Inflation-Hedging Properties of Equity REITs:

Before and After the 1990s Structure Break

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Abstract

Unsecuritized real estate is often hailed for its inflation-hedging quality. Do equity real estate investment trusts (REITs) exhibit the desirable inflation hedging characteristics as well? Does the early 1990s structure change in the REIT industry affect the properties? The results reveal a change in the inflation-hedging properties before and after the early 1990s. Particularly REITs provide significant hedging service for expected inflation in the long-run after the structure break but not before the break. This finding is consistent with the view that a more sophisticated investor base in the REIT market after the break improves information flow and helps REIT prices better reflect the performance of underlying real estate (Ziering et al. (1997)).

Keywords: real estate, REIT, inflation, DOLS, structure break

Introduction

Inflation is a risk which essentially erodes the purchasing power of assets. Investors are searching for investments that can keep pace with inflation. Real estate is often hailed for its inflation-hedging quality. Because of some adverse features, unsecuritized real estate investments are in practice mainly limited to large domestic institutional investors. These features include large fund outlay, low liquidity, high transaction costs, maintenance expenditure, need of market knowledge, and management requirements (Wilson and Zurbruegg (2003)). From the perspectives of portfolio managers and small investors, real estate stocks overcome many of these drawbacks. Nevertheless a critical question is whether real estate securities exhibit desirable inflation hedging characteristics as do unsecuritized real estate investments.

To address this issue, academic studies have examined the inflation risk of real estate stocks. Many focus on the short-run relationship between US REIT (real estate investment trust) returns and inflation. Most of the studies indicate that REITs provide no or perverse inflation hedge (expected inflation as well as unexpected inflation) in the short run, each of which are equally supported approximately. With regards to their long-run relationships, the relatively few existing studies, Chatrath and Liang (1998), Glascock et al. (2002), and Stevenson (2001), reveal conflicting results on the hedging ability of REITs on total inflation. The study of Hoesli et al. (2008) is the exception that investigate the long-run relationship with expected inflation as well as unexpected inflation. According to their results, US REITs provide significantly reverse (perverse) hedges on expected (unexpected) inflation in the long-run.

Viewed from the vantage point of the generalized Fisher hypothesis, real estate securities are anticipated to hedge expected inflation, in light of the inflation-hedging quality of direct real estate documented in the literature.[1] Central to this particular form of the Fisher effect is the proposition that real estate security prices in nominal terms positively reflect expected inflation and their positive relationship can be found statistically (Al-Khazali and Pyun (2004)). However as mentioned above, comparatively few studies provide empirical evidence for the Fisher effect. A well-known explanation for this phenomenon is the proxy hypothesis introduced by Fama (1981).

The proxy hypothesis attributes the observed inflation- real estate security relationships to missing variables (Hoesli et al. (2008)). Real activity, monetary policy, and stock market movement are those most commonly considered in the real estate stock literature (Chatrath and Liang (1998); Glascock et al. (2002); Hoesli et al. (2008)). The literature is frequently unclear whether the Fisher effect is expected to

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[1] Generally direct real estate is found a good hedge against expected inflation, but is inconclusive on the impact of unexpected inflation (Brueggeman et al. (1984); Hartzell et al. (1987); Rubens et al. (1989); Huang and Hudson-Wilson (2007)).

appear in the short run and/or long run (Lee et al. (1998)). Nevertheless, in the literature, distinctions are made between short-run and long-run relationships with the hypothesis that the effect hold in the long run (Lee et al. (1998); Hoesli et al. (2008)). Interestingly Hoesli et al. (2008) is the only one study found to explore the proxy hypothesis in a long-run framework.

The purpose of this study is to study both the short-run and long-run inflation-hedging properties of equity REITs. To consider the inflation proxy hypothesis, the study conducts the examination with dynamic ordinary least squares (DOLS) and error-correction modeling approaches. The motivation is twofold. First, the structure change in the REIT industry in the 1990s is well documented in the literature (e.g. Glascock et al. (2000); Lee and Lee (2003); Clayton and Mackinnon (2003); Lee et al. (2008)). Furthermore this structure change could be a partial reason for the mixed results about REIT inflation-hedging properties reported in the previous studies (Hoesli et al. (2008)). Although Hoesli et al. (2008) clearly point out this possibility, no study explicitly examines its influence. This study fills this void and contributes to the literature. Second, the long-run inference of Hoesli et al. (2008) is likely to be clouded with an endogeneity issue (Stock and Watson (1993); Enders (1995); Wooldridge (2003)). By employing dynamic ordinary least squares, this study improves the inference on the long-run inflation hedging properties of real estate stocks and makes another contribution.

The next section reviews the relevant literature discussing the proxy hypothesis for real estate stock prices. Section 3 describes the data and methodology employed to analyze the inflation-price relationships. Section 4 presents the empirical findings and discussions. Section 5 concludes the paper.

The Proxy Hypothesis and Real Estate Stock Price

The theory of interest rates, postulated by Fisher (1930), hypothesizes that, in expectations, the nominal return on an asset should equal to its expected real return plus expected rate of inflation. Higher expected inflation, thus, ought to push higher nominal return rewarded to asset investors, all things equal. The literature of direct real estate appears to reach a consensus to support this Fisher hypothesis (Glascock et al. (2002)). To prevent arbitrage, real estate stocks, which represent claims against real estate assets, thus are expected to serve as a hedge against expected inflation (Al-Khazali and Pyun (2004)).

Nevertheless the literature of real estate stocks produces sparse evidence for the generalized Fisher hypothesis. Recent studies have attempted to explain the anomaly with the proxy hypothesis which attributes the observed inflation- real estate security relationships to missing variables (Hoesli et al. (2008)). The hypothesis can be traced to Fama (1981) and extended by Geske and Roll (1983) who explain the inconsistency in terms of the fundamental relationship among real activities, stock returns and monetary policy. According to Fama (1981), money demand theory with rational expectation predicts a negative relation between expected inflation and anticipated real activity. This negative inflation-real activity relation can be reinforced by counter-cyclical monetary responses of central banks to real activity shocks (Geske and Roll (1983)). Meanwhile, under rational expectation, favorable future real activity should imply positive stock price movement. This chain of events induces spurious negative relations between stock returns and inflation documented in empirical studies.

In addition to real activities and monetary policy proxies, the literature commonly incorporate stock market returns in studying the short-run inflation-hedging properties of real estate stocks. Darrat and Glascock (1989) investigate the properties of real estate stock portfolios include REITs, builders, real estate investment and management firms during January 1965 to December 1986. After controlling the influences of monetary policy and the stock market, total inflation has no significant effects on returns of US real estate stocks.[2]

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[2] Considering the influences of stock market and monetary policy, Simpson et al. (2007) reveal asymmetric response of REIT returns to inflation with pool regressions. Nevertheless their results are not robust under time-series regressions.

Murphy and Kleiman (1989), Yobaccio et al. (1995), and Chatrath and Liang (1998) are examples of studies on the REIT inflation-hedging ability, controlling stock market-induced proxy effect only. In the study of Murphy and Kleiman (1989), incorporation of stock market returns makes the correlation between REIT returns and expected inflation from significantly negative to insignificant during 1972-1985. Nevertheless REIT returns are still significantly and negatively correlated with expected inflation in Yobaccio et al. (1995) study. Similarly, purged of the stock market component, hedged REIT returns are significant negatively associated with inflation in the study of Chatrath and Liang (1998) over the 1972-1995 interval. Accordingly they rule out the possibility of the stock market-induced proxy effect on REIT inflation-hedging properties in the short-run.

Extending Darrat and Glascock (1989), Glascock et al. (2002) focus on REITs and separate expected inflation from unexpected inflation in their investigation over the interval from January 1972 to December 1995. They examine the causal relationship among REIT returns, real activity, monetary policy, and inflation through a vector error correction model (VECM). Their results indicate inflation does not cause REIT returns in the short run. Although they document the cointegration among REIT, expected inflation index, unexpected inflation index, Federal Fund rate, and industrial production, Glascock et al. (2002) do not provide explicit evidence on the long-run hedging properties of REITs on expected inflation.

Hoesli et al. (2008) is the first explicitly investigating the proxy hypothesis in REITs both in the long run and in the short run. Adopting an error correction model (ECM), they examine the linkages between inflation, real activity, monetary policy, common stocks, and REITs. Notably, consistent with the generalized Fisher hypothesis, they are able to produce significantly positive associations between real estate stock prices with expected inflation in the long run. Same to Darrat and Glascock (1989), Glascock et al. (2002) and others, the associations are insignificant in the short run. The results echo the argument of Lee et al. (1998) that the Fisher effect need hold only in the long run according to theory. However the second-order bias may cloud the long-run inference of Hoesli et al. (2008) study (Stock and Watson (1993); Enders (1995); Wooldridge (2003); West and Agbola (2005)). Furthermore they do not examine the possible influence of structure changes in early 1990s on REIT inflation hedging properties.

Data and Methodology

Data Sources and Preview

This study covers the period from 1971:12 to 2007:12. To examine the impact of the structure break in the early 1990s, empirical investigations cover both the full sample period (1971:12-2007:12), and the three sub-periods: 1971:12-1990:12, 1991:12-2007:12, and 1993:01-2007:12. The selection of the 1993 cut-off point is same to Clayton and Mackinnon (2003) and Lee et al. (2008). The separation of the 1991–1992 period from the full sample is because during this time period there was market expectation about the Revenue Reconciliation Act of 1993 (Lee et al. (2008)). The tax legislation included in the Act made large-scale investments in REITs more desirable to institutional investors.

This study collects the monthly series below to measure the performances of the REIT market and the stock market, inflation, monetary policy and real activities. The total return index for equity REITs ($ERTI$) is taken from the National Association of Real Estate Investment Trust (NAREIT). The return index for the US stock market (MI) is obtained from DataStream. Seasonally adjusted consumer price index (CPI), Fed Fund rate (FF), and seasonally adjusted total industrial production index (IP) are obtained from Economagic.com. Return series on 1-month Treasury bill (TB) is collected from Stocks, Bonds, Bills, and Inflation (SBBI) Yearbook and used as the proxy for the risk-free rate.

Following many traditional inflation hedging papers, this study uses the Fama and Gibbons (1984) model to estimate expected and then expected inflation.[3] This

[3] According to Liu et al. (1997), this model performs better than other inflationary estimator. Hoesli et

model starts from the assumption that the risk-free rate (proxied by the expected return on a Treasury bill) is the sum of the expected real risk-free rate and the expected rate of price inflation (Hoesli et al. (2008); Ibbotson Associates (2008)).

By re-arrangement and taking weighted average of past 12 month real rates (estimated as the prior Treasury bill return less the actual inflation) as the expected real risk-free rate, the study defines expected inflation as:

$$EI_t = TB_{t-1} - \frac{1}{12}\sum_{s=t-1}^{t-12}\left(TB_{s-1} - \Delta CPI_s\right) = TB_{t-1} - \frac{1}{12}\sum_{s=t-1}^{t-12}\left[TB_{s-1} - \left(CPI_s - CPI_{s-1}\right)\right]$$

in which EI_t, TB_t, and CPI_t are expected inflation, the 1-month T-bill return, and the consumer price index at time t respectively. Then unexpected inflation at time t, UEI_t is computed as $\Delta CPI_t - EI_t$. From these, we construct EII_t (expected inflation index) and $UEII_t$ (unexpected inflation index) (Glascock et al. (2002)). All indexes are set at 1.00 for January 1994 to eliminate scaling effects, logged for the long-run/level analyses and differenced as appropriate (Hoesli et al. (2008)).

Before estimating the long-run and short-run hedging properties, these series are investigated for their time series properties. Table 1 reports the results from the Phillips-Person (PP) test. The unit-root test is robust to autocorrelation and heteroskedascity and commonly used in previous REIT inflation-hedging studies (Chatrath and Liang (1998); Hoesli et al. (2008); Glascock et al. (2002)). The results

al. (2008) indicate the T-bill based estimation yield qualitative similar results to those of other estimators.

show that the level series contain unit-roots and their first differenced are stationary.[4] Given the integrational properties of the series, we proceed to test the presence of co-integration among the level series with the Johansen and Juselius (JJ) trace test.[5] Panel A of Table 2 show that $\ln(ERTI)$, $\ln(EII)$, $\ln(UEII)$, $\ln(IP)$, and $\ln(FF)$ are co-integrated during the full sample period and during the sub-periods. Previous studies generally do not incorporate stock market indices in the long-run REIT-inflation system. However, according to Glascock et al. (2000), REITs and common stocks share a common stock trend after and do not before the 1993 Act. Thus the first co-integration system is expanded to include $\ln(MI)$ for the sub-periods after 1990. Panel B indicates that the seven series in the second co-integration system are governed by common long-term economic forces.

Long-Run Equilibriums and Short-Run Dynamics

According to the real estate stock-inflation literature, particularly Glascock et al. (2002), real estate stocks, inflation, industrial production, and monetary policy are included in the long-run relationship in US REIT market. Therefore the long-run equilibrium is:

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4 Each series is graphed first to decide whether to include an intercept or a trend in the Phillip-Perron test.

5 Same to West and Agbola (2005) and Herzer and Nowak-Lehnmann (2006), evidence for the presence of co-integration is suffice for the purpose of the current study.

$$\ln(ERTI_t) = \beta_0 + \beta_1 \ln(EII_t) + \beta_2 \ln(UEII_t) + \beta_3 \ln(IP_t) + \beta_4 \ln(FF_t) + u_t \qquad (1)$$

in which $\ln$ is the natural logarithm, t denotes time, $ERTI$ is the equity REIT return index, EII and $UEII$ are expected and unexpected inflation indices, IP and FF are industrial production index and Federal Fund rate, respectively. Extending Equation (1) to incorporate the stock market influence after 1990 leads to the following equation:

$$\ln(ERTI_t) = \beta_0 + \beta_1 \ln(EII_t) + \beta_2 \ln(UEII_t) + \beta_3 \ln(IP_t) + \beta_4 \ln(FF_t) + \beta_5 \ln(MI_t) + u_t \qquad (2)$$

where MI is the stock market index.

Although ordinary least square (OLS) estimators of Equation (1) and (2) are super-consistent, they do not have asymptotic t-distribution (Enders (1995); Wooldridge (2003)). This is because the right-hand side series may be endogenous and likely to be arbitrarily correlated with the co-integration errors. The endogenity invalidates the strict exogeneity assumption which is the important condition needed to obtain an approximately normal statistic for regression estimators of right-hand side series (Wooldridge (2003)). Thus, temptation to conduct significance tests on OLS estimators should be avoided (Enders (1995)).

To overcome this, this study adopts the Stock and Watson (1993) dynamic ordinal least squares (DOLS) to derive the long-run equilibriums implied by Equation

(1).[6] Based on Monte Carlo evidence, DOLS is more favorable, particularly in small samples, compared to a number of alternative estimators of long-run parameters, including those proposed by Engle and Granger (1987), Johansen (1988), and Phillips and Hansen (1990) (Stock and Watson (1993); Masih and Masih (1996)). The DOLS procedure includes contemporaneous, lagged, and lead values of differences of the right hand I(1)-regressors (Stock and Watson (1993); Wooldridge (2003)). Consequently, Equation (1) can be stated in a DOLS-framework as:

$$\begin{aligned}\ln(ERTI_t) = {} & \beta_0 + \beta_1 \ln(EII_t) + \beta_2 \ln(UEII_t) + \beta_3 \ln(IP_t) + \beta_4 \ln(FF_t) + \sum_{k_1=-m_1}^{m_1} \gamma_{k_1} \Delta \ln(EII_{t+k_1}) \\ & + \sum_{k_2=-m_2}^{m_2} \gamma_{k_2} \Delta \ln(UEII_{t+k_2}) + \sum_{k_3=-m_3}^{m_3} \gamma_{k_3} \Delta \ln(IP_{t+k_3}) + \sum_{k_4=-m_4}^{m_4} \gamma_{k_4} \Delta \ln(FF_{t+k_4}) + \zeta_t \end{aligned} \tag{3}$$

Similarly, in a DOLS-framework, Equation (2) can be stated as:

$$\begin{aligned}\ln(ERTI_t) = {} & \beta_0 + \beta_1 \ln(EII_t) + \beta_2 \ln(UEII_t) + \beta_3 \ln(IP_t) + \beta_4 \ln(FF_t) + \beta_5 \ln(MI_t) \\ & + \sum_{k_1=-m_1}^{m_1} \gamma_{k_1} \Delta \ln(EII_{t+k_1}) + \sum_{k_2=-m_2}^{m_2} \gamma_{k_2} \Delta \ln(UEII_{t+k_2}) + \sum_{k_3=-m_3}^{m_3} \gamma_{k_3} \Delta \ln(IP_{t+k_3}) \\ & + \sum_{k_4=-m_4}^{m_4} \gamma_{k_4} \Delta \ln(FF_{t+k_4}) + \sum_{k_4=-m_5}^{m_5} \gamma_{k_5} \Delta \ln(MI_{t+k_5}) + \zeta_t \end{aligned} \tag{4}$$

where Δ denotes the difference operator, and m_1 to m_5 are the numbers of leads of the differenced regressors. Following Bentzen (2004), leads and lags of the differenced variables up to the order of two are initially included in the model estimations, and then insignificant parameters of the leads and lags are omitted

[6] Examples of studies adopting DOLS to estimate long-run equilibriums are Christeva and Noorbakhsh (2000), Zivot (2000), Bentzen (2004), West and Agbola (2005), Herzer and Nowak-Lehnmann (2006) and Chen and Chen (2007).

stepwise to decide the final lead-lag lengths. To correct the possible serial correlation in ζ_t, Equation (3) and (4) is computed with Hildreth-Lu AR(1) correction (Wooldridge (2003)).

A principal feature of cointegrated variables is that their short-run dynamics are influenced by the extent of any deviation from long-run equilibrium. Furthermore, the real estate stock-inflation literature suggests stock market returns incorporated in the short-run dynamics estimation, in addition to those included in the long-run equilibrium.[7] Thus, in this study, the following error correction model (ECM) is specified:

$$\begin{aligned}\Delta \ln(ERTI_t) &= \alpha_0 + \alpha_1 \Delta \ln(EII_t) + \alpha_2 \Delta \ln(UEII_t) + \alpha_3 \Delta \ln(IP_t) \\ &\quad + \alpha_4 \Delta \ln(FF_t) + \alpha_5 \Delta \ln(MI_t) + \alpha_6 ecm_{t-1} + \varepsilon_t\end{aligned} \tag{5}$$

in which ecm is the estimated residual from Equation (1) or (2) whenever appropriate (Phillips and Loretan (1991); Enders (1995); Carruth and Dickerson (2003); Wooldridge (2003)).

Results

Long-run hedging properties

Table 3 reports the Stock-Watson DOLS long-run parameter estimators from Equation (3). Over the full sample period, 1972-2007, the coefficient of $\ln(EII)$ is

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[7] Glascock et al. (2002) and Hoesli et al. (2008) are another studies whose cointegrating regressions contain less variables than sort-run regressions.

not statically significant at any conventional level. This result implies that REIT price is not correlated with the expected inflation index in the long-run. In other words, REITs are neither perverse nor reverse inflation hedge. This contradicts with Hoesli et al. (2008) who suggest REITs provide significant long-run inflation hedge. Consistent with their results, on the other hand, $\ln(UEII)$ has a statically significant and negative coefficient. This coefficient suggests that unexpected inflation hurts REIT investors even in the long-run. The coefficients of $\ln(IP)$ and $\ln(FF)$ are far from being significant at any conventional level. The result implies that industrial production and Federal Fund rate may not be responsible for the controversy over the REIT inflation-hedging properties, at least in the long-run.

Applying the same analysis to the three sub-periods of 1972-1990, 1991-2007, and 1993-2007 reveals that the inflation-hedging properties of REITs evolve over time. Same to the full sample period, REIT price is not moved by expected inflation but hurt by unexpected inflation shock during 1972-1990. On the contrary, $\ln(EII)$ has statically significant and positive coefficients after 1990. The results support the generalized Fisher hypothesis in the long-run. This means that REITs, same to direct real estate, can provide hedge against expected inflation when institutional investors get more involved in the REIT market, due to the Revenue Reconciliation Act of 1993. On the other hand, the coefficient of $\ln(UEII)$ changes from significantly negative to insignificant since 1990.

As shown in Table 4, the changes are robust and remain clear even when the stock market index incorporated in the co-integrating system. Similar to in the full-sample period, the coefficients of $\ln(IP)$ and $\ln(FF)$ in sub-periods are not significant at conventional levels. Except before 1990, $\ln(FF)$ has a significant and negative coefficient. This implies that an increase in Federal Fund rate declines REIT prices before the structure break.

Short-run hedging properties

Table 5 reports the short-run ECM parameter estimators when the stock market index is not in the long-run relationship. Over the full-sample period, REIT returns are not significantly associated with expected inflation, but are negatively with unexpected inflation. The results are similar for the 1972-1990 period. This is consistent with Hoesli et al. (2008). Again a clear change surges after the structure break. Although still insignificant linked to expected inflation, REITs are no longer perverse hedge for unexpected inflation in the short-run after 1990. This is similar to the finding of Glascock et al. (2002). This phenomenon does not affected by the incorporation of the stock market index in the co-integrating system, as shown in Table 6.

Similar to Glascock et al. (2002), the coefficients of $\Delta\ln(IP)$ are not significant at conventional levels in any study periods. $\Delta\ln(FF)$ has significant and negative coefficients during the full-sample period, and before 1990. Nevertheless its coefficient is not significant after that. This pattern indicates that the Fund rate changes decrease REIT returns in the short-run before the structure break. The coefficients of $\Delta\ln(MI)$ are significant and positive in all periods. This reveals that stock market fluctuations affect REIT returns in the short-run. The significant and negative coefficients of error correction terms indicate that the REIT market responds to the discrepancy from long-run equilibrium. The coefficients are larger in magnitude after 1990. This suggests that that adjustment to the discrepancy becomes quicker after the break.

Conclusion

This study investigates the inflation-hedging properties of equity REITs. The DOLS estimates indicate that REITs provide a positive hedge to expected inflation to investors in the long-run after the 1990s structure break. This offers new evidence supporting the Fisher hypothesis. Nevertheless the desirable property does not appear before the structure break. The results confirm the conjecture of Hoesli et al. (2008) that the structural change in the REIT industry may be a partial reason for the mixed results about REIT inflation-hedging properties reported in the previous studies.

This finding is consistent with the idea that a more sophisticated investor base in the REIT market improves information flow and helps REIT prices better reflect the performance of underlying real estate (Ziering et al. (1997)). Furthermore, the result suggests REITs appear to become a better investment candidate to investors, particular those with long time horizons, such as immature defined benefit pension plans.

Table 1: Philips and Perron Unit-Root Tests

	Level Series	Differenced Series
Panel A:1971:12-2007:12		
REIT return index	-2.286	-19.050***
Expected inflation index	-1.998	-2.771*
Unexpected inflation index	-2.098	-16.576***
Industrial production index	-2.125	-14.458***
Federal Fund rate	-1.512	-12.372***
Stock return index	-2.107	-20.562***
Panel B: 1971:12-1990:12		
REIT return index	-1.684	-13.140***
Expected inflation index	0.660	-2.662*
Unexpected inflation index	-1.377	-12.092***
Industrial production index	-2.425	-9.288***
Federal Fund rate	-2.456	-9.744***
Stock return index	-2.296	-14.490***
Panel C: 1991:01-2007:12		
REIT return index	-2.038	-13.867***
Expected inflation index	-0.809	-3.294**
Unexpected inflation index	-1.916	-11.297***
Industrial production index	-0.661	-13.764***
Federal Fund rate	-1.352	-7.135***
Stock return index	-1.345	-14.826***
Panel D: 1993:01-2007:12		
REIT return index	-1.853	-13.144***
Expected inflation index	-0.794	-2.961**
Unexpected inflation index	-1.879	-10.648***
Industrial production index	-1.269	-13.114***
Federal Fund rate	-0.966	-6.187***
Stock return index	-1.285	-13.371***

Notes: ***, **, and * indicate rejection of the unit –root null at the 1%, 5% and 10% level of significance.

Table 2: Johansen and Juselius's Trace tests for co-integration

Panel A: $\ln(ERTI)$, $\ln(EII)$, $\ln(UEII)$, $\ln(IP)$, and $\ln(FF)$ system

r	1971:12-2007:12	1971:12-1990:12	1991:01-2007:12	1993:01-2007:12
0	887.668***	615.593***	326.333***	319.842***
1	108.782***	88.586**	87.087***	87.911***
2	38.018	48.333**	26.675	29.181
3	14.715	15.199	13.751	13.401
4	4.179	5.188	3.729	3.741

Panel B: $\ln(ERTI)$, $\ln(EII)$, $\ln(UEII)$, $\ln(IP)$, $\ln(FF)$, and $\ln(MI)$ system

r	1991:01-2007:12	1993:01-2007:12
0	385.841***	366.721***
1	120.973***	118.475***
2	56.959	52.469
3	31.819	31.917
4	16.353	16.317
5	3.762	4.099

Notes: r indicates the number of co-integrating relationships. $\ln(ERTI)$, $\ln(EII)$, $\ln(UEII)$, $\ln(IP)$, $\ln(FF)$, and $\ln(MI)$ are the logarithms of the equity REIT index, the expected and unexpected inflation indices, industrial production index, Federal Fund rate, and stock market index respectively. ***, **, and * indicate rejection at the 1%, 5% and 10% level of significance.

Table 3: Stock-Watson DOLS long-run parameter estimates from Equation (3)

Time-Period	1972-2007	1972-1990	1991-2007	1993-2007
Constant	27.857***	4.418**	-0.172	-0.362*
	(3.781)	(2.098)	(-1.119)	(-1.662)
$\ln(EII)$	-1.091	-1.318	5.505***	5.607***
	(-1.270)	(-1.157)	(6.011)	(5.680)
$\ln(UEII)$	-7.009***	-8.762***	-3.109	-2.508
	(-3.538)	(-3.650	(-0.857)	(-1.128)
$\ln(IP)$	-0.296	0.117	-0.179	0.347
	(-0.720)	(0.235)	(-0.248)	(0.435)
$\ln(FF)$	-0.064	-0.320***	-0.062	-0.042
	(-0.928)	(-3.260)	(-0.911)	(-0.661)
$\hat{\rho}$	0.999***	0.998***	0.963***	0.964***
	(799.209)	502.153**	42.894***	(45.409)
DW	1.904	1.754	1.970	2.008
LB Q(3)	1.136	3.690	0.220	0.101
Adjusted R^2	0.999	0.998	0.996	0.995
df	405	203	180	160
n	427	223	198	174

Notes: Leads and lags have been included in the equation estimations as indicated by Equation (3) but the parameter values are not reported. $\hat{\rho}$ stands for the autocorrelation of the residuals. D.W. stands for Durbin-Watson statistics. LBQ(3) is Ljung-Box Q test for the null of as a group of up to 3rd order serial correlation among the residuals. d.f. is degree of freedom and n is the sample size. T-values are in the parentheses. $\ln(ERTI)$, $\ln(EII)$, $\ln(UEII)$, $\ln(IP)$, and $\ln(FF)$ are the logarithms of the equity REIT index, the expected and unexpected inflation indices, the industrial production index, and Federal Fund rate respectively. ***, **, and * indicate rejection at the 1%, 5% and 10% level of significance.

Table 4: Stock-Watson DOLS long-run parameter estimates from Equation (4)

Time-Period	1991-2007	1993-2007
Constant	-0.348	-0.677**
	(-1.178)	(-2.066)
$\ln(EII)$	4.660***	5.168***
	(4.033)	(4.438)
$\ln(UEII)$	-0.732	-1.577
	(-0.231)	(-0.848)
$\ln(IP)$	0.400	0.800
	(0.507)	(0.955)
$\ln(FF)$	-0.036	-0.059
	(-0.579)	(-0.986)
$\ln(MI)$	0.172	0.192
	(1.205)	(1.319)
$\hat{\rho}$	0.979***	0.975***
	(60.788)	(62.616)
DW	2.010	2.052
LB Q(3)	2.101	1.325
Adjusted R^2	0.997	0.996
df	180	160
n	198	174

Notes: Leads and lags have been included in the equation estimations as indicated by Equation (4) but the parameter values are not reported. $\hat{\rho}$ stands for the autocorrelation of the residuals. D.W. stands for Durbin-Watson statistics. LBQ(3) is Ljung-Box Q test for the null of as a group of up to 3rd order serial correlation among the residuals. d.f. is degree of freedom and n is the sample size. T-values are in the parentheses. $\ln(ERTI)$, $\ln(EII)$, $\ln(UEII)$, $\ln(IP)$, $\ln(FF)$, and $\ln(MI)$ are the logarithms of the equity REIT index, the expected and unexpected inflation indices, the industrial production index, and Federal Fund rate respectively. ***, **, and * indicate rejection at the 1%, 5% and 10% level of significance.

Table 5: ECM parameter estimates from Equation (1) and (5)

Time-Period	1972-2007	1972-1990	1991-2007	1993-2007
Constant	0.013***	0.013**	0.008	0.007
	(3.654)	(2.195)	(1.047)	(0.803)
$\Delta\ln(EII)$	-0.865	-0.987	1.476	1.850
	(-1.169)	(-1.030)	(0.439)	(0.526)
$\Delta\ln(UEII)$	-1.798**	-2.265**	-0.742	-0.573
	(-2.160)	(-2.046)	(-0.565)	(-0.421)
$\Delta\ln(IP)$	-0.067	0.468	-0.555	-0.500
	(-0.222)	(1.231)	(-1.019)	(-0.848)
$\Delta\ln(FF)$	-0.092***	-0.161***	0.030	0.039
	(-2.690)	(-3.668)	(0.469)	(0.564)
$\Delta\ln(MI)$	0.099***	0.114**	0.121*	0.129*
	(2.229)	(1.976)	(1.720)	(1.719)
ecm_{t-1}	-0.018*	-0.043**	-0.079***	-0.080***
	(-1.744)	(-2.264)	(-2.794)	(-2.702)
DW	1.932	1.834	2.045	2.064
LB Q(3)	0.485	2.794	0.537	0.689
Adjusted R^2	0.047	0.096	0.035	0.033
df	419	215	190	166
N	426	222	197	173

Notes: D.W. stands for Durbin-Watson statistics. LBQ(3) is Ljung-Box Q test for the null of as a group of up to 3rd order serial correlation among the residuals. d.f. is degree of freedom and n is the sample size. T-values are in the parentheses. $\Delta\ln(ERTI)$, $\Delta\ln(EII)$, $\Delta\ln(UEII)$, $\Delta\ln(IP)$, $\Delta\ln(FF)$, and $\Delta\ln(MI)$ are first differences of the logarithms of the equity REIT index, the expected and unexpected inflation indices, the industrial production index, Federal Fund rate and the stock market index respectively. *ecm* is the estimated residual from Equation (1). ***, **, and * indicate rejection at the 1%, 5% and 10% level of significance.

Table 6: ECM parameter estimates from Equation (2) and (5)

	1991-2007	**1993-2007**
Constant	0.008	0.006
	(0.975)	(0.736)
$\Delta \ln(EII)$	1.773	2.163
	(0.530)	(0.617)
$\Delta \ln(UEII)$	-0.765	-0.581
	(-0.583)	(-0.426)
$\Delta \ln(IP)$	-0.607	-0.567
	(-1.116)	(-0.964)
$\Delta \ln(FF)$	0.027	0.034
	(0.422)	(0.482)
$\Delta \ln(MI)$	0.129*	0.137*
	(1.822)	(1.805)
ecm_{t-1}	-0.078***	-0.078**
	(-2.726)	(-2.588)
DW	2.051	2.069
LB Q(3)	0.445	0.556
Adjusted R^2	0.033	0.030
df	190	166
N	197	173

Notes: D.W. stands for Durbin-Watson statistics. LBQ(3) is Ljung-Box Q test for the null of as a group of up to 3rd order serial correlation among the residuals. d.f. is degree of freedom and n is the sample size. T-values are in the parentheses. $\Delta \ln(ERTI)$, $\Delta \ln(EII)$, $\Delta \ln(UEII)$, $\Delta \ln(IP)$, $\Delta \ln(FF)$, and $\Delta \ln(MI)$ are first differences of the logarithms of the equity REIT index, the expected and unexpected inflation indices, the industrial production index, Federal Fund rate and the stock market index respectively. ecm is the estimated residual from Equation (2). ***, **, and * indicate rejection at the 1%, 5% and 10% level of significance.

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