB* (small minus big) is the REIT-based size factor, *ReitHML* (high minus low) is the REIT-based style factor and *ReitUMD* (up minus down) is the REIT-based momentum factor. *t*-stats are reported beneath each parameter estimate. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

To better understand the interrelationship between EREITs and MREITs, we present rolling pairwise correlations derived from the previous 60 month (5-year) rolling windows in Figure 1. The first correlation coefficient (1986:02, February 1986) is based on the prior 60-month window which ranges from

1980:01 to 1986:01. The average correlation is 0.5787 over the 1986:02-2014:12 period. We observe that the correlation was as high as 0.78 in the early years of the index followed by a steep decline to as low as 0.30 in 1998. Since then, the peak correlation of 0.76 of EREITs and MREITs have been increasingly associated with 2007:08 based on the 2002:08-2007:07 window. The correlation decreased to 0.50 to 0.60 after the housing bubble burst. Interestingly, the correlation between EREITs and MREITs was systematically lower during the crisis. A possible explanation consistent with the argument in Glascock, Lu, and So (2000) is that EREITs act more stock-like and MREITs act more bond-like. During a crisis, investors tend to sell stocks and buy bonds according to the flight-to-quality theory. Although both EREITs and MREITs are equity, investors might be more likely to sell EREITs than MREITs during a crisis.[16] Thus, the correlation of their returns is found to be lower. In sum, the correlations between EREITs and MREITs greatly fluctuate over time and are intertemporally unstable.

Figure 1 Rolling Correlation between EREIT and MREIT from 1985 01 – 2014 12



The results of the four unit root tests are provided in Table 3. Income stream *I*, is nonstationary with the unit root, consistent with Campbell, Lo and MacKinlay (1997). However, the appreciation component *A*, which is the first difference of the dividend-excluded prices (P_{t+1}-P_t), is stationary without the unit root. This matches our expectation based on Equation (8). Income *I* and appreciation *A* for both EREITs and MREITs are plotted in Figure 2, which

[16] One possibility is an investor clientele effect: institutional investors tend to invest exclusively in EREITs, whereas individual investors—especially retirees—tend to make heavy use of MREITs, and perhaps institutional investors reacted more strongly than individual investors. Indeed, many institutional investors were essentially forced to sell their REIT holdings because they also had significant holdings of illiquid real estate, which was not marked down properly and therefore suddenly exceeded policy targets, and which could not be liquidated when they became desperate for cash.

clearly shows that the income stream is nonstationary and trending upward while appreciation component *A* moves up and down along the zero line.

Table 3 Unit Root Test 1980 01 – 2014 12

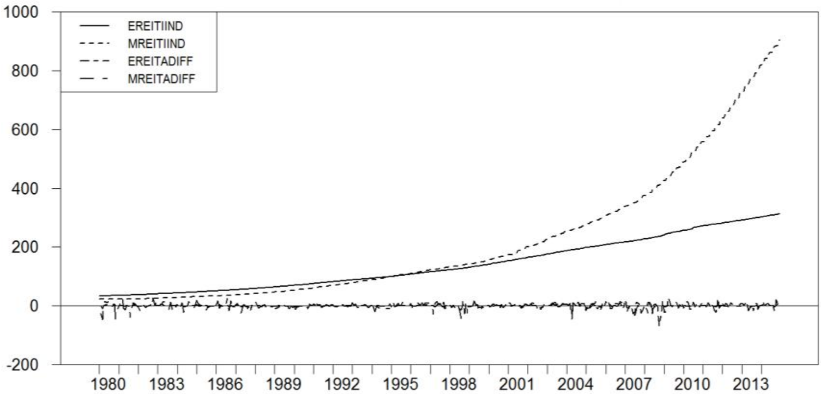
	DF	PP	KPSS(*mu*)	ZA
EREIT Income Stream (*I*) Expectation: Nonstationary	2.50	9.57	3.24**	-3.13
EREIT Appreciation (*A*) Expectation: Stationary	-5.02***	-18.97**	0.08	-6.31**
MREIT Income Stream (*I*) Expectation: Nonstationary	1.06	29.47	2.72**	-2.33
MREIT Appreciation (*A*) Expectation: Stationary	-5.35***	-19.25**	0.05	-5.71**

Note: Test period is from 198001 to 201412. Income Stream *I* is provided by CRSP/Ziman (*iind*). Appreciation *A* is the first difference in appreciation price index (*aind*). Four unit root tests are performed on the price levels of each data series: Dicky-Fuller (DF), Phillips-Perron (PP), Kwiatkowski, Phillips, Schmidt, Shin (KPSS), and Zivot-Andrews (ZA). DF, PP, and ZA tests all examine the null hypothesis of a unit root and nonstationarity against the alternative hypothesis that no unit root is present and the data series is stationary. The KPSS tests the null hypothesis of no unit root present and data is stationary. All tests allow for maximum of 12 lags. ZA test uses AIC criteria to decide lag length from maximum of 12 lags. DF test of unit root critical values: 1%= -3.44, 5%= -2.87, and 10%= -2.57; PP unit root test critical values: 1%= -3.468, 5%= -2.878, and 10%= -2.575 (reported statistics are with 4 lags); ZA unit toot test (Model C allowing break=both, maximum 12 lags) critical values: 1%= -5.57, 5%= -5.08, and 10%= -4.82; KPSS unit root test with *mu* statistics (H0: stationary around a level) critical value: 1%= 0.739 and 5%= 0.463 and 10%=0.347 (reported statistics are with 4 lags). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Both He (1998) and Glascock, Lu, and So (2000) document a long term cointegration relation between EREITs and MREITs. To conduct long-term cointegration tests, we first convert return series into price series.[17] In Table 4, we report the results of cointegration rank and exclusion tests to examine the long-term relationship between the total price indices of EREITs and MREITs. Panel A of Table 4 shows a significant cointegration relation between EREITs and MREITs (Bartlett λ_{trace} = 35.961, Bartlett P-value = 0.001). As a standard cointegration test, we further report the results of cointegration exclusion tests in Panel B of Table 4 to see if either of these two types of REITs can be excluded from the cointegration relation.

[17] We also conduct our cointegration tests by using original CRSP/Ziman price indices, and obtain consistent results. CRSP/Ziman set their indices to 100 on December 30, 1994. After the conversion, all our indices start with 100 on 198001.

Figure 2 EREIT and MREIT Income and Appreciation Components



Note: The data are from 198001 to 201412. EREITIIND is the EREIT income component, *I*, reported by CRSP/Ziman, MREITIIND is the MREIT income component, I, reported by CRSP/Ziman, Both EREITIND and MREITIND are logarithmically transformed. EREITADIFF is the first difference in EREIT dividend-excluded prices, and MREITADIFF is the first difference in MREIT dividend-excluded prices.

Price indices with significant (insignificant) L-R test statistics are cointegrated (segmented). Since there are only two indices in the cointegrative system (n=2) and they are found to be cointegrated (r=1) in Panel A, it is not surprising that neither can be excluded from the CIV ($\text{L-R}_{\text{EREIT}} = 20.640$, $\text{P-value}_{\text{EREIT}} = 0.000$; $\text{L-R}_{\text{MREIT}} = 5.253$, $\text{P-value}_{\text{MREIT}} = 0.022$). Panel C of Table 4 displays the results based on tests of weak exogeneity. A significant L-R statistic rejects the hypothesis that the index is weakly exogenous. Both EREITs ($\text{L-R}_{\text{EREIT}} =18.229$) and MREITs ($\text{L-R}_{\text{MREIT}} =15.187$) are with significant L-R statistics, thus suggesting that none of the indices are considered weakly exogenous in the CIV.[18] The results in Panel C show that neither of the two price indices can be separately considered as the source of cointegration relations.

A set of robustness tests of cointegration is not provided here but available upon request. Specifically, we conduct the recursive test based on "R-representation" and recursive likelihood-ratio test based on the "test of beta" from Hansen and Johansen (1999).[19] The recursive test based on "R-representation" discerns how trace statistics evolve over time. The recursive likelihood-ratio test based on the "test of beta" assesses the consistency of the cointegration relation and the

[18] In theory, there need not be any weakly exogenous variables and can be no more than n-r (2-1=1 in our case) weakly exogenous variables in the CIV.

[19] The recursive analysis can be conducted under with "Z-representation" or "R-representation". However, Hansen and Johansen (1999) argue that the test results from "R-representation" are more appropriate in the recursive estimation test.

adequacy of the error correction model. We find that the "R-representation" indicates only one significant cointegration relation between the total price indices of EREITs and MREITs over the sample period. The "test of beta" shows that the cointegration relation is stable, which is consistent with the Johansen cointegration test.

Table 4 Cointegration Analyses between Total Price Indices

Panel A: Test of Cointegration Rank

n-r	r	Eig. Value	5% C.V.	Bartlett λ_{Trace}	Bartlett *p*-value
2	0	0.068	36.030	35.961	0.001***
1	1	0.015	6.412	6.408	0.421

Panel B: Test of Exclusion

Price Indices (n=2)	r	DGF	5% C.V.	EREIT Total Index	MREIT Total Index
L-R statistic	1	1	3.841	20.640	5.253
P-value				0.000***	0.022**

Panel C: Test of Weak Exogeneity

Price Indices (n=2)	r	DGF	5% C.V.	EREIT Total Index	MREIT Total Index
L-R statistic	1	1	3.841	18.229	15.187
P-value				0.000***	0.000***

Note: Test period is from 198001 to 201412. DGF represents the degree of freedom. Eig. Value is the eigenvalue. Bartlett Trace is a small sample correction for each cointegration rank test. Bartlett P-value corresponds to Bartlett trace statistics. L-R statistic is a likelihood ratio test statistic. C.V. represents the critical value at 5% level. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Decomposed income and appreciation indices allow us to further examine the mechanism of the long-term cointegration relation. Given that there is a cointegration relation between the total price indices of EREITs and those of MREITs, it is of interest to study which decomposed component (or both) contributes to this cointegration equilibrium. Table 5 reports the results among the four decomposed REIT indices.

In Panel A of Table 5, n = 4 shows that there are four indices in the system. As expected, one significant CIV still remains as the significant trace statistic (Bartlett λ_{trace} =229.028, *p*-value = 0.000) rejects the null hypothesis of r = 0. Trace statistics cannot reject the null hypothesis of $r \leq 1$ (Bartlett λ_{trace} = 37.235, P-value = 0.166) thus implying that there is only one significant CIV. The results of the exclusion tests of the four indices are presented in Panel B. The insignificant L-R test statistics implies exclusion from the cointegration relation, and vice versa. Both EREIT Appreciation (L-R = 0.080, *p*-value =

0.777) and MREIT Appreciation (L-R = 0.930, *p*-value = 0.335) should be excluded from the cointegration equilibrium based on their insignificant L-R test statistics. Again, we conduct robustness tests by using the recursive test based on "R-representation" and recursive likelihood-ratio test based on the "test of beta" from Hansen and Johansen (1999) to confirm that there is one and only one significant cointegration relation between the EREIT and MREIT income streams, and that this relationship is stable over time. Together, the results in Tables 4 and 5 offer an important finding: the total price indices of EREITs and MREITs have a long-term cointegration relation due to income streams, but the appreciation component does not contribute to long-term cointegration.

Table 5 Long-run Cointegration Analyses among Decomposed Indices

Panel A: Test of Cointegration Rank with Four Decomposed Indices

n-r	r	Eig. Value	5% C.V.	Bartlett λ_{Trace}	Bartlett *p*-value
4	0	0.304	232.334	229.028	0.000***
3	1	0.109	80.711	37.235	0.166

Panel B: Test of Exclusion with Four Decomposed Indices

Indices (n=4)	r	DGF	5% C.V.	EREIT Appreciation	EREIT Income	MREIT Appreciation	MREIT Income
L-R statistic	1	1	3.841	0.080	8.739	0.930	14.373
p-value				0.777	0.003***	0.335	0.000***

Note: Test period is from 198001 to 201412. DGF represents the degree of freedom. Eig. Value is the eigenvalue. Bartlett trace is a small sample correction for each cointegration rank test. Bartlett P-value corresponds to Bartlett trace statistics. L-R statistic is a likelihood ratio test statistic. C.V. represents the critical value at 5% level. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Next, we focus on the relation between EREITs and MREITs in the short-term. He (1998) documents a short-term causal relationship that runs from the total returns of EREITs to those of MREITs. With a decomposed return series, we want to know which component (i.e. appreciation or income returns) produces such short-term causality. The first step is to examine and verify the short-term causal relationship between TEREITs and TMREITs by conducting Granger causality, CVD, and IRF tests.

To test if total EREIT returns (TEREIT) Granger-cause total MREIT returns (TMREIT) in the short-run, we test if the coefficient on the lagged TEREIT is jointly significant as measured by the F-statistic or if the coefficient of the one-period lagged $ECT\{1\}$ is significant as measured by the *t*-statistic, and vice versa. *ECT* is the error correction term from the above cointegration test. Panel

A of Table 6 shows that TEREIT is neither Granger-caused by the lagged TMREIT (F-test$_{\mathrm{TMREIT}}$ = 1.4607, p-value$_{\mathrm{TMREIT}}$ = 0.14) nor by the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = -0.0060, p-value$_{ECT\{1\}}$ = 0.66). On the contrary, TMREIT is significantly Granger-caused by not only the lagged TEREIT (F-test$_{\mathrm{TEREIT}}$ = 1.7885, p-value$_{\mathrm{TEREIT}}$ = 0.05) but also by the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = 0.0194, p-value$_{ECT\{1\}}$ = 0.09). These results suggest that short-term causality runs unilaterally from TEREIT to TMREIT but not in the opposite direction.

To test if total EREIT returns (TEREIT) Granger-cause total MREIT returns (TMREIT) in the short-run, we test if the coefficient on the lagged TEREIT is jointly significant as measured by the F-statistic or if the coefficient of the one-period lagged $ECT\{1\}$ is significant as measured by the t-statistic, and vice versa. *ECT* is the error correction term from the above cointegration test. Panel A of Table 6 shows that TEREIT is neither Granger-caused by the lagged TMREIT (F-test$_{\mathrm{TMREIT}}$ =1.4607, p-value$_{\mathrm{TMREIT}}$ = 0.14) nor by the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = -0.0060, p-value$_{ECT\{1\}}$ = 0.66). On the contrary, TMREIT is significantly Granger-caused by not only the lagged TEREIT (F-test$_{\mathrm{TEREIT}}$ = 1.7885, p-value$_{\mathrm{TEREIT}}$ = 0.05) but also by the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = 0.0194, p-value$_{ECT\{1\}}$ = 0.09). These results suggest that short-term causality runs unilaterally from TEREIT to TMREIT but not in the opposite direction.

For testing of robustness, we report the CVD up to 6 months in Panel B of Table 6. When we examine the decomposition of variance for TEREIT, the results in the left panel suggest that 100% (0%) of the 1-month ahead forecast error variance of TEREIT is explained by itself (TMREIT). Up to 2-months (6-months) ahead, TMREIT explains only 0.768% (2.345%) of the TEREIT variance. In contrast, the results of the variance decomposition for TMREIT, in the right panel, suggest that TMREIT partially explains 72.73% of its own 1-month ahead forecast error variance and the rest, 27.27%, can be explained by TEREIT. The explanatory power of TEREIT on TMREIT increases to 29.107% in 6 months. The results suggest that, in the first 6 months, a quarter of the TMREIT forecast error variances can be explained by TEREIT but almost no TEREIT forecast error variances can be explained by TMREIT. This supports the unilateral causality that runs from TEREIT to TMREIT.

The IRF test discerns the speed with which a one-standard-deviation shock in the return of an asset is transferred to the return of another asset. We report up to 6 months after the initial shock. As shown in Panel C of Table 6, a one-standard-deviation shock from TEREIT produces a contemporaneous increase in itself by 0.047491 and TMREIT by 0.028339 units. After one period, TEREIT is still 0.008983 units above the initial value whereas TMREIT is still 0.007568 units away from its initial value. On the contrary, a one-standard-deviation shock from TMREIT has no contemporaneous effect (0.000000) on TEREIT even though it impacts itself by 0.046280 units. After 6 months,

Table 6 Short-run Causal Analyses between Total Return Series

Panel A: Total Price Indices Ganger Causality F-test within CIV

	TEREIT (X)	**TMREIT (X)**	***ECT*{1}**
TEREIT (Y)	-	1.4607	-0.0060
p-value	-	0.14	0.66
TMREIT (Y)	1.7885	-	0.0194
P-value	0.05***	-	0.09**

Panel B: Cholesky Variance Decomposition of Total Return Series

Decomposition of Variance for TEREIT				**Decomposition of Variance for TMREIT**			
Step	**Std. Error**	**TEREIT (%)**	**TMREIT (%)**	**Step**	**Std. Error**	**TEREIT (%)**	**TMREIT (%)**
1	0.047491	100.000	0.000	1	0.054267	27.27	72.73
2	0.04852	99.232	0.768	2	0.054914	28.531	71.469
3	0.048551	99.229	0.771	3	0.055264	29.406	70.594
4	0.049247	98.958	1.042	4	0.055772	29.083	70.917
5	0.050577	98.103	1.897	5	0.056314	29.383	70.617
6	0.051135	97.655	2.345	6	0.056823	29.107	70.893

Panel C: Impulse Response Function of Total Return Series

Response to Shock in TEREIT			**Response to Shock in TMREIT**		
Entry	**TEREIT**	**TMREIT**	**Entry**	**TEREIT**	**TMREIT**
1	0.047491	0.028339	1	0.000000	0.04628
2	0.008983	0.007568	2	0.004251	0.003655
3	0.001697	0.006142	3	0.000315	0.000933
4	0.007809	0.002555	4	0.002664	0.007058
5	0.010464	0.005215	5	0.004823	0.005792
6	0.006635	0.002828	6	0.003574	0.007042

Note: Test period is from 198001 to 201412. TEREIT represents total EREIT returns while TMREIT represents total MREIT returns. Panel A shows Granger causality F-test statistics, (X) represents independent variables; (Y) represents dependent variables, *ECT*{1} represents the error correct term with 1 lag. In Panel B, the Cholesky variance decomposition depicts a rich interaction between two indices. We report by what percentage of one index's forecast error variance can be explained by both itself and another index up to 12 steps ahead. In Panel C, the impulse response function shows how one index's return responses to one standard deviation shock to its own returns and another index's returns up to 12 subsequent entries. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

TMREIT (TEREIT) is 0.007042 (0.003574) units above its initial value. The IRF shows that TMREIT responds significantly to contemporaneous shocks from TEREIT and the response continues for several months after the initial shocks in TEREIT. However, TEREIT does not respond to contemporaneous shocks from TMREIT. We conclude that TEREIT returns lead TMREIT returns and the direction is unidirectional. Results from both the CVD and IRF tests are consistent with the Granger-causality test, thus confirming that short-term causality from EREIT to MREIT is unidirectional which is consistent with the argument in He (1998).

More importantly, we want to know which component (i.e. appreciation or income returns) produces a unidirectional short-term causality from EREIT to MREIT. In Tables 7 to 9, we provide the results from the Granger-causality, CVD, and IRF tests, respectively, on decomposed AEREIT, AMREIT, IEREIT, and IMREIT.

In Panel A of Table 7, similar to their total return series, AEREIT is Granger-caused by neither the lagged AMREIT (F-test$_{\text{AMREIT}}$ = 1.5048, p-value$_{\text{AMREIT}}$ = 0.12) nor by the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = 0.0039, p-value$_{ECT\{1\}}$ = 0.66). However, AMREIT is significantly Granger-caused by both the lagged AEREIT (F-test$_{\text{AEREIT}}$ = 1.8893, p-value$_{\text{TEREIT}}$ = 0.03) and the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = 1.1211, p-value$_{ECT\{1\}}$ = 0.04). In Panel B of Table 7, we find that IEREIT is not Granger-caused by either the lagged IMREIT (F-test$_{\text{IMREIT}}$ = 0.8286, p-value$_{\text{IMREIT}}$ = 0.62) or the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = 0.0019, p-value$_{ECT\{1\}}$ = 0.51). IMREIT is also not Granger-caused by the lagged IEREIT (F-test$_{\text{IEREIT}}$ = 0.9161, p-value$_{\text{IEREIT}}$ = 0.53) and the one-period lagged error correction term (t-stat$_{ECT\{1\}}$ = 0.0008, p-value$_{ECT\{1\}}$ = 0.54). Thus, the unidirectional short-term causality between TEREIT and TMREIT is unlikely produced by income components. These results show a large similarity between total and appreciation returns in terms of causality. We conclude that a short-term causality runs unilaterally from AEREIT to AMREIT but not in the opposite direction.

In Table 8, we report the CVD on the appreciation component (income component) in Panel A (Panel B). In Panel A, AEREIT explains 100% of its 1-month ahead forecast of the error variance while AMREIT explains only 0.443% (1.813%) of the 2-month (6-month) ahead forecast error variance in AEREIT. Similar to the results of the total return series in Table 6, AMREIT partially explains 73.923% (first row in the last column) of its own 1-month ahead forecast error variance and the remaining 26.077% is explained by AEREIT, and such explanatory power by AEREIT on AMREIT increases to 28.385% after 6 months. In Panel B, however, each index can only be explained by itself, and not by its counterpart. IEREIT explains 100% and IMREIT explains 99.279% of their own 1-month ahead forecast error variance. In 6 months, IEREIT (IMREIT) explains 99.618% (98.793%) of its forecast error variance. In conclusion, the appreciation returns of MREITs can be explained by itself and EREIT. However, the appreciation of EREIT can only be explained by itself and not MREITs. For the income component, each income return series can only be explained by itself, thus suggesting that there is no causal relation between the income components of the EREITs and MREITs.

Table 7 Short-run Causal Analyses among Decomposed Return Series

Panel A: Ganger Causality F-test within the Appreciation CIV

	AEREIT (X)	AMREIT (X)	*ECT*{1}
AEREIT (Y)	-	1.5048	0.0039
P-value	-	0.12	0.66
AMREIT (Y)	1.8893	-	0.1211
P-value	0.03**	-	0.04**

Panel B: Ganger Causality F-test within the Income CIV

	IEREIT (X)	IMREIT (X)	*ECT*{1}
IEREIT (Y)	-	0.8286	0.0019
P-value	-	0.62	0.51
IMREIT (Y)	0.9161	-	0.0008
P-value	0.53	-	0.54

Note: Test period is from 198001 to 201412. AEREIT and AMREIT represent appreciation component of EREIT and MREIT returns respectively. IEREIT represents income component of EREIT returns while IMREIT represents income component of MREIT returns. Panel A shows Granger causality F-test statistics, (X) represents independent variables; (Y) represents dependent variables, *ECT*{1} represents the error correction term with 1 lag. Panel A shows the Granger causality test results with cointegration vector of appreciation component and Panel B shows the Granger causality test results with Income as a component of the cointegrative vector.

The IRF test results in Table 9 also show a similarity in the relationship between AEREIT and AMREIT as that between their total return series. As shown in Panel A of Table 9, a one-standard-deviation shock from AEREIT produces a contemporaneous increase in itself by 0.047252 and AMREIT by 0.027748 units. A one-standard-deviation shock from AMREIT has no contemporaneous effect (0.000000) on AEREIT but a unit impact of 0.046719 on itself. This pattern is very similar to the one presented in Table 6 with total returns. Alternatively, in Panel B of Table 9, a one-standard-deviation shock from IEREIT results in a contemporaneous jump in itself by merely 0.001625 and IMREIT by 0.000759 units, and a one-standard-deviation shock from IMREIT has no contemporaneous effect (0.000000) on IEREIT and an infinitesimal unit impact of 0.004708 on itself. It is clear that a shock in the return of either IEREIT or IMREIT does not transfer to its counterpart.

Table 8 CVD among Four Decomposed Return Series

Panel A: CVD on Appreciation Returns

Decomposition of Variance on AEREIT				Decomposition of Variance on AMREIT			
Step	Std. Error	AEREIT (%)	AMREIT (%)	Step	Std. Error	AEREIT (%)	AMREIT (%)
1	0.047252	100.000	0.000	1	0.054338	26.077	73.923
2	0.048276	99.557	0.443	2	0.054996	27.617	72.383
3	0.048327	99.528	0.472	3	0.055344	28.521	71.479
4	0.048985	99.275	0.725	4	0.056033	27.996	72.004
5	0.050335	98.656	1.344	5	0.056585	28.583	71.417
6	0.050894	98.187	1.813	6	0.05695	28.385	71.615

Panel B: CVD on Income Returns

Decomposition of Variance on IEREIT				Decomposition of Variance on IMREIT			
Step	Std. Error	IEREIT (%)	IMREIT (%)	Step	Std. Error	IEREIT (%)	IMREIT (%)
1	0.001625	100.000	0.000	1	0.004769	0.721	99.279
2	0.001627	99.825	0.175	2	0.004829	0.837	99.163
3	0.001632	99.811	0.189	3	0.004836	0.89	99.11
4	0.001717	99.828	0.172	4	0.004979	0.948	99.052
5	0.001724	99.829	0.171	5	0.004997	1.098	98.902
6	0.001738	99.618	0.382	6	0.005019	1.207	98.793

Note: Test period is from 198001 to 201412. IEREIT (AEREIT) represents income (appreciation) component of EREIT returns while IMREIT (AMREIT) represents income (appreciation) component of MREIT returns. In Panel A, the Cholesky variance decomposition depicts a rich interaction between two AEREIT and AMREIT. We report by what percentage of one index's forecast error variance can be explained by both itself and another index up to 6 steps ahead. In Panel B, the Cholesky variance decomposition depicts a rich interaction between two IEREIT and IMREIT. We report by what percentage of one index's forecast error variance can be explained by both itself and another index up to 6 steps ahead. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

To present a more straightforward comparison among the total, appreciation, and income returns, we provide a graphical demonstration of IRF up to 12 subsequent periods after the initial shocks in Figure 3. In sum, we find that the unidirectional short-term causality from the total returns of EREIT to those of MREIT is produced by the appreciation returns (i.e. from AEREIT to AMREIT) but not by the income components.

Lastly, we focus on seven economic factors (four macroeconomic factors, two real estate related factors, and one stock market factor as explained in Section 5.4) that drive the heterogeneity between the income and appreciation components of EREITs and MREITs. Based on these factors, we perform a VAR analysis to examine whether the four components (AEREIT, AMREIT, IEREIT and IMREIT) respond to the changes of the same economic factors. Following a standard procedure, we impose 12 lags on each of the seven economic factors and the 1-month lagged REIT return is the control variable. The results are reported in Table 10.

Table 9 IRF among Four Decomposed Return Series

Panel A: Impulse Response Function of Appreciation Returns

Response to Shock in AEREIT			Response to Shock in AMREIT		
Entry	**AEREIT**	**AMREIT**	**Entry**	**AEREIT**	**AMREIT**
1	0.047252	0.027748	1	0.000000	0.046719
2	0.009355	0.008084	2	0.003212	0.002565
3	0.002061	0.006188	3	0.000835	0.000343
4	0.007593	0.002325	4	0.002526	0.008445
5	0.010835	0.006017	5	0.004082	0.005093
6	0.006611	0.002331	6	0.003591	0.006004

Panel B: Impulse Response Function of Income Returns

Response to Shock in IEREIT			Response to Shock in IMREIT		
Entry	**IEREIT**	**IMREIT**	**Entry**	**IEREIT**	**IMREIT**
1	0.001625	0.000759	1	0.000000	0.004708
2	-0.000017	0.000166	2	0.000068	-0.00074
3	0.000128	-0.00026	3	0.000020	0.000027
4	0.000535	0.000384	4	-0.000006	0.001118
5	0.000147	0.000234	5	0.000004	0.000360
6	0.000205	0.000152	6	0.000080	0.000438

Note: Test period is from 198001 to 201412. IEREIT (AEREIT) represents income (appreciation) component of EREIT returns while IMREIT (AMREIT) represents income (appreciation) component of MREIT returns. In Panel A (Panel B), the impulse response function shows return responses of one index to a standard deviation shock to its own returns and returns of another index up to 12 subsequent entries for appreciation (income) components. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Prior studies have documented an increasing integration of REITs with equity markets (see Nelling and Gyourko, 1998; Ling, Naranjo, and Ryngaert, 2000) so we expect that the S&P 500 index returns affect all REIT returns. We first examine the sensitivity of income returns to economic factors, see Panel A of Table 10. For IEREIT, the S&P 500 index return is the only economic factor that significantly affects IEREIT returns (F-stat$_{SP500R}$= 1.72, p-value$_{SP500R}$= 0.06). Similarly, for IMREIT, the S&P 500 index return is also the only economic factor that significantly affects IMREIT returns (F-stat$_{SP500R}$= 1.91, p-value$_{SP500R}$= 0.03). This finding supports the argument made by Peterson and Hsieh (1997) that EREITs have a similar performance as common stocks. However, our finding that IMREIT is also sensitive to stock market returns has not been reported in the real estate literature. [20] We do not see much heterogeneity between IEREIT and IMREIT, which is evidence of their long-term stable cointegration relation.

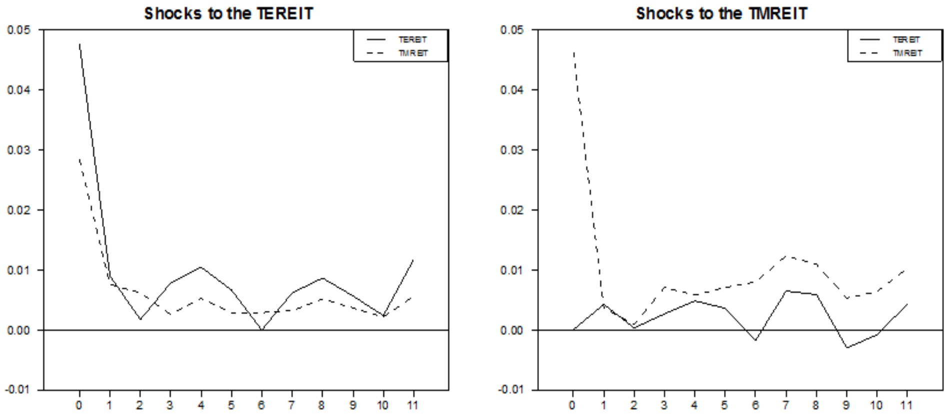
We further look at the sensitivity of the appreciation returns to the economic factors, see Panel B of Table 10. In contrast to the findings based on income returns, three economic factors significantly influence AEREIT: the S&P 500 index return (F-stat$_{SP500R}$= 10.80, p-value $_{SP500R}$= 0.00), industrial production growth rate (F-stat$_{INDPRO}$= 1.64, p-value$_{INDPRO}$= 0.08), and changes in mortgage rate (F-stat$_{MTGER}$=1.95, p-value$_{MTGER}$= 0.03). In addition, both the S&P 500 index return (F-Stat$_{SP500R}$= 5.01, p-value$_{SP500R}$= 0.00) and term structure (F-stat$_{TS}$=1.90, p-value$_{TS}$= 0.04) significantly affect AMREIT returns.

The term structure (TS) reflects the expectations of market participants on future changes in interest rates. Table 10 shows that AMREIT is responsive to the TS but AEREIT is not (F-stat=0.81, p-value=0.64). According to the literature, mortgage REITs are more bond-like securities and bond prices are sensitive to interest rate changes. Bond duration measures the effective time to maturity so that bonds with longer durations are more price sensitive to changes in interest rates, all else being equal. An MREIT index can be treated as a portfolio that consists of many mortgage REIT securities with different durations. We expect that the appreciation returns of MREITs are more correlated to duration as to interest rate risk. As a comparison, equity REITs are more stock-like securities, so their appreciation returns are less responsive to interest rate risk.

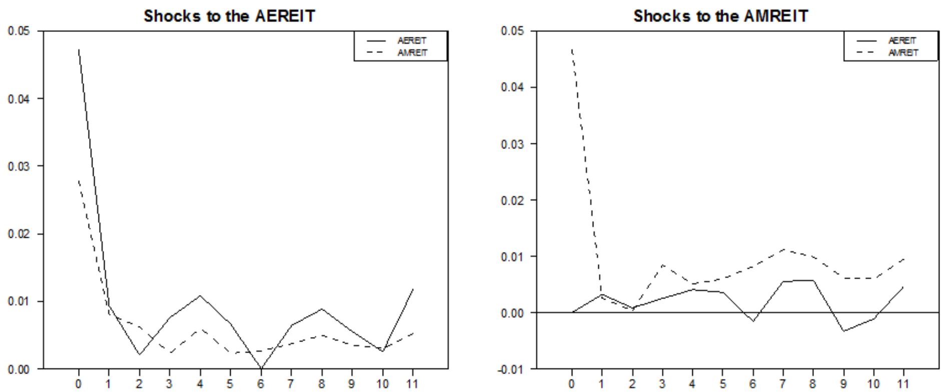
[20] We follow the model in Lee and Chiang (2004) that has seven economic factors which include the S&P500 return factor. We believe the including the S&P500 return variable in the model is not subject to endogeneity problems. Any equity portfolio would be expected to be affected by the market portfolio. We orthogonalize the REIT returns by running them against S&P500 returns and use the residual series to replace the original REIT returns. We then run the same VAR model. After orthogonalization, the S&P500 variable becomes insignificant but other variables are not affected.

Figure 1 Impulse Response Functions

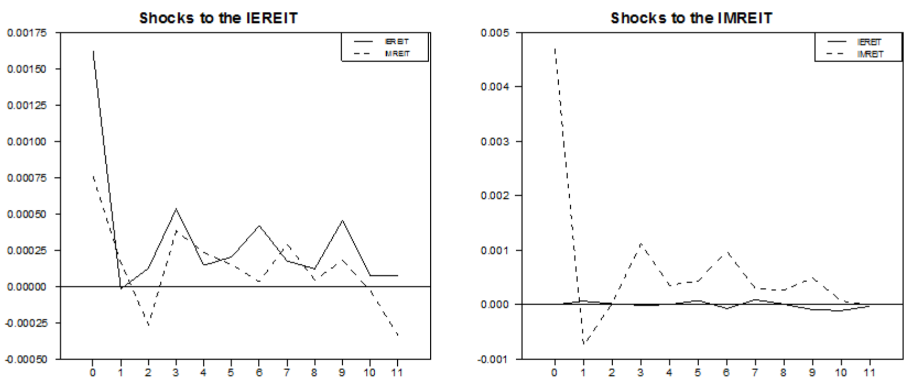
Panel A: Impulse Response Functions on Total Returns



Panel B: Impulse Response Function on Appreciation Component



Panel C: Impulse Response Functions on Income Component



Neither AEREIT nor AMREIT is affected by its own return lags since the appreciation return series are shown to be a stationary process with no autocorrelation, see Kleiman, Payne, and Sahu (2002). The results reported in Panel B of Table 10 show that the economic factors that drive AEREIT returns are different from those that drive AMREIT returns, except for the common SP500 returns. In sum, our findings show that IEREIT and IMREIT are affected by the same market factors while AEREIT and AMREIT returns are affected by different macroeconomic factors which cause heterogeneity between these two REIT securities.

Table 10 Sensitivity of Returns to Economic Factors

Panel A: Sensitivity of Income Returns to Economic Factors

Sensitivity of IEREIT			**Sensitivity of IMREIT**		
Variable	**F-Stat**	***p*-value**	**Variable**	**F-Stat**	***p*-value**
INDPRO	1.49	0.13	INDPRO	0.83	0.62
TS	0.57	0.87	TS	0.74	0.72
DEF	0.95	0.50	DEF	0.71	0.74
INFL	1.02	0.43	INFL	0.82	0.63
SP500R	1.72*	0.06	SP500R	1.91**	0.03
MTGER	0.46	0.94	MTGER	0.65	0.80
HSTARTS	0.7	0.75	HSTARTS	1.22	0.27
IEREITt-1	15.31***	0.00	IMREITt-1	35.99***	0.00

Panel B: Sensitivity of Appreciation Returns to Economic factors

Sensitivity of AEREIT			**Sensitivity of AMREIT**		
Variable	**F-Stat**	***p*-value**	**Variable**	**F-Stat**	***p*-value**
INDPRO	1.64 *	0.08	INDPRO	0.84	0.61
TS	0.81	0.64	TS	1.90**	0.04
DEF	1.39	0.17	DEF	0.56	0.87
INFL	1.11	0.35	INFL	0.93	0.52
SP500R	10.80***	0.00	SP500R	5.01***	0.00
MTGER	1.95**	0.03	MTGER	1.43	0.15
HSTARTS	0.66	0.79	HSTARTS	1.02	0.43
AEREITt-1	0.65	0.79	AMREITt-1	0.94	0.51

Note: This exhibit reports analysis results of VAR with 12 lags, with REIT returns as the dependent variable. Test period is from 198001 to 201412. IEREIT (AEREIT) represents income (appreciation) component of EREIT returns while IMREIT (AMREIT) represents income (appreciation) component of MREIT returns. INDPRO is the industrial production growth rate, INFL is the unexpected inflation rate which is defined as changes in seasonally adjusted consumer price index, TS is the term structure which is defined as (20-yr)-(1-yr) yield, DEF is the risk premium which is defined as BAA-AAA yield, MTGED is the changes in 30-year conventional mortgage rate, HSTARTS is the percentage change of new private housing starts, and SP500R is the S&P 500 index return. Each of the eight independent variables is with its 1 lag in the VAR system. This exhibit reports if the coefficients on the lagged economic factors are jointly significant as measured by the F-statistics. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

7. Conclusion

Prior studies have focused on total prices (returns) when examining the long-term cointegration (short-term causal) relation between EREITs and MREITs. We investigate the long-term and short-term relations between EREITs and MREITs by decomposing the total data series into income and appreciation components. In particular, we study the interrelationship between the income and appreciation components of EREITs and MREITs. We offer three important contributions to the real estate literature. First, consistent with previous findings, we report a stable long-term cointegration relation between the total price index of EREITs and that of MREITs. In contrast to prior studies, we find that the cointegration relation stems from income streams while the appreciation component does not contribute to the cointegration equilibrium.

Second, by using a total return series, we also confirm the finding in He (1998) that EREIT returns cause MREIT returns. However, after further examining the decomposed return series, we find that a short-term Granger causality runs unilaterally from the appreciation returns of EREITs to those of MREITs while income return does not produce any unilateral or bilateral causal relations. The CVD and IRF tests further suggest that the previously documented short-term unilateral causality in the total return level is a manifestation of the underlying appreciation return causality between EREITs and MREITs.

Last, the VAR tests show that income returns of both EREITs and MREITs are affected by the same factor - the S&P 500 return. This helps explain their long-term stable relation. For appreciation returns, we report that the S&P 500 index return, industrial production growth rate, and mortgage rate changes affect the appreciation returns in EREITs while only the S&P 500 index return and TS affect the appreciation returns in MREITs. Different macroeconomic factors explain for the heterogeneous performance in appreciation returns between EREITs and MREITs. In sum, the income components help to maintain the long-term cointegration relation between EREITs and MREITs while the appreciation components produce heterogeneities between them.

Given that EREIT and MREIT total prices are cointegrated in the long-run, our empirical results suggest that there would be few risk reducing benefits from holding both assets in a portfolio. EREITs and MREITs would not complement each other in a broadly diversified portfolio due to their cointegration relation. In addition, we report that the total returns of EREITs Granger cause those of MREITs, thus implying that EREITs have a primary role and MREITs have a subordinate role. In terms of asset class allocation, we contend that MREITs are redundant assets and EREITs are the preferred public real estate securities needed in a portfolio.

The results of the decomposed data also have implications for portfolio management. In the future, when separate trading of REIT appreciation and income securities becomes available, it would be sub-optimal to hold both EREITs and MREITs as the income securities simultaneously in a portfolio due to their cointegration relation. In addition, it would also be sub-optimal to hold both EREITs and MREITs as appreciation securities simultaneously due to their causal relation. An optimal strategy would be collective, with either the appreciation securities of EREITs plus the income security of MREITs or just the entire EREIT (EREIT as appreciation plus income securities).

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