Is There A Periodically Collapsing Bubble In The Indian Real Estate Market?

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ABSTRACT

The study finds evidence in favor of Evans' (1991) definition of periodically collapsing speculative bubbles in the Indian real estate market when the market is tested for a bubble by examining data from May 1, 2009, to May 30, 2012. Using consistent momentum threshold auto regressive (MTAR) model developed by Enders and Siklos (2001) with Chan's (1993) methodology, this study finds evidence of co-integration as well as asymmetric adjustment toward long-run equilibrium, which is evidence of a periodically collapsing positive speculative bubble. However, except for the residuals-augmented Dickey–Fuller (RADF) test, none of the conventional tests such as the augmented Dickey–Fuller and the Phillips–Perron tests find evidence of a bubble.

Keywords: Indian Real Estate; Periodically Collapsing Bubbles; RADF, MTAR

INTRODUCTION

Irrational expectations leading to any unexplained rise and fall of the market have intrigued economists for many years, whether in the stock market, real estate market, futures, commodities, etc. This interest has also resulted in the development of many sophisticated econometric models, each with its own advantage. Even though the stock market is thought of as efficient, the persistent deviation of the stock market from its fundamentals has led many researchers to study this behavior. Hart and Kreps (1986), Shiller (1981), Cochrane (1992), as well as Diba and Grossman (1988a, 1988b) have worked extensively in this area. However, these researchers assumed linearity and symmetric adjustment of the market, which turned out to be a major flaw in these types of studies (Evans, 1991). Specifically, Evans (1991) showed that linear unit root and cointegration techniques fail to detect a class of rational bubbles known as periodically collapsing bubbles.

To overcome this nonlinearity issue, Taylor and Peel (1998) proposed the residuals-augmented Dickey–Fuller (RADF) unit root test. This test accounts for excess skewness and kurtosis, which are typically more suitable for periodically collapsing bubbles. In that same line of thought, Bohl (2003) applied a momentum threshold autoregressive (MTAR) model to test stationarity as well as asymmetry in the United States (US) stock market. Van Norden and Schaller (1993, 1996) and van Norden (1996) proposed regime-switching models to test bubble-like behavior in the stock market to tackle non-linearity in the market.

Using these techniques, many studies have investigated speculative bubble-like behavior in real estate markets. Brooks, Katsaris, McGough, and Tsolacos (2001) tested the United Kingdom (UK) market for bubbles by applying excess volatility and variance bound tests. Jirasakuldech, Campbell, and Knight (2006) tested bubbles in the US real estate market using a unit root test, cointegration tests, Johansen's cointegration test, and the duration dependence test with various factors to measure fundamentals. Payne and Waters (2005) followed Evans' (1991) approach to find evidence of negative periodically collapsing bubbles in mortgage and hybrid real estate investment trusts (REITs). Waters and Payne (2007) tested equity REITs, mortgage REITs, and hybrid REITs for the presence of speculative bubbles by employing Taylor and Peel's (1998) RADF model and Enders and Siklos's (2001) MTAR model. When conducting these tests, the researchers found evidence of bubbles only in the MTAR tests.

Studies on real estate market bubbles have also been carried out on various real estate markets around the world. Roce (2001) studied the Irish housing market for bubbles, and Clayton (1997) found evidence of a bubble in the Canadian market. Hendershott (2000) found evidence of bubbles in Sydney's real estate market, and Bjorklund and Sodeberg (1999) found evidence of bubbles in the Swedish market. Paskelian and Vishwakarma (2011) found evidence of a growing bubble in the Chinese real estate market.

Although markets around the world have been studied, the literature related to the Indian real estate market is quite limited. Joshi (2006) used a vector auto regressive model to find that interest rates and credit growth affect the real estate market in India. Vishwakarma and French (2010) examined the dynamic relationships between the Indian real estate market and macroeconomic variables, and found that the depreciation of the rupee against the US dollar has had a negative impact on Indian real estate. The researchers also found that positive innovation spread between long- and short-term interest rates can forecast positive returns to real estate. This study extends the literature on the Indian real estate market; specifically, the present study tests for the non-linearity and asymmetric nature of Indian real estate and looks for evidence of periodically collapsing bubbles. To conduct these tests, we employed a conventional unit root and cointegration tests. Second, we used unit root tests that are more suitable for non-linearity and asymmetry: Taylor and Peel's (1998) RADF model and Enders and Siklos's (2001) MTAR model.

We found no evidence of a bubble when we applied conventional methods of unit root such as the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests. However, when we applied the RADF and MTAR methods, the results show signs of a bubble in the Indian real estate market. Consistent MTAR also finds evidence of cointegration and asymmetric adjustment in prices and dividends in the CNX Realty index, which is an indication of a periodically collapsing positive bubble (Evans, 1991). This is the first study on Indian real estate to test for a bubble using threshold models and the asymmetric method.

This paper is structured as follows: Section 2 presents the data and the different methodologies used to test for bubbles in the Indian real estate market. Empirical results are presented in Section 3. Section 4 summarizes and concludes the study.

DATA AND METHODOLOGY

This paper uses daily prices and dividend data from the CNX Realty index as a proxy for the Indian real estate sector and market fundamentals, respectively. The data collected is from May 1, 2009, to May 30, 2012, a total of 766 observations. The CNX Realty is a sector index of Indian real estate maintained by the National Stock Exchange (NSE) of India. This index comprises ten listed companies from the real estate sector with considerable track records. This study also employs data from the consumer price index as a measure of inflation, obtained from the Labor Bureau, Government of India.

This study uses Water and Payne's (2007) model of positive and negative periodically collapsing bubbles. Readers are advised to refer to Diba and Grossman (1988a), Evans (1991), Payne and Waters (2005, 2007), and Water and Payne (2007) for details of the model.

We begin by deflating the original price index by the consumer price index and converting to a natural logarithm. The first test conducted is the null hypothesis of a unit root in the CNX Realty prices and the dividend series for the index. This test forms the basis of Diba and Grossman's tests for bubbles, in which evidence of cointegration between prices and dividends is treated as evidence against a bubble. Hence, the unit root must be tested in individual data series. The cointegration equation that will be examined is as follows:

$$P_t = \alpha + \beta D_t + \epsilon_t \ . \qquad (1)$$

In equation (1), P_t is the price of the index, and D_t is the dividend. However, this test is based on the assumption of the linearity of a bubble process and the normality of the residuals. To conduct a more efficient estimation in the presence of excess kurtosis and skewness, Taylor and Peel's (1998) RADF test is conducted. The RADF test equation is given by

$$\Delta\epsilon_t = \theta\epsilon_{t-1} + \gamma\widehat{\omega_t} + \vartheta_t \ , \qquad (2)$$

Where $\widehat{\omega_t} = [(\widehat{u_t^3} - 3\,\widehat{\sigma^2}\ \widehat{u_t}), (\widehat{u_t^2} - \widehat{\sigma^2}\,)]$. The vector, $\widehat{\omega_t}$, corrects the estimate of θ for skewness and excess kurtosis of the residuals. $\widehat{u_t}$ are the residuals of equation (3), and $\widehat{\sigma_t^2}$ estimates the variance. ϑ_t is white noise:

$$\Delta\widehat{\epsilon_t} = \theta\widehat{\epsilon_{t-1}} + u_t \ . \tag{3}$$

The test statistic is $\tau_A = \hat{\theta}/\sqrt{Var(\hat{\theta})}$. $\hat{\theta}$ is estimated in equation (3); $var(\hat{\theta})$ is the variance-covariance matrix of $\hat{\theta}$; it is given by Im and Schmidt (2008). Critical values are given by Sarno and Taylor (2003).

Next, a series of cointegration tests are conducted. The first is the Engle-Granger cointegration test using the following equation:

$$\Delta\widehat{\epsilon_t} = \theta_1\widehat{\epsilon_{t-1}} + \sum_{i=1}^{n}\theta_{i+1}\Delta\widehat{\epsilon_{t-\iota}} + u_t \ . \tag{4}$$

If the test rejects the null hypothesis $\theta_1 = 0$, we can conclude that the residual sequence is stationary and that the variables are cointegrated. However, the usual Dickey-Fuller critical values cannot be used in such circumstances (Enders, 2004).

The Engle-Granger cointegration test is mis-specified if the adjustment is asymmetric. Thus, an alternative specification of the error-correction model, called the threshold autoregressive (TAR) model, is used such that (4) can be written as:

$$\Delta\widehat{\epsilon_t} = I_t\rho_1\hat{\epsilon}_{t-1} + (1 - I_t)\,\rho_2\hat{\epsilon}_{t-1} + \sum_{i=1}^{p}\gamma_i\,\Delta\widehat{\epsilon_t} + v_t \ , \tag{5}$$

Which will follow $\rho_1, \ \rho_2 < 0$ as a condition of convergence. I_t is a Heaviside indicator function that depends on the level of ϵ_t:

$$I_t = \begin{cases} 1 \ if \ \hat{\epsilon}_{t-1} \geq \tau \\ 0 \ if \ \hat{\epsilon}_{t-1} < \tau \end{cases} \ . \tag{6}$$

Enders and Siklos's (2001) MTAR model is applied to the residuals generated from equation 1. The MTAR model tests for cointegration of systems, which shows nonlinearity and asymmetric adjustments in a long-run equilibrium relationship. This model suits the specific dynamics of periodically collapsing bubbles. In the MTAR model, the threshold depends on the previous period's change in $\hat{\epsilon}_{t-1}$. The rule for the Heaviside indicator becomes:

$$I_t = \begin{cases} 1 \ if \ \Delta\hat{\epsilon}_{t-1} \geq \tau \\ 0 \ if \ \Delta\hat{\epsilon}_{t-1} < \tau \end{cases} \ . \tag{7}$$

The final cointegration test is consistent MTAR, where τ , ρ_1 , and ρ_2 are estimated simultaneously. While doing so, Chan's (1993) procedure is followed, which minimizes the sum of the squared errors from the fitted model yielding a superconsistent estimate of the threshold. The null hypothesis of no cointegration is tested with the restriction, $\rho_1 = \rho_2 = 0$, and the null hypothesis of symmetry is tested with the restriction $\rho_1 = \rho_2$. Since this is the most consistent test for cointegration and asymmetric adjustment, our conclusions on periodically collapsing bubbles will be based on the consistent MTAR model.

EMPIRICAL RESULTS

Table 1. Unit root test statistics for prices and dividends

	P_t^i	ΔP_t^i	D_t^i	ΔD_t^i
ADF	-0.3906	-23.6143***	-2.3579	-30.7498***
PP	-0.6126	-23.6858***	-2.3631	-30.8490***

Critical values for the test:
ADF: 1%(***) -3.44, 5%(**) -2.87, 10%(*) -2.57
PP: 1%(***) -3.451947, 5%(**) -2.870474, 10%(*) -2.571499

Table 1 provides the results from the unit root tests. It shows the results of the tests on the prices and dividends of the CNX Realty data, respectively. The ADF and PP unit root tests are shown in the table, and we find that each series has unit roots. After we difference them, they show no sign of a unit root. We conducted a unit root test because if the series contains a bubble then it is less likely for the series to achieve a stationary process by differencing the series a number of times because of the explosive nature of the bubbles. If the series are stationary after differencing, it is more likely that the non-stationarity is caused by market fundamentals. Thus, this test indicates a bubble is not developing in Indian real estate.

Table 2. Test of cointegration between prices and dividends

	ADF	PP	Skewness	Kurtosis	Jarque-Bera	RADF
CNX Realty						
	-24.3380***	-24.4068***	1.7492***	17.7495***	9968.5364***	0.0911

Critical values for the test:
ADF: 1% (***) -3.44, 5% (**) -2.87, 10%(*) -2.57
PP: 1% (***) -3.451947, 5% (**) -2.870474, 10%(*) -2.571499
RADF: 1% (***) -3.98, 5% (**) -3.44, 10%(*) -3.13 (Capelle-Blancard & Raymond, 2004)

Next, we conducted a cointegration test between the prices and dividends following Diba and Grossman's approach using equation (1). The results are shown in Table 2. Columns 1 and 2 show the results of the ADF and PP tests statistics applied to the residuals from the cointegration equation (1), under the null hypothesis of no cointegration for the ADF and PP tests. Statistics from the first two columns clearly indicate the presence of cointegration between prices and dividends. According to Diba and Grossman's approach, this cointegration can be taken as evidence against bubbles. However, Evans (1991) found a problem with this approach as this kind of test is based on a normality assumption of residuals from equation (1).

In Table 2, columns 3, 4, and 5 show the tests of normality. The CNX Realty index clearly has excess skewness and kurtosis, and is non-normal as shown by the significant Jarque-Bera test statistic. These test results point to the fact that Diba and Grossman's approach for testing cointegration is not appropriate. To address this non-normality issue, the RADF test is presented in the sixth column of Table 2. As expected, after adjusting for skewness and kurtosis, the significant cointegration between prices and dividends disappears in the RADF test. The null hypothesis of no cointegration using RADF tests cannot be rejected for the CNX Realty index. If we follow the RADF tests, then there is more evidence of a bubble in the market.

Table 3. Cointegration test between prices and dividends using threshold models

	EG	TAR ($\boldsymbol{\tau = 0}$)	MTAR ($\boldsymbol{\tau = 0}$)	MTAR consistent
CNX Realty				
$\boldsymbol{\tau}$		0.0000	0.0000	0.0142
$\boldsymbol{\rho_1}$	-0.0136*	-0.0080	-0.0153***	-0.0303***
	(-3.2041)	(-1.4362)	(-2.5081)	(-3.5232)
$\boldsymbol{\rho_2}$	NA	-0.0211***	-0.0121**	-0.0082*
		(-3.2969)	(-2.0529)	(-1.6903)
$\boldsymbol{\varphi}$	NA	6.3390	5.1957	7.7036**
$\boldsymbol{\rho_1 = \rho_2}$	NA	2.3817	0.1439	5.0527**
		(0.1234)	(0.7045)	(0.0250)

Critical values for the Engle-Granger cointegration test for two variables are 1% (-3.92), 5% (-3.35), and 10% (3.05). φ represents the F-statistic corresponding to the null hypothesis of no cointegration (i.e. $\rho_1 = \rho_2 = 0$) With critical values provided by Enders and Siklos (2001) Table 5 p. 172. $\rho_1 = \rho_2$ represents F-statistic corresponding to the null hypothesis of symmetry using the standard F-distribution with critical values 1% (4.61), and 5% (3.00). *t*-statistics are given in parentheses. The significance at 1%, 5%, and 10% is denoted with *, **, and ***, respectively.

The RADF test accounts for non-normality but does not account for asymmetric adjustment toward the long-run equilibrium. Hence, Enders and Siklos's (2001) MTAR model is applied, and the result is shown in Table 3. Column 2 presents the Engle-Granger cointegration test using equation (4) for two variables. The value of the t-statistic for ρ_1 is 3.2041, which is significant only at the 10% level and indicates cointegration between prices and dividends. The third column is an estimation of the TAR model using equations 1, 5, and 6 with τ = 0. The point estimates of ρ_1 and ρ_2 indicate convergence, but only one point estimate is significant. Moreover, this model fails to reject the null hypothesis of no cointegration (φ) and fails to reject the null hypothesis of symmetry ($\rho_1 = \rho_2$). Thus, the conventional TAR model is unable to detect cointegration and asymmetry in the market. The fourth column is an estimation of the MTAR model using equations 1, 5, and 7 with $\tau = 0$ and has φ and $\rho_1 = \rho_2$ as an insignificant value. This also indicates no cointegration and symmetric adjustment, which is not surprising considering the low power of the test. Next is the consistent MTAR estimate using equations 1, 5, and 7 obtained using Chan's (1993) methodology. For the CNX Realty index, a threshold of 0.0142 is obtained. The point estimates of ρ_1 and ρ_2 are less than zero and statistically significant, which indicates convergence. Further, the coefficient estimate of φ is 7.7036, and $\rho_1 = \rho_2$ is 5.0527, which are statistically significant, indicating the rejection of the null hypothesis of no cointegration and providing evidence of asymmetric adjustments toward long-run equilibrium. The evidence of cointegration, a positive threshold value, $|\rho_1| > |\rho_2|$, and evidence of asymmetry provide evidence in favor of Evans' (1991) definition of positive periodically collapsing bubbles in the CNX Realty index. The evidence presented clearly indicates that prices and dividends are cointegrated but still indicates the presence of a bubble.

CONCLUSION

This study is an attempt to discover whether a periodically collapsing bubble exists according to Evans's (1991) definition in the Indian real estate market using the CNX Realty index maintained by National Stock Exchange of India as a proxy using data from May 1, 2009, to May 30, 2012. First, we conducted the unit root test on the index and dividends. If this series becomes stationary after differencing, then it is evidence against the bubble, and non-stationarity may have occurred because of market fundamentals. No evidence of a bubble was found. Second, we tested the cointegration between the index prices and dividends following Diba and Grossman's (1988a, 1988b) approach, where the null of no cointegration is tested using the ADF and PP tests. Evidence of cointegration was found, which is taken as proof there is no bubble in the real estate market. However, these tests have lower power because of the presence of non-linearity in the CNX Realty index. To account for non-linearity, Taylor and Peel's (1998) RADF test was conducted, which found evidence of a bubble.

To capture the asymmetric process of adjustment toward long-run equilibrium, we used various threshold autoregressive models of which the Engel-Granger cointegration test can be seen as a special case. Specifically, it uses TAR, MTAR, and Enders and Siklos's (2001) MTAR using Chan's (1993) methodology. Using a consistent MTAR model study finds cointegration between prices and dividends but also finds evidence of asymmetric adjustment toward long-run equilibrium, a sign of a positive periodically collapsing bubble in the Indian real estate market. Overall, the study shows that conventional methods of detecting bubbles have lower power. The CNX Realty index might remain cointegrated for a long run but may show the signs of a bubble that can go unnoticed with conventional techniques.

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