REIT Markets: Periodically Collapsing Negative Bubbles?

James E. Payne  
Professor and Chair  
Department of Economics  
Illinois State University  
Normal, IL 61790-4200  
jepayne@ilstu.edu  
309-438-8588

and

George A. Waters  
Assistant Professor  
Department of Economics  
Illinois State University  
Normal, IL 61790-4200  
gawater@ilstu.edu  
309-438-7301

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Abstract: This note tests for the presence of negative bubbles in the REIT markets over the period 1972:01 to 2004:05 using the momentum threshold autoregressive (MTAR) model. There is evidence of asymmetric adjustment towards the long-run equilibrium between REIT prices and dividends indicative of negative bubbles for mortgage and hybrid REITs.
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I. Introduction

Rational bubbles due to self-fulfilling expectations can disrupt the relationship between prices and dividends, as defined by the standard present value model of stock prices. Much of the theoretical literature argues that if rational bubbles exist they must be positive, implying that the asset price could rise above levels justified by fundamentals. The empirical literature has also confined itself to exploring positive bubbles. In this note we provide evidence that the mortgage and hybrid REIT markets have experienced negative bubbles with prices below levels implied by their dividends.

REIT prices are a prime candidate for demonstrating the existence of negative bubbles. Given a REIT is a company that owns and in some cases finances and operates income generating real estate, price bubbles associated with the underlying real estate asset may be transmitted into price bubbles for the securitized real estate assets known as REITs. Moreover, there is a relatively close connection between the income generated from the real estate asset and the dividends distributed to REIT shareholders. Specifically, at least 90 percent of a REIT's taxable income must be distributed in the form of dividends to shareholders on an annual basis (www.nareit.com). Thus, a positive bubble in real estate prices, as many have suggested we are currently experiencing, would lead to a sharp increase in dividends. If investors do not believe such dividend streams are sustainable, REIT prices will not rise in response to the increase in dividends. This response by investors will appear as a negative bubble in the REIT markets.
Diba and Grossman (1988), among others, have argued that negative rational bubbles are impossible since they imply that investors believe that future asset prices could be negative. However, since positive bubbles similarly imply that investors expect unreasonably large prices with some probability, some argue that positive and negative bubbles have equal status and for short term dynamics, both possibilities are relevant. Weil (1990) goes further and shows how the interaction between prices and fundamentals could lead to prices falling relative to dividends, indicative of a negative bubble.

Diba and Grossman (1984, 1988) argue that cointegration between prices and dividends constitutes evidence against the presence of rational bubbles. Evans (1991) suggests that the Diba and Grossman methodology will not be able to detect a class of rational bubbles known as periodically collapsing bubbles, in which the bubble component may follow a nonlinear process. Taylor and Peel (1998) provide a modification to the standard cointegration least squares estimator in the detection of periodically collapsing bubbles motivated by the skewness and excess kurtosis in the residuals when bubbles are present. However, we pursue an alternative approach for the detection of negative periodically collapsing bubbles in the REIT markets using the momentum threshold autoregressive (MTAR) model advanced by Enders and Granger (1998) and Enders and Siklos (2001).

Our results show that negative periodically collapsing bubbles exist in the REIT markets. Section II provides the theoretical rationale for the empirical analysis. Section III presents the empirical methodology, the data and empirical results with concluding remarks in Section IV.
II. Theoretical Rationale for Periodically Collapsing Negative Bubbles

The theoretical foundation for the possibility of periodically collapsing negative bubbles is based on an extension of Evans (1991). The asset price $P_t$ at time $t$ depends on the expectation at time $t$ of next period’s price $P_{t+1}$ and dividend $D_t$ as follows:

$$P_t = \rho E_t(P_{t+1} + D_{t+1})$$

(1)

where the interest rate is $r$ and the discount factor, $\rho=(1+r)^{-1}$, lies between zero and one. The general solution to (1) is

$$P_t = \sum_{j=1}^{\infty} \rho^j E_t D_{t+j} + B_t.$$  

(2)

The term $B_t$ must satisfy the submartingale property $E_t B_{t+1} = (1+r)B_t$, which represents a bubble produced by self-fulfilling expectations. Following Cochrane (2001, p. 27), the bubble term must be zero, so $B_t = 0$, via the transversality condition in which the asset price $P_t$ is determined solely by expected future dividends.4

Given the conditions mentioned above, some researchers have argued for the non-existence of bubbles. However, Evans (1991) discusses a class of bubbles, known as periodically collapsing bubbles, represented as follows.

$$B_{t+1} = \rho^{-1} B_t v_{t+1}, \quad \text{if } |B_t| \leq \alpha$$

(3a)

$$B_{t+1} = \left[ \delta + (\rho \pi)^{-1} \theta_{t+1} (B_t - \rho \delta) \right] v_{t+1}, \quad \text{if } |B_t| > \alpha.$$  

(3b)

The parameters in (3a) and (3b) satisfy $\delta, \alpha > 0$ and $0 < \delta < (1+r)\alpha$. The stochastic process $v_t$ is iid and has a mean of unity such that a bubble will not switch sign. The term $\theta_t$ is a Bernoulli process that takes the value 1 with probability $\pi$ and the value 0 with probability 1- $\pi$. Equation (3a) represents the phase when the bubble grows at mean rate $1+r$, but equation (3b) shows that if the bubble exceeds the threshold $\alpha$, it explodes at
mean rate \((1+r)\pi^{-1}\). However, this phase does not last indefinitely as the bubble collapses with probability \(1-\pi\) each period.

Evan’s model of a bubble incorporates three important characteristics, \(B_t\) satisfies the martingale property \(E_t B_{t+1} = (1+r)B_t\), bubbles cannot be detected by simply examining cointegration between asset prices and dividends, and bubbles that are initially positive stay positive. The last statement is equivalent to saying that whether a bubble is positive or negative depends entirely on the sign of the initial condition \(B_0\) of the bubble component. Hence, all that is required for Evan’s model to produce a negative bubble is for \(B_0 < 0\).

### III. Methodology, Data, and Results

The momentum threshold autoregressive (MTAR) model is used to capture the asymmetries in REIT prices and the presence of periodically collapsing negative bubbles. We begin our analysis by specifying the following cointegration equation representing the relationship between REIT prices, \(P_t\), and dividends, \(D_t\).

\[
P_t = \alpha + \beta D_t + u_t
\]

If REIT prices and dividends are each integrated of order one, the residuals from the cointegration equation, \(u_t\), should be stationary in levels. The possibility of asymmetric adjustment is undertaken in the following cointegration tests with respect to the residuals.

\[
\Delta u_t = I_t \rho_1 u_{t-1} + (1-I_t) \rho_2 u_{t-1} + \sum_{i=1}^{\rho} \gamma_i \Delta u_{t-i} + v_t
\]

Heaviside indicator function, \(I_t\), is represented by:

\[
I_t = \begin{cases} 
1 & \text{if } \Delta u_{t-1} \leq \tau \\
0 & \text{if } \Delta u_{t-1} > \tau 
\end{cases}
\]
where the threshold $\tau \leq 0$ is non-positive to detect the sharp decrease in price relative to dividends that characterize negative bubbles. The value for $\tau$ minimizes the residual sum of squares for each given model specification. The MTAR model is especially valuable when the adjustment is believed to exhibit more momentum in one direction than the other. The null hypothesis of no cointegration is tested by the restriction, $\rho_1 = \rho_2 = 0$. If REIT prices and dividends are cointegrated, the null hypothesis of symmetry is tested by the restriction, $\rho_1 = \rho_2$. Indeed, if the estimated coefficient, $\rho_1$, is statistically significant and negative and larger in absolute terms relative to the estimated coefficient, $\rho_2$, there is evidence of a sharp correction when prices have risen above a certain threshold relative to dividends. Therefore, if the null hypothesis of symmetric adjustment is rejected and $|\rho_2| < |\rho_1|$, we conclude that negative periodically collapsing bubbles are present in REIT prices.

Monthly data on the prices and dividends for equity, mortgage, and hybrid REITs were obtained from the National Association of Real Estate Investment Trusts (NARIET) for the period 1972:01 to 2004:05. The original data has been converted to natural logarithms. Augmented Dickey-Fuller (ADF, 1979) Phillips-Perron (PP, 1988), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, 1992) unit root tests with and without a deterministic trend for the respective REIT prices and dividends are presented in Table 1. The results suggest that the REIT prices and dividends are integrated of order one. The cointegration and momentum threshold tests are displayed in Table 2. Given the present value model in Campbell and Shiller (1988), the cointegrating parameter $\beta$ should be one, but ambiguity about dividends and/or their growth rate may very well cause $\beta$ to differ from unity.
The cointegrating parameter for equity REITs is significantly greater than one at the 1 percent significance level while mortgage and hybrid REITs are not statistically different from one at the 10 percent level. However, the respective REIT prices and dividends appear cointegrated based on the significant ADF test statistics, denoted by CRADF. If one follows the Diba and Grossman methodology the presence of cointegration can be interpreted as evidence against the presence of speculative bubbles. However, the MTAR model will allow for possible asymmetries in the adjustment towards the long-run equilibrium relationship between REIT prices and dividends that might occur in the presence of periodically collapsing bubbles. Given the point estimates of $\rho_1$ and $\rho_2$ from equations (5) and (6) of the MTAR specification, the null hypothesis of no cointegration, $\rho_1 = \rho_2 = 0$, (F_C in Table 2) is rejected as well as the null hypothesis of symmetry, $\rho_1 = \rho_2$, (F_A in Table 2). Furthermore, the point estimates, $\rho_1$ and $\rho_2$, satisfy the condition $|\rho_2| < |\rho_1|$. There is evidence of negative periodically collapsing bubbles in the respective REIT markets. The results in Table 2 show compelling evidence in favor of periodically collapsing negative bubbles in both the mortgage and hybrid REIT markets with F-statistics far surpassing the critical values. While equity REITs are superficially similar, the estimate of $\rho_2$ in this case is not significantly different from zero and the estimate of $\tau$ is implausibly small, suggesting almost all upward reversions back to the long-run equilibrium are interpreted as collapsing bubbles.

IV. Concluding Remarks

The momentum threshold autoregressive (MTAR) model is estimated to detect
negative periodically collapsing bubbles in REIT markets. The respective REIT prices and dividends are cointegrated; however, there are asymmetries in the adjustment towards the long-run equilibrium. The estimated coefficients in the MTAR models indicate the presence of periodically collapsing negative bubbles in the mortgage and hybrid REIT markets, but not equity REITs. An interesting extension of research in the evaluation of periodically collapsing bubbles in the REIT markets would be to apply the Taylor and Peel cointegration approach to the detection of periodically collapsing bubbles using the residuals-augmented Dickey-Fuller test.
Table 1
Unit Root Tests
REIT Prices and Dividends

### Panel A: Equity REITs

<table>
<thead>
<tr>
<th></th>
<th>ADF(C)</th>
<th>ADF(C+T)</th>
<th>PP(C)</th>
<th>PP(C+T)</th>
<th>KPSS(C)</th>
<th>KPSS(C+T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_t$</td>
<td>-0.54</td>
<td>-2.54</td>
<td>-0.54</td>
<td>-2.49</td>
<td>2.10$^a$</td>
<td>0.25$^a$</td>
</tr>
<tr>
<td>$\Delta P_t$</td>
<td>-18.03$^a$</td>
<td>-18.02$^a$</td>
<td>-18.03$^a$</td>
<td>-18.02$^a$</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>$D_t$</td>
<td>-1.78</td>
<td>-1.35</td>
<td>-1.63</td>
<td>-1.46</td>
<td>2.10$^a$</td>
<td>0.40$^a$</td>
</tr>
<tr>
<td>$\Delta D_t$</td>
<td>-16.27$^a$</td>
<td>-16.35$^a$</td>
<td>-19.53$^a$</td>
<td>-19.61$^a$</td>
<td>0.21</td>
<td>0.06</td>
</tr>
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</table>

### Panel B: Mortgage REITs

<table>
<thead>
<tr>
<th></th>
<th>ADF(C)</th>
<th>ADF(C+T)</th>
<th>PP(C)</th>
<th>PP(C+T)</th>
<th>KPSS(C)</th>
<th>KPSS(C+T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_t$</td>
<td>-1.95</td>
<td>-1.74</td>
<td>-2.00</td>
<td>-2.22</td>
<td>1.86$^a$</td>
<td>0.14$^c$</td>
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<tr>
<td>$\Delta P_t$</td>
<td>-18.78$^a$</td>
<td>-18.82$^a$</td>
<td>-19.15$^a$</td>
<td>-19.11$^a$</td>
<td>0.13</td>
<td>0.07</td>
</tr>
<tr>
<td>$D_t$</td>
<td>-1.56</td>
<td>-2.27</td>
<td>-1.05</td>
<td>-2.06</td>
<td>1.92$^a$</td>
<td>0.23$^a$</td>
</tr>
<tr>
<td>$\Delta D_t$</td>
<td>-5.46$^a$</td>
<td>-5.46$^a$</td>
<td>-20.12$^a$</td>
<td>-20.10$^a$</td>
<td>0.09</td>
<td>0.09</td>
</tr>
</tbody>
</table>

### Panel C: Hybrid REITs

<table>
<thead>
<tr>
<th></th>
<th>ADF(C)</th>
<th>ADF(C+T)</th>
<th>PP(C)</th>
<th>PP(C+T)</th>
<th>KPSS(C)</th>
<th>KPSS(C+T)</th>
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</thead>
<tbody>
<tr>
<td>$P_t$</td>
<td>-2.66</td>
<td>-2.69</td>
<td>-1.86</td>
<td>-1.84</td>
<td>0.53$^b$</td>
<td>0.29$^a$</td>
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<tr>
<td>$\Delta P_t$</td>
<td>-7.74$^a$</td>
<td>-7.74$^a$</td>
<td>-19.17$^a$</td>
<td>-19.15$^a$</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>$D_t$</td>
<td>-1.96</td>
<td>-2.07</td>
<td>-1.39</td>
<td>-1.61</td>
<td>0.58$^b$</td>
<td>0.32$^a$</td>
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<tr>
<td>$\Delta D_t$</td>
<td>-3.95$^a$</td>
<td>-3.93$^b$</td>
<td>-18.32$^a$</td>
<td>-18.30$^a$</td>
<td>0.11</td>
<td>0.08</td>
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Notes: Lag length selection for the ADF unit root tests is based on Akaike’s information criterion. Lag length selection for the PP unit root tests is based on Newey-West bandwidth using Bartlett kernel. ADF(C) and PP(C) critical values: a(1%) -3.45, b(5%) -2.87, and c(10%) -2.57. KPSS(C) critical values: a(1%) 0.739, b(5%) 0.463, and c(10%) 0.347. ADF(C+T) and PP(C+T) critical values: a(1%) -3.98, b(5%) -3.42, and c(10%) -3.13. KPSS(C+T) critical values: a(1%) 0.216, b(5%) 0.146, and c(10%) 0.119.
### Table 2
Cointegration and Momentum Threshold Tests
REIT Prices and Dividends

<table>
<thead>
<tr>
<th>Panel A: Equity REITs</th>
<th>β</th>
<th>CRADF</th>
<th>τ</th>
<th>ρ₁</th>
<th>ρ₂</th>
<th>F_C</th>
<th>F_A</th>
<th>Q(5)</th>
<th>Lags</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.12</td>
<td>-3.97(^a)</td>
<td>-0.006</td>
<td>-0.13</td>
<td>-0.01</td>
<td>14.47(^a)</td>
<td>17.08(^a)</td>
<td>2.29</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>[0.019](^a)</td>
<td>(-5.36)(^a)</td>
<td>(-0.43)</td>
<td>[0.808]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Mortgage REITs</th>
<th>β</th>
<th>CRADF</th>
<th>τ</th>
<th>ρ₁</th>
<th>ρ₂</th>
<th>F_C</th>
<th>F_A</th>
<th>Q(5)</th>
<th>Lags</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90</td>
<td>-4.25(^a)</td>
<td>-0.062</td>
<td>-0.18</td>
<td>-0.05</td>
<td>12.34(^a)</td>
<td>24.66(^a)</td>
<td>1.02</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>[0.086](^a)</td>
<td>(-4.42)(^a)</td>
<td>(-2.26)(^b)</td>
<td>[0.961]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: Hybrid REITs</th>
<th>β</th>
<th>CRADF</th>
<th>τ</th>
<th>ρ₁</th>
<th>ρ₂</th>
<th>F_C</th>
<th>F_A</th>
<th>Q(5)</th>
<th>Lags</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.95</td>
<td>-3.39(^b)</td>
<td>-0.127</td>
<td>-0.31</td>
<td>-0.05</td>
<td>15.92(^a)</td>
<td>29.87(^a)</td>
<td>0.50</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>[0.029](^a)</td>
<td>(-4.88)(^a)</td>
<td>(-2.91)(^a)</td>
<td>[0.992]</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notes: β represents the cointegrating parameter. CRADF denotes the cointegrating regression ADF statistic. τ is the estimated threshold. ρ₁ and ρ₂ are the estimated parameters off the M-TAR specification. Standard errors denoted by [ ], t-statistics denoted by ( ), and probability values in { } where “a” denotes significance at the 1 percent level. F_C represents the F-statistic corresponding to the null hypothesis of no cointegration (i.e. ρ₁=ρ₂=0) and F_A represents the F-statistic corresponding to the null hypothesis of symmetry (i.e. ρ₁=ρ₂). Enders and Siklos (2001, Table 5, p. 172, n = 250 and four lagged changes) provide the critical values associated with F_C. Four lagged changes: a(1%) 8.47 and b(5%) 6.32 and one lagged change a(1%) 8.84 and b(5%) 6.63. Given the respective prices and dividends are cointegrated, the standard F distribution can be used to test for symmetry (F_A) where “a” denotes significance at the 1 percent level. Q(5) denotes the Ljung-Box Q-statistic at 5 lags.
Footnotes

1. Researchers (see Case and Shiller (1989, 1990), Kim and Suh (1993), Abraham and Hendershott (1996), Bjorklund and Soderberg (1999), and Hendershott (2000) for examples) have investigated whether or not real estate markets have experienced “excessive price volatility” or an asset price bubble, however to the best of our knowledge, an examination of periodically collapsing negative bubbles in the REITs markets has not been undertaken.

2. The following is quoted from Payne and Mohammadi (2004): “Equity REITs hold at least 75 percent of their assets in income generating real estate properties. Mortgage REITs hold at least 75 percent of their assets in residential and commercial mortgages as well as short-and-long-term construction loans, acquisition of loans or indirect lending through mortgage-backed securities. Hybrid REITs share the properties of equity and mortgage REITs by both owning properties and lending to owners and operators.”

3. Taylor and Peel’s (1998) residuals augmented least squares Dickey-Fuller tests for periodically collapsing bubbles has been used in the examination of East Asian and Australian stock markets by Sarno and Taylor (1999), asset price bubbles in Latin American emerging financial markets by Sarno and Taylor (2003), and for stock price bubbles in France, Germany, Japan, United States, and the United Kingdom by Capelle-Blancard and Raymond (2004).

4. McCallum’s (1983, 1997) minimum state variable criterion could also be invoked to rule out bubbles.

5. The only other change from Evan’s (1991) model, besides the emphasis on the initial value $B_0$ is the inclusion of absolute values on the conditions in equations (3a) and (3b).


7. The Chan (1993) method sorts the estimated residuals in ascending order, eliminating 15 percent of the largest and smallest values and is typical used in the selection of the threshold value. The idea of eliminating extreme values when testing for bubble behavior seems counter intuitive, thus we do not eliminate any residuals.
References


