BUBBLE IN THE INDIAN REAL ESTATE MARKETS: IDENTIFICATION USING REGIME-SWITCHING METHODOLOGY

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ABSTRACT

India has a growing economy that can support high-income levels and in turn sustain higher real estate prices. The high prices of Indian real estate seem to be in harmony with its fast growing economy. However, there are concerns about speculative bubble behavior in the Indian real estate market. In this paper, we utilize a sophisticated regime-switching speculative bubble model developed by van Norden and Schaller (1993) along with other traditional econometric methods to test for the presence of bubbles in the Indian real estate market. Our results provide evidence that India real estate bubble was not affected by the 2007-2008 global economic slowdown. The Indian Real Estate market grew from the end of 2008 through early 2011.

JEL: C22, C41, L85, R33

KEYWORDS: Indian Real Estate, Rational speculative bubbles, Regime-switching tests, duration dependence tests, REITs

INTRODUCTION

While the US and European housing markets are still struggling to recover from their pre-global final crisis of 2007-2008, the Indian housing market has recovered quickly from its 2007 slide. RESIDEX, an Index created by National Housing Bank (NHB) of India clearly indicates that except for a few small cities, the prices of real estate are significantly above pre-crisis levels. In H1 2011 prices in the four major Indian cities of Delhi, Mumbai, Kolkata, and Chennai rose 26%, 75%, 111%, and 118 %, respectively. The Reserve Bank of India - RBI (Central bank of India) observed the higher real estate prices and became concerned about a potentially damaging real estate bubble (Business Standards, July 2011).

The RBI based its concern on two trends: (1) the growth of non-performing assets in residential mortgages and that commercial real estate was at record high levels (2) teaser rates offered by Indian banks since 2009 may have over-stimulated loan demand. The teaser rates are set at fixed low rates for the first few years of the loan period and then, depending on the contract, the rate can become floating or remain fixed based on the State Bank Advance Rate – Benchmark Lending Rate. The RBI's main concern is that teaser rates may cause borrowers to default on loans when interest costs are increased. Jones Lang LaSalle, the leading Indian real estate consultants group has noted the higher level of risk and the bubble behavior of investors and borrowers.

Indian economists and policy makers believe that the current Indian real estate market demonstrates similarities to the U.S. real estate market shortly before the subprime mortgage crisis. However, policy makers do not consider the situation alarming at this point because of several factors. First, property prices in some Indian cities are much higher than the sustainable level of income but fast growing economy and rising income levels may be able support high real estate prices. Second, the cause of the real estate bubble burst in U.S. and other Western countries was the widespread bundling and sale of real estate mortgages in the form of financial derivatives. Financial derivatives are not available in the Indian

economy. Finally, Indian savings rates are significantly higher than U.S. savings rates during the time of rising real estate prices. Higher savings rates allow borrowers to put a greater percentage of money down on a property and provide a greater cushion for borrowers in the event that mortgage payments are adjusted upward by lending institutions.

The Indian economy depends heavily on the real estate sector. Therefore, any destabilization can be disastrous to the Indian economy and would create an immediate and long-term recession that will be very hard to overcome (Vishwakarma and French (2010) and Newell and Kamineni (2007) provides a comprehensive sketch of historical background and significance of real estate sector in India.). According to the "Report on Trend & Progress of Housing in India, 2006" by the National Housing Bank of India: "The real estate sector is one of the fastest growing sectors in India with its size close to US $12 billion and with an annual growth rate of 30% with 5% contribution to GDP".

Bubbles in the real estate markets are characterized by rapid increases in the values of real property because market participants are willing to buy and hold the asset because they believe that they can resell the asset at an even higher price in the future. This is possible because of increasing prices in the case of a positive bubble until unsustainable price levels are reached relative to incomes and other economic fundamentals. A similar result occurs for negative bubbles.

Several studies attempt to detect the presence of bubbles in different real estate markets. Arshanapalli and Nelson (2008) find evidence of bubbles in the U.S. housing market during the 2000 to 2007 period. Bordo and Jeanne (2002) and Helbling (2003) find evidence of housing bubbles in 14 OECD countries over the period of 1973-2000. Abraham and Hendershott (1996), Case and Shiller (2003) and Cecchetti (2005) present evidence for the presence of a speculative bubble in the U.S. housing market. Roche (2001) finds some evidence of a speculative bubble in the Irish housing market in Dublin. Clayton (1997) studies the Canadian real estate market and reports evidence of bubble behavior. Levin and Wright (1997) divided housing prices into two components for UK housing market, one driven by economic fundamentals and the other due to speculation in the housing market. They find strong evidence of bubble behavior in the UK housing market. Hendershott (2000) and Bjorklund and Sodeberg (1999) find evidence of bubbles in the commercial real estate market in Sydney and Sweden, respectively. Qin (2005) tests for bubbles in Seoul and Hong Kong markets and finds some evidence of bubbles lasting a few years in both markets. Paskelian, Hassan and Huff (2011) test for the presence of rational speculative bubbles in the U.S. REITs market and find evidence of bubble-behavior using regime-switching methodology. Also, Paskelian and Vishwakarma (2011) test for the presence of bubbles in the Chinese real estate market and find evidence of a growing real estate bubble. Finally Joshi (2006), attempts to isolate the factors affecting the real estate bubble in the Indian property market using VAR framework. He finds that interest rate levels and credit growth play an important role in influencing housing prices as well as stabilizing other sectors in the Indian economy.

In this paper, we employ various econometric methods to test for the presence of rational speculative bubbles in the Indian REITs market. Our study focuses on the methodology of van Norden (1996), and van Norden and Schaller (1999). The regime-switching model proposed by van Norden and Schaller tests for periodically collapsing speculative bubbles by estimating time-varying probability of the collapse of positive and negative speculative bubbles. This paper is the first paper that examines data for the presence of rational speculative bubbles in Indian real estate markets using the regime-switching model. We find a relatively strong presence of bubbles in the Indian REITs market. In particular, our findings suggest that bubble behavior in the Indian REITs market intensifies at the end of 2007 and continues to increase in intensity through the end of 2010.

In the succeeding sections of this paper, we present a brief review of literature dedicated to the behavior and existence of real estate bubbles. We describe the data and the methodology used in the paper,

including the advantages and disadvantages of the econometric techniques employed in the analysis. The results section follows with explanations of the analysis and test result interpretation. Finally, the last section is a summary of conclusions.

LITERATURE REVIEW

The econometric literature describes several methods to test for the presence of bubbles in asset prices. The three major techniques for testing bubbles are variance bound tests, stationarity and cointegration tests, and regime switching models. Hart and Kreps (1986) were first to test for bubbles in stock markets using excess volatility and variance-bound tests. Shiller (1981) and Cochrane (1992) used similar procedures to test the movement of stock prices. These tests compared actual data with fundamentals to find evidence of a speculative bubble. However, finding the appropriate fundamental is a major challenge. Stationarity and cointegration tests are proposed by Diba and Grossman (1988a and 1988b), and Hamilton and Whiteman (1985), to establish the presence of speculative bubbles. According to this methodology, asset prices that are cointegrated with their dividends are evidence against the presence of bubbles. However, these methods tend to reject the presence of bubbles too often (Evans, 1991) because other factors tend to cause a lack of cointegration.

Regime-switching models were introduced by Blanchard and Watson (1983). These models test for the presence of bubbles as changes in regimes occur, and then analyze price process properties in out-of-the bubble regimes. van Norden and Schaller (1993) and Schaller and van Norden (1997) refined this model by formulating a periodically collapsing, positive and negative speculative bubble model that has a time varying probability of collapse (see more detail in methodology section).

Real estate research has incorporated the above-mentioned techniques with some improvisation i.e. Brooks, Katsaris, McGough and Tsolacos (2001) for UK market, Jirasakuldech, Campbell, and Knight (2006) for US market, Payne and Waters (2005), Payne and Waters (2007), Waters and Payne (2007), and Paskelian et al. (2011).

Brooks, Katsaris, McGough and Tsolacos (2001) applied excess volatility and variance-bound methods to test for the presence of speculative bubbles in the real estate market of the UK. They designated the dividend growth rate taken from Gordon's model in order to test for the presence of a speculative bubble. They found evidence of a UK real estate bubble due to the presence of low volatility in fundamental measures rather than real estate prices.

Jirasakuldech et al. (2006) looked for the presence of rational speculative bubbles in the US securitized real estate market from January 1973 to December 2003 using four methods. They used various factors for calculation of fundamentals e.g., the consumer price index (CPI), industrial production, the federal funds rate and the default risk premium. First, they applied unit root test following Diba and Grossman (1988a, 1988b) but found no evidence of a speculative bubble. Second, they used Blackburn and Sola (1996) methodology to conduct cointegration tests. Again they found no evidence of a bubble. Their third test was Johansen's cointegartion test with Junttila's (2003) methodology that resulted in a finding of no bubble evidence. Lastly, they applied the McQueen and Thorley (1994) model for duration dependence test and found no evidence of a bubble.

Payne and Waters (2005, 2007) argue that the Diba and Grossman (1988a) approach will not detect periodically collapsing bubbles. Payne and Waters (2005) followed the methodology of Evans (1991) finding some evidence of negative periodically collapsing bubbles in mortgage and hybrid REITs markets. However, Payne and Waters (2007) find mixed evidence of bubble in equity REIT markets. Conversely, Waters and Payne (2007) test for both positive and negative periodically collapsing bubbles using the residual-augmented Dickey-Fuller model of Taylor and Peel (1998) and the momentum

threshold autoregressive (MTAR) model of Enders and Siklos (2001); which resulted in a finding of some evidence of negative periodically collapsing bubbles in the mortgage real estate market.

An exhaustive study conducted by Paskelian et al., (2011) on equity, mortgage and hybrid real estate markets in the US from 1972-2009 employed the unit-root test, variance ratio test, duration dependence test and regime switching regression models of van Norden and Schaller (1993). Study results revealed that only the regime-switching model showed weak evidence of a periodically collapsing bubble in the mortgage and hybrid REITs sectors during the period 2000-2005. However, traditional methods employed in the same study failed to detect the existence of any speculative bubble.

This paper adds to the current literature by providing insights into the presence of periodically collapsing speculative bubbles in the Indian securitized real estate market. The study employs a regime-switching bubble methodology not previously utilized in existing Indian securitized real estate bubble literature.

DATA AND METHODOLOGY

This paper uses daily and monthly data from the CNX realty index from January 2007 to July 2011 as a proxy for the Indian real estate sector. The daily CNX realty index is used for the regime-switching methodology; while the monthly CNX realty price index is employed for all other estimations. The CNX realty index is a sector index of Indian real estate maintained by the National Stock Exchange (NSE) of India. It is comprised of ten listed companies from the real estate sector with considerable track record. Monthly Indian rental property series data and consumer price index data was obtained from the Labour Bureau of the Government of India.

Gurkaynak (2005) provides a comprehensive reference concerning the econometric tests for speculative bubbles. Jirasakuldech et al. (2006) analyze the U.S. Equity REITs market by testing for the presence of rational speculative bubbles using the unit root, variance ratio and duration dependence methodologies. Following Jirasakuldech et al. (2006), we test for stationary properties of the Indian CNX Realty price index utilizing a fundamental variable measured by the Indian rental index series that tests for the existence of rational speculative bubbles. The Indian rental index is used as the proxy for the fundamental process. If the Indian CNX Realty price index contains bubbles, then the explosive nature of speculative bubbles will make it less likely for the series data to achieve a stationary process by repeatedly differencing the series. Therefore, if the Indian CNX Realty prices are stationary in the first differences, it is more likely that the non-stationary is caused by the nature of market fundamentals, rather than explosive bubbles. We test for the stationarity of the Indian CNX Realty price index returns by using the Augmented Dickey Fuller (ADF) (1979) and the Phillips Perron (PP) (1988) unit root tests.

The variance ratio test has been widely used to test for weak-form efficiency of financial markets since Lo and MacKinlay (1988). A comprehensive survey of recent methodological developments is given in Charles and Darne (2009). We use the following procedure to calculate the variance of an asset's return over the holding period k, denoted as Vk. We define the variance ratio V(k) as the ratio of the variance of the k-period return to that of one-period return times k.

Next, we follow the popular McQueen and Thorley's (1994) duration dependence methodology to test for rational speculative bubbles in the Indian real estate index. The continuously compounded monthly real return as the first difference of the natural log normalized using the first difference of the natural log of the Indian monthly consumer price index (CPI) is used for the duration dependence test.

The duration dependence procedure tests for the presence of rational speculative bubbles by looking at the length sequence of positive returns. To sustain a bubble the probability of negative return decreases with the increase of length of sequence of positive returns. Technically, this means the presence of bubbles

creates negative duration dependence and decreasing hazard rate. Therefore, to test for rational speculative bubbles, we need to examine the hazard rate h_i for runs of positive and negative returns. If condition of $h_{i+1} < h_i$ exists in runs of positive returns then it means bubble exists. Where $h_i = Prob\ (\epsilon_t < 0 | \epsilon_{t-1} > 0, \epsilon_{t-2} > 0 \dots \dots, \epsilon_{t-i} > 0, \epsilon_{t-i-1} > 0)$ rate (McQueen and Thorley (1994); Jirasakuldech, Campbell and Knight (2006)).

Finally, in order to circumvent the shortcomings of conventional econometric tests for the existence of speculative bubble, and continuing with the line of research started by Payne and Waters (2005, 2007), we test for the presence of periodically partially collapsing speculative bubbles based on the regime-switching methodology of van Norden and Schaller (1993). van Norden (1996) and van Norden and Schaller (1993 and 1999) show that periodically collapsing bubbles incorporate regime switching processes in asset returns which may cause the bubbles to either survive or collapse. Schaller and van Norden (1997) show that the probability of the collapse depends on the size of the bubble, thus switches in regime can be predicted using a measure of the size of the bubble in the previous period.

The paragraph below is a brief overview of the van Norden and Schaller (1993) model and estimation procedure. The time varying probability of collapse is measured by the model which incorporates periodicallity, partial collapsibility as it pertains to the positive and negative speculative bubble model and is stated as follows:

$$E_t(b_{t+1}) = \begin{cases} \frac{(1+i)b_t}{q(B_t)} - \frac{1-q(B_t)}{q(B_t)}\, u(B_t) P_t \ with\ Probability\ of\ q(B_t) \\ \\ u(B_t)\ P_t\ with\ probability\ of\ 1 - q(B_t) \end{cases} \quad (1)$$

$E_t(b_{t+1})$ is the expected size of bubble and $u(B_t)$ is the relative size of bubble. Since this model allows negative bubbles the probability of bubbles ($q(B_t)$) survival is modeled as a negative function of the size of bubble i.e. $q(B_t)$ as a function of $\frac{\partial q(B_t)}{\partial |B_t|} < 0$. Gross returns in surviving and collapsing state can be written as follows:

$$E_t(r_{t+1} | W_{t+1} = S) = \left[M(1 - B_t) + \frac{MB_t}{q\ (B_t)} - \frac{1-q(B_t)}{q\ (B_t)}\, u(B_t) \right] with\ probability\ q\ (B_t) \quad (2)$$

$$E_t(r_{t+1} | W_{t+1} = C) = [M(1 - B_t) + u(B_t)] with\ probability\ 1 - q(B_t) \quad (3)$$

Where r_{t+1} is the return of period t+1 conditioned on the survival state S and collapsing state C; W_t is an unobserved indicator that determines the current state at time t using probit model $P(W_{t+1} = S) = q(B_t) = \Omega\left(\beta_{q,0} + \beta_{q,b} |B_t|\right)$, and M is the gross fundamental return on asset. After linearizing, the estimable linear regime-switching model becomes:

$$\begin{aligned} r_{t+1}^S &= \beta_{S,0} + \beta_{S,b} B_t + u_{t+1}^S \\ r_{t+1}^C &= \beta_{C,0} + \beta_{C,b} B_t + u_{t+1}^C \\ P(W_{t+1} = S) &= q(B_t) = \Omega\left(\beta_{q,0} + \beta_{q,b} |B_t|\right) \end{aligned} \quad (4)$$

Where u_{t+1}^S and u_{t+1}^C are the unexpected returns for period t+1 in the surviving and collapsing regimes respectively and are assumed to have zero mean and constant variance i.i.d. normal random variables. Four restrictions are imposed in case of periodically collapsing speculative bubbles. The first restriction $\beta_{S,0} = \beta_{C,0} = \beta_0 = \beta_{S,b} = \beta_{C,b} = \beta_{q,b} = 0$ implies that the mean across the two regimes is different. The second restriction is $\beta_{C,0} < 0$ which implies the expected return should be negative if the

collapsing regime is observed. The third restriction is $\beta_{S,b} > \beta_{C,b}$ which implies the bubble yields higher (lower) returns if a positive (negative) bubble is observed in the surviving regime than if it is observed in the collapsing regime. The fourth restriction is $\beta_{q,b} < 0$ which implies the probability of the bubble continuing to exist decreases with the size of increasing bubble.

This study also tests the above model in three different specifications: Volatility of regimes, mixture of normals, and mean reversion specifications. Volatility of regimes specifications is achieved by applying ARCH (Auto regressive conditional heteroskedasticity) on the estimation by imposing condition of $\beta_{S,0} = \beta_{C,0} = \beta_0 = \beta_{S,b} = \beta_{C,b} = \beta_{q,b} = 0$ and $\sigma_s \neq \sigma_c$. Mixture of normals is achieved by $\beta_{S,b} = \beta_{C,b} = \beta_{q,b} = 0$. This specification tests the leverage effect of markets. Mean reversion can be achieved by $\beta_{S,0} = \beta_{C,0} = \beta_0 = \beta_{S,b} = \beta_{C,b} = \beta_1 \; and \; \beta_{q,b} = 0$. This specification can capture the linearly predictability of returns with different mean across regimes.

For the relative bubble size, we use van Norden and Schaller (1993) approximation: $B_t = \frac{b_t}{p_t} = 1 - \frac{\rho d_t}{p_t}$ with ρ being the sample mean of the price over rent ratio.

EMPIRICAL RESULTS

Table 1 provides descriptive statistics of daily real returns of the Indian realty price index. During the period 2007 to July 2011, the Indian realty price index provided an average daily real return of 0.052%, with a standard deviation of 0.083%. The corresponding monthly average return was 1.56%. The return of the Indian CNX realty price index shows peaks of maximum and minimum returns with significant negative skewness and excess kurtosis which indicates the potential for the existence of a rational speculative bubble. Further indication of the existence a of speculative bubble can be obtained from significant six month lags (Q6) and twelve month lags (Q12) autocorrelation results in Table 1.

Table 1: Summary Statistics for the Indian CNX Realty Price Index Returns

Variable	CNX Realty Index Returns
Mean (%)	0.0519
Median (%)	0.0832
Minimum (%)	-12.202
Maximum (%)	17.745
Standard Deviation (%)	1.934
Skewness	-0.3833*** (0.000)
Kurtosis	8.575*** (0.000)
Jarque-Bera	42.317*** (0.000)
Q(6)	9.268*** (0.0027)
Q(12)	18.241** (0.0147)

*The returns are continuously compounded. The mean, the median, the standard deviation, the minimum and the maximum are expressed in percentage terms. Q9(6) and Q(12) are the Ljung-Box portmanteau test statistics for 6 and 12 autocorrelations. ***, ** and * indicate significance at 1, 5 and 10 percent levels respectively.*

After preliminary investigation of normality and serial autocorrelation, the paper examines the stationarity of the Indian realty price returns by using the Augmented Dickey Fuller (ADF) (1979) and the Phillips Perron (PP) (1988) unit root tests. The ADF and PP unit root tests are applied to the Indian realty price

index after normalizing the monthly price levels by the monthly Indian consumer price index to obtain real price levels. Table 2 reports the ADF and PP unit root tests for the Indian realty price index (Panel A) and changes in the Indian realty price index levels (Panel B) with trend as well as without trend. Results from panel A indicate show non-stationarity, however, panel B is stationary. This implies there is no speculative bubble in the Indian real estate market. Had there been some kind of speculative bubble, differencing the series cannot make it stationary (Campbell and Shiller (1988) and Diba and Grossman (1988a and 1988b)). However, the application of stationarity test methodology is not sufficient to reach meaningful conclusions about the existence or lack of existence of speculative bubbles.

Table 2: The ADF and PP Unit Root Tests on Monthly Real Returns of The Indian CNX Realty Price Index

	ADF without Trend	ADF with Trend	PP without Trend	PP with Trend
Panel A: Real Price Index Level				
CNX Realty Index Returns	4.284	0.9582	4.845	1.052
Panel B: Change In Real Price Index Level				
CNX Realty Index Returns	-5.325***	-6.843***	-11.585***	-17.922***

The table shows the estimates of the Augmented Dickey Fuller (ADF) regression: $\Delta Y_t = a_0 + \gamma Y_{t-1} + a_2 t + \sum_{i=1}^{p} \beta_i \Delta Y_{t-1} + \varepsilon_t$ *, where* $\Delta Y_t = Y_{t-i} + Y_{t-i-1}$ *and t is the time period. If* $\gamma_0 = 0$ *, then the* Y_t *series has a unit root, indicating that he series is non-stationary. The Phillips-Perron regression is* $Y_t = \widetilde{a_0} + \widetilde{a_1} Y_{t-1} + \widetilde{a_1}\left(t - \frac{T}{2}\right) + \varepsilon_t$ *, where T is the number of observations. If* $a_1 = 1$ *then* Y_t *has unit root. ***, ** and * indicate significance at 1, 5 and 10 percent levels respectively.*

The variance ratio test (which is a test for random walk hypothesis) is an indirect way of testing for speculative bubbles. Table 3 reports the variance ratio test results for the Indian realty index and corresponding Z-statistics for various lags. The real returns are greater than one for all lags and seem to be increasing with lags, indicating some form of positive autocorrelation or mean reversion which is an indication of rejection of the applicable random walk hypothesis. Rejection of the random walk hypothesis further confirms the absence of bubbles in the Indian real estate market.

Table 3: The Variance Ratio Test On Monthly Real Returns Of The Indian CNX Realty Index Returns.

	2-Month	Z-Statistic	4-Month	Z-Statistic	8-Month	Z-Statistic	16-Month	Z-Statistic	32-Month	Z-Statistic
CNX Realty Index Returns	1.124*	(2.963)	1.151*	(2.931)	1.365	(1.501)	1.368**	(6.105)	1.368**	(3.158)

The table shows the estimates of the variance ratio test given by the following model: $VR(q) = \frac{\bar{\sigma}_c^2(q)}{\bar{\sigma}_a^2}$ *, where* $\bar{\sigma}_a^2$ *is the estimated variance of the monthly differences* $X_t - X_{t-1}$ *, and* $\bar{\sigma}_c^2(q)$ *is the unbiased estimation of 1/q times the variance of* $X_t - X_{t-q}$ *. Under the random walk null hypothesis, the variance ratio is 1 and the test statistic z(q) follows a standard normal distribution asymptotically. ***, ** and * indicate significance at 1, 5 and 10 percent levels respectively.*

Table 4, reports the results of duration dependence tests to detect the possibility of rational speculative bubbles. For this purpose, hazard function (h_i) statistics for the actual number of positive and negative runs for monthly real returns for the Indian realty price index are calculated. Following McQueen and Thorley's (1994) duration dependence methodology, the study uses continuously compounded monthly real returns as the first difference of the natural log normalized using the first difference of the natural log of the monthly Indian consumer price index (CPI) as the data to be used for the duration dependence test.

Table 4: The Duration Dependence Test Results for The Indian CNX Realty Index Returns

	Positive Runs				Negative Runs		
Variable	**Run Length**	**Actual Run**	**Sample Hazard Rate**	**Variable**	**Run Length**	**Actual Run**	**Sample Hazard Rate**
	1	12	0.3521		1	5	0.2674
	2	8	0.2588		2	2	0.3684
	3	3	0.2515		3	2	0.3847
	4	4	0.2141		4	1	0.1576
	5	3	0.4216		5	2	0.3654
	6	1	0.4285		6	0	0.000
	7	1	0.3333		7	0	0.0000
	8	0	0.0000		8	0	0.0000
	9	0	0.0000		9	0	0.0000
	10	0	0.0000		10	0	0.0000
Total Runs		32		Total Runs		12	
Log-Logistic Test				**Log-Logistic Test**			
α		-0.5217		α			-0.4147
β		-0.1284		β			0.3847
LRT of H_1: $\beta = 0$		0.5714		LRT of H_1: $\beta = 0$			0.6581
(p-value)		(0.0521)		(p-value)			(0.0524)

The hazard function (h_i)*, defined as* $h_i = Prob(I = i|I \geq i)$*, represents the probability that a specific run ends at length i, provided that it lasts until length i. The log likelihood expression of the hazard function is defined as:* $h_i L(\theta|S_T) = \sum_{i=1}^{\alpha} N_i Lnh_i + M_i Ln(1-h_i) + Q_i Ln(1-h_i)$*, the estimated hazard rate for length i is derived by maximizing the log likelihood function with respect to* h_i*.***, ** and * indicate significance at 1, 5 and 10 percent levels respectively.*

From Table 4, the longest positive run lasts 12 months for the Indian realty price index. The negative runs are typically shorter in length. The longest negative run lasts 5 months for the Indian realty price index. The sample hazard rates reported in Table 4 determine the probability that a specific run ends at length i, given that the run has lasted until i. For the Indian realty price index, there are 32 positive runs and 12 negative runs for a total of 44 runs of real returns. The hazard rate associated with a positive run length of 7 months for the Indian realty index is 0.3333. Therefore, there is a probability of 33.33% that a bubble will burst at the 8 month mark. Our results show that there is a moderately increasing pattern in the hazard rate of the Indian realty price index, but there is no such evidence for negative runs. These findings are supportive evidence for the presence of rational expectations bubbles. The significantly positive beta found in the Indian realty price index indicates that as the sequence length of positive returns increases, the probability that the positive run will end increases. Therefore, the presence of bubble behavior using the duration dependence test is confirmed.

The literature review section and methodology section review of the regime-switching methodology of van Norden and Schaller (1993) revealed many advantages over unit root tests, variance ratio tests, and duration dependence tests. Thus, the paper incorporates a regime-switching estimation model for the Indian real estate market. The estimated parameters of the speculative regime-switching model are presented in Table 5 along with the likelihood ratio test statistic for the restrictions implied by the volatility regime, mixture of normals, and mean reversion models of stock returns. The volatility regime model tests for equal variance in two regimes. Failure to reject means no evidence of speculative bubbles. Table 5 shows that the volatility regime specification has a value of 14.252 which is significant at 1%. Therefore, the model rejects the null hypothesis which results in a conclusion that there is some evidence of speculative bubbles in the Indian real estate market. The mixture of normals model specification tests the deviation from the fundamentals which are not simply related to the leverage effect while still having predictive power for the distribution of returns. Again, in this case we find an estimated

value of 12.361 which is significant at 1 %. This result supports the conclusion that bubble-like behavior exists in the Indian real estate market. Finally, the mean reversion model tests for a possible relationship between the return process and the B_t. Rejection of the null hypothesis implies a different return process which is indicative of the presence of a speculative bubble. The mean reversion statistic has a value of 14.586 which is significant at 1%, thus this model also demonstrates evidence of the existence of speculative bubbles in the Indian real estate market.

The coefficient restrictions of the model are highly significant and correctly predicted for the Indian real estate market. The point estimate of $\beta_{S,0}$ is 1.085 and is significant at 1% implying a monthly rate of return of 8.5%. Conversely, the point estimate of $\beta_{C,0}$ is 0.978 and is significant at 1% implying a monthly rate of return of -2.2% in the collapsing regime. The difference in the monthly rate of return between the two regimes indicates the presence of speculative bubbles in the Indian real estate market. Therefore, based on highly significant estimates for three stylized specifications, significant coefficient restrictions, and large-sized differences in the respective monthly rates of return of the surviving and collapsing regimes, it can be concluded that strong evidence confirms the existence of speculative bubble behavior phases in the Indian real estate market.

Table 5 Results of the Regime-Switching Speculative Bubble model for the Indian CNX realty Index Returns

Variable	Equity REITs
$\beta_{S,0}$	1.085***
$\beta_{S,b}$	0.005
$\beta_{C,0}$	0.987***
$\beta_{C,b}$	-0.0364
$\beta_{q,0}$	3.158**
$\beta_{q,b}$	-4.028**
σ_S	0.105***
σ_C	0.154***
Log-Likelihood	584.638
AIC	-5.158
SC	-8.529
HQ	-4.325
$\beta_{N,0} \neq \beta_{S,0} \neq \beta_{C,0}$	5.185**
$\beta_{C,b} < 0$	1.521
$\beta_{S,b} > \beta_{C,b}$	5.236**
$\beta_{S,Y} > 0$	7.415**
Volatility Regimes	14.252***
Mixture of Normals	12.361***
Mean Reversion	14.586***

The table shows the estimates of the following model: $r_{t+1}^S = \beta_{S,0} + \beta_{S,b}B_t + u_{t+1}^S$ and $r_{t+1}^C = \beta_{C,0} + \beta_{C,b}B_t + u_{t+1}^C$; with $P(W_{t+1} = S) = q(B_t) = \Omega(\beta_{q,0} + \beta_{q,b}|B_t|)$. r_{t+1} *denotes the return of period t+1 conditioning on being in the surviving (S) or collapsing (C) state and t,* Ω *is the standard normal cumulative density function,* $\beta_{S,0}, \beta_{S,b}, \beta_{C,0}, \beta_{C,b}$ *are the coefficients to be estimated,* u_{t+1}^S *and* u_{t+1}^C *are the error terms with mean zero and variance* σ_u^C *and* σ_u^S *. ***, ** and * indicate significance at 1, 5 and 10 percent levels respectively.*

Our results provide evidence of the presence of bubbles in the Indian real estate market. The regime-switching model coefficients are highly significant and are indicative of speculative bubble behavior in

the Indian real estate market. The test results rule out regime shifts based on volatility, leverage effects or linear predictability of returns.

CONCLUSION

The Indian real estate sector suffered a slight slowdown due to the global financial crisis of 2007-2008. However, and in contrast to its western counterparts, 2011 Indian real estate prices are already above their pre-crisis benchmark. Some economists and the central bank of India are viewing the combination of extraordinarily high prices in the real estate sector and low house financing rates as indicative of a real estate bubble in India. Other economists and property dealers argue that the fast growing economy of India has rapidly growing income levels and relatively high savings rates which serve to distinguish India from other countries suffering from the effects of the recent financial crisis. Thus, they argue that real property price increases in India are perfectly normal and not the result of the existence of speculative bubbles. The unique characteristics of the Indian economy and the real estate sector provide an opportunity to study the Indian real estate sector and test for the existence of speculative bubbles.

Our study is one of the first attempts to analyze and test for the existence of speculative bubbles in the Indian real estate sector. The paper tests for the presence of rational speculative bubbles in the Indian real estate market during the period 2007-2011 by studying the CNX Realty Index maintained by the National Stock Exchange (NSE) of India. Several econometric bubble identification techniques are used including the unit root tests, the variance ratio test, the duration dependence test and a regime-switching test. The regime-switching test is based on van Norden-Schaller (1993) methodology.

The conventional techniques employed provide no conclusive evidence of the existence of a speculative bubble in the Indian real estate market. However, the regime-switching test provides conclusive evidence of such a bubble. The volatility regime specification has a value of 14.252 with 1% significance indicating there are two distinct regimes in the Indian REITs sector which differ in more than their variances; thus indicating the presence of two distinct and opposite behaviors in the Indian REITs sector. The mixture of normals statistic has a value of 12.361 with 1% significance which indicates that the Indian REITs prices have significant deviations from their fundamentals values during the period of 2007-2011. This provides evidence of bubble-like behavior in the Indian REITs sector. Finally, the mean-reversion statistic has a value of 14.586 with 1% significance which indicates the presence of two distinct regimes with different constant and autoregressive terms and different volatility. The difference in the monthly rate of return between the surviving and collapsing regimes also indicates the presence of speculative bubbles in the Indian real estate market.

The results from our study have significant policy implications for the Indian government as well as for practitioners. For the Indian government, it is necessary to devise a solution to softly diffuse the speculative bubble without creating an anti-investing sentiment in the markets or alienating the real property owners. Practitioners should not rely on conventional tools for detecting bubbles. Global portfolio holders should incorporate the existence of the Indian real estate bubble into their investment strategy. The Indian government most probably will take some actions to stop bubble growth or burst which will affect any portfolio including REITs shares. Hence, an appropriate hedging strategy should be devised well in advance.

We have provided a thorough analysis of the Indian real estate sector by analyzing the CNX realty index. However, we do not pretend to have written a flawless paper. The paper has some limitations such as unavailability of suitable proxy for Indian real estate market; none of realty indices goes back beyond year 2007. It would have been optimal to include other proxies of real estate market thereby providing a more complete coverage of the Indian real estate sector. We believe that we were consistent in our work and accurate, in which the results are robust in all material respects. To check the robustness of our

results, we used several different econometric specifications. An extension of our study can be done using hand collected data from major cities of India to test the behavior of real estate market in different cities of India. In doing so, our conclusions can be stronger and the results more robust.

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