An investigation of bubble spillovers from the stock market and the residential property market to REITs

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Abstract

Previous research has focused on the link between returns in the REIT industry, the stock market and the housing market. However, none, so far, have examined the possibility of bubble spillovers from either of the markets to the securitised real estate market. In this paper, we test for the presence of periodically collapsing bubbles in the three markets using a regime switching approach. Significant evidence of this class of bubbles exists in the three markets. Using a Granger causality test, we discover that bubbles spillover from the unsecuritised real estate market to the REIT market, only. Further analyses show that over eight quarters, over 9.5% of the variation in the REIT market bubble is caused by shocks to the housing market bubble compared to the stock market bubble which contributes to only 1.1% of changes. Given these findings, we proceed to compare REIT trading rules that rely on signals from the forecasted probabilities of a crash occurring in the unsecuritised real estate market to other strategies. Between 2000 and 2009, this trading rule outperforms the traditional buy-and-hold strategy.

Key words: periodically collapsing speculative bubbles, REITs, trading rules

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1. Introduction

The Real Estate Investment Trust (REIT) market has been popular among investors as an alternative to direct investment in real estate. Formally introduced by the Congress in 1960, US REITs are not only legally required to have at least 75% of their assets and income derived from real estate, but they must pay 95% of their taxable income as dividends. These requirements make investing in REITs attractive to investors since they are designed to provide a stream of dividends that is directly related to the rental income received. Since the introduction of REITs, there have been a series of favourable structural reforms in the regulations guiding REITs and industry innovations.[1] The intervening period saw an initial public offering (IPO) wave in the REIT market. Reports from the National Association of Real Estate Investment Trusts (NAREIT) show that there were 95 IPOs in the industry between 1993 and 1994 compared to 48 between 1988 and 1992.[2]

The surge in the size of the REIT market prompted the interest of academic and industry researchers. Whilst many researchers focused on primary offerings in the REIT market, others examined the effects of the stock market and the underlying property market on the price dynamics of REIT stocks. These studies lack consensus on this issue. Goetzmann and Ibbotson (1990) show that, despite the requirement to distribute dividends, the returns of REITs are more correlated with the stock market than with indices representing real estate and, thereby conclude that REITs should not be viewed as real estate. More recently, He (2000) finds there to be a positive causal relationship between house prices and stock prices of apartment REITs, whilst Goodman (2003) concludes that there is a significant correlation between house prices and REIT stocks only in the 1976 to 2001 period. Goodman, however, reveals that there is a linkage between macroeconomic factors and REIT returns. With the use of vector autoregressive (VAR hereafter) models, Glascock et al. (2001) evaluate the relationship between returns in stocks, bonds and REITs, finding REITs to be more similar to stocks than to bonds. Clayton and MacKinnon (2003) examine whether there is a linkage between returns in REITs, unsecuritized real estate and other financial assets. They decompose the variance of returns and find that between 1993 and 1998, REITs with small

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[1] The introduction of the umbrella partnership REIT (popularly referred to as UPREIT) was a major propelling factor of growth in the industry mainly because this structure facilitated acquisitions of depressed private real estate properties following the housing market downturn of 1989.

[2] Various publications by NAREIT show that funds from IPOs in REITs exceeded $15bn for 1993 and 1994 while funds raised from IPOs in non-REIT firms was about $49.5bn. This shows that around 30% of funds raised from IPOs in the US came from the REIT sector alone. The percentage in 1992 was 3.82% and 1.28% the year before, hence signifying that 1993/1994 was the hottest year in the REIT market.

market capitalization are more closely linked to the underlying property market. Others who critically examined these relationships between REITs and other assets include Ewing and Payne (2005), Laopodis (2009), Simon and Ng (2009) and Lee and Chiang (2010).

Significant interest has also been shown on examining the possibility of speculative bubbles in the securitised real estate market. Applying a variance bound test, Brooks et *al.* (2001) test for bubbles in publicly traded real estate stocks in the UK. This variance bound test, introduced by Shiller (1981) and LeRoy and Porter (1981), examines the variances of fundamental prices and of actual stock prices. A bubble exists if the stock prices are more volatile than the fundamental prices. Brooks et *al.* find strong evidence to suggest that there was a bubble in these stocks between 1987 and 1989, as well as from 1996 onwards. Jirasakuldech et *al.* (2006) test for rational speculative bubbles in equity REIT prices using a fairly simple approach involving unit root and co-integration tests. It is important to note that Evans (1991) concludes that cointegration tests are poor at detecting bubbles that burst and regenerate. Taking this into consideration, Payne and Waters (2007) test for the presence of periodically collapsing bubbles in REITs using a more advanced approach involving a residual based augmented Dickey Fuller test and a momentum threshold autoregressive model. They find bubbles in the lodging subsector only.

To our knowledge there has been no paper that has researched the spillover of any class of bubbles from either the stock market or the underlying property market to the REIT market. This paper aims to fill that gap in the literature. In the light of the heavily publicised collapse in the housing and stock market bubbles in the late 2000s, this research aims to provide a more detailed analysis of whether speculative bubbles in the REIT market were influenced by the sizes of bubbles in the unsecuritised property market and the stock market. This is a relevant piece of research as it evaluates the short term and long term impact of the sizes of the underlying property market and stock market bubbles on the price dynamics of REITs.

Using a regime switching model for bubbles, we test for the presence of periodically collapsing bubbles in the stock market and the underlying residential property market between 1972 and 2009. We find that bubbles exist in both the stock market and the underlying property market. Our results show that only the housing market bubbles spillover to the REIT market. The stock market bubble does not influence over-valuation in the REIT market. Further analyses also show that, over a two year period, 9.5% of the variation in REIT prices is caused by shocks to the size of the housing market bubble compared to the stock market bubble's 1.1%. Hence, we infer that the underlying property market plays a role in determining the price dynamics of REITs.

The outline of this paper is as follows. Section 2 explains the methods implemented, focusing on the regime switching test and the other econometric tests used to determine the bubble spillover effect. In Section 3, we provide a detailed description of the sample used in this research. The following section, Section 4, gives an overview of the fundamental measures of the housing and stock market. Sections 5 and 6 provide our findings and trading rule respectively. Finally, in Section 7, we summarise and draw conclusions.

2. Methodology

2.1 The regime-switching bubble model

Assuming rational expectations, constant discount rates, market equilibrium, risk-neutral investors and the no arbitrage condition, asset pricing theory suggests that the price of a stock (P_t^a) today is given by its expected price in the next period plus the income generated from holding that stock in the next period:

$$P_t^a = \frac{E_t(P_{t+1} + D_{t+1})}{(1+i)} \tag{1}$$

where D_t represents the income stream of the asset (e.g. dividends for stocks and rents for real estate), $E_t(.)$ is the expectation operator and i is the discount rate or the real rate of return.

In order to test for asset bubbles, it is necessary to determine the fundamental value of the asset. The fundamental price (P_t^f), as its name suggests, is influenced solely by market fundamentals and it is traditionally calculated by discounting the summation of the asset's future income to the present value:

$$P_t^f = \sum_{g=1}^{\infty} \frac{E_t(D_{t+g})}{(1+i)^g} \tag{2}$$

Equation (2) is the mathematical representation of the fundamental price of a stock under an infinite planning horizon.

Empirically, the actual asset price often deviates from the fundamental price. These deviations often arise as a result of speculation in the asset's market, where excessive demand by market agents induces price jumps that may exceed the fundamental value of the asset. Hence, asset prices are split into two separate components in the speculative bubble literature, namely the fundamental price and the bubble component, (B_t):

$$P_t^a = P_t^f + B_t + u_t \tag{3}$$

where $u_t \sim N(0, \sigma^2)$ is the unexpected innovation of the fundamental price and the bubble term. The difference between the actual price and the fundamental price at period t, is the bubble component. Note that the bubble must satisfy (1) i.e. $E_t(B_{t+1}) = B_t(1+i)$

Over time, various speculative bubble models have been introduced. Blanchard (1979) and Blanchard and Watson (1982) propose the first notable bubble model. In this model, the bubble component grows exponentially and cannot be negative i.e. the fundamental price cannot be greater than the actual price of the asset. This model also assumes that there are two possible bubble states: the first one being a state in which the bubble survives and the other being a collapsing state. Blanchard and Watson conclude that in period t + 1 the expected bubble can be modelled by the following process:

$$E_t(B_{t+1} \mid S) = \frac{(1+i)}{q} B_t \qquad \text{with probability } q$$

$$E_t(B_{t+1} \mid C) = 0 \qquad \text{with probability } 1 - q \tag{4}$$

where q is the probability of the bubble surviving and $1 - q$ is the probability of a collapse in period t + 1, C and S represent the collapsing and survival states respectively .

Equation (4) implies that in period t + 1, if the bubble does not collapse, the bubble component is expected to grow at a rate higher than the real rate of return. This compensates the investor for risk-taking. However, if the bubble collapses, it collapses immediately to zero (the collapse of a bubble is not a gradual process) and prices return to their fundamental value. This model also concludes that the bubble cannot be regenerated once it collapses. These are empirically unrealistic conclusions, as there have been significant episodes of bubble crashes and regenerations, e.g. the stock market "Great Depression" of 1929 and the "dot-com" bubble of the late 1990s. There were significant price corrections and bubble collapses after those episodes (see Brooks and Katsaris, 2005).

Van Norden and Schaller (1993, 1999) lift these unrealistic assumptions by modifying the Blanchard and Watson model in two ways. Firstly, they allow the probability of being in the surviving bubble state to depend on the relative size of the bubble ($b_t = B_t / P_t$). The probability of being in state S decreases as the relative size of the bubble grows:

$$\frac{\partial q(b_t)}{\partial |b_t|} < 0 \tag{5}$$

The second modification by van Norden and Schaller involves allowing for partial collapses in bubbles, where the size of the bubble gradually decreases in the collapsing state:

$$E_t(B_{t+1} | C) = u(b_t)P_t^a \tag{6}$$

where $u(b_t)$ is a continuous and everywhere differentiable function:

$$0 \leq \frac{\partial u(b_t)}{\partial b_t} \leq 1 \tag{7}$$

Equation (7) allows for the bubble to shrink in the collapsing state, as $\left| u(b_t)P_t^a \right|$ is less than $\left| B_t \right|$. Given these two modifications, van Norden and Schaller introduce the modified bubble process:

$$E_t(B_{t+1} | S) = \frac{(1+i)}{q(b_t)} B_t - \frac{1-q(b_t)}{q(b_t)} u(b_t).P_t^a \qquad \text{with probability } q(b_t)$$

$$E_t(B_{t+1} | C) = u(b_t).P_t^a \qquad \text{with probability } 1 - q(b_t) \tag{8}$$

When $u(b_t)$ equals zero and $q(b_t)$ is a constant, q, the process reduces to that of Blanchard and Watson.

Asset returns under the van Norden and Schaller bubble specification model depends on whether the bubble is in a surviving or collapsing state i.e. returns are state dependent. Where M is the gross fundamental return, the gross return on the asset follows a non-linear switching process:

$$E_t(R_{t+1} \mid S) = \left[M(1-b_t) + \frac{Mb_t}{q(b_t)} - \frac{1-q(b_t)}{q(b_t)} u(b_t) \right] \qquad \text{with probability } q(b_t)$$

$$E_t(R_{t+1} \mid C) = M(1-b_t) + u(b_t) \qquad \text{with probability } 1 - q(b_t) \qquad (9)$$

Equation (9) shows the gross return of the asset at time t + 1 depends on the state at the previous time period. Using a first-order Taylor series approximation method, equation (9) is linearised, hence, making it possible to estimate the model. A linear switching regime model for returns is derived with a single state-independent probability of a regime switch, $q(b_t)$:

$$\begin{aligned} R^s_{t+1} &= \beta_{s,0} + \beta_{s,1} b_t + u_{s,t+1} \\ R^c_{t+1} &= \beta_{c,0} + \beta_{c,1} b_t + u_{c,t+1} \\ P(R_{t+1} \mid S) &= q(b_t) = \Phi(\beta_{q,0} + \beta_{q,1} \mid b_t \mid) \end{aligned} \qquad (10)$$

where the unexpected returns in the collapsing and surviving regimes are represented by $u_{c,t+1}$ and $u_{s,t+1}$, respectively, and they have constant variance and zero mean. Φ is the standard normal cumulative distribution function and so $\Phi(\beta_{qo})$ is the expected or average collapsing regime probability. $\beta_{q,1}$ measures how the probability of being in the collapsing regime changes with respect to the absolute relative bubble size. The condition in equation (5) implies that $\beta_{q,1} \leq 0$. Estimation of parameters in (10) is done by maximising the following log-likelihood function, ℓ :

$$\ell(R_{t+1} \mid \xi) = \sum_{t=1}^{T} \ln \left[P(R_{t+1} \mid S) \frac{\phi\left(\frac{R_{t+1} - \beta_{s,0} - \beta_{s,1} b_t}{\sigma_s} \right)}{\sigma_s} + [1 - P(R_{t+1} \mid S)] \frac{\phi\left(\frac{R_{t+1} - \beta_{c,0} - \beta_{c,1} b_t}{\sigma_c} \right)}{\sigma_c} \right] \qquad (11)$$

where ξ represents the set of parameters to be estimated by maximising the likelihood in (11). These parameters include $\beta_{s,0}$, $\beta_{s,1}$, $\beta_{c,0}$, $\beta_{c,1}$, $\beta_{q,0}$, $\beta_{q,1}$, σ_s and σ_c. The notation ϕ represents the standard normal probability density function, σ_s and σ_c are the disturbance's standard deviation in the surviving and collapsing regimes respectively.[3]

[3] Note that the estimation of van Norden and Schaller's bubble model is done using Matlab 7.9 and we use the BFGS method for solving optimisation problems that are non-linear.

2.2 The test for periodically collapsing speculative bubbles

If periodically collapsing speculative bubbles are present in the asset market, the bubble model must efficiently predict returns, and there are four restrictions on the coefficients that are implied by the speculative behaviour model introduced by van Norden and Schaller. Firstly, $\beta_{c,0}$ and $\beta_{s,0}$ must differ. This means that the average return in the two regimes must not be the same. The mean return in the collapsing state should be less than that of the surviving regime. Secondly, $\beta_{c,1}$ must be less than zero and this shows the expected return on the asset is negative in the collapsing regime. Thirdly, $\beta_{s,1}$ must be greater than $\beta_{c,1}$, implying that the return yielded by the bubble is greater if there is a positive bubble. And finally, $\beta_{q,1}$ should be less than zero, and this implies that as the bubble size increases, the probability of being in the surviving regime is expected to fall.

To ensure that there are no misspecification errors, this bubble model is tested against three other stylised alternatives using a likelihood ratio test. These specifications may mimic stylised features of asset returns. The first specification, referred to as the volatility regime model, introduced by Schwert (1989), involves setting $\beta_{s,0}$, $\beta_{s,1}$, $\beta_{c,0}$ and $\beta_{c,1}$ to zero and imposing equal constants across the regimes:

$$R_{t+1} = \beta_0 + u_{t+1} \tag{12}$$

where

$$u_{t+1} \sim N(0, \sigma_s) \qquad \text{with probability } q$$

$$u_{t+1} \sim N(0, \sigma_c) \qquad \text{with probability } 1 - q \tag{13}$$

The second stylised alternative is the mixture-normal model due to Akgiray and Booth (1987). In this model, returns are not related to the stock price deviation from its fundamental price and so $\beta_{s,1}$, $\beta_{c,1}$ and $\beta_{q,1}$ are all equal to zero. This model is expressed as:

$$R_{t+1} \sim N(\beta_{s,0}, \sigma_s) \qquad \text{with probability } q$$

$$R_{t+1} \sim N(\beta_{c,0}, \sigma_s) \qquad \text{with probability } 1 - q \tag{14}$$

The final stylised alternative is the fads model introduced by Cutler et al. (1991). This model implies that returns can be predicted linearly and so average returns do not vary in either regime. Here, $\beta_{s,0}$ and $\beta_{c,0}$ are both equal to β_0, $\beta_{s,1}$ and $\beta_{c,1}$ are both equal β_1, and $\beta_{q,1}$ is equal to zero. Therefore, the fads model is expressed as:

$$R_{t+1} = \beta_0 + \beta_1 b_t + u_{t+1} \tag{15}$$

where

$u_{t+1} \sim N(0, \sigma_s)$ with probability q

$u_{t+1} \sim N(0, \sigma_c)$ with probability $1 - q$ (16)

See Section 5 for the bubble model's estimated parameters and the likelihood ratio test of the model against the stylised alternatives.

2.3 Determining whether there is a spillover of bubbles to REIT prices

In order to study the spillover of bubbles in the stock market and the residential property market, we use a VAR model. We construct a VAR system which comprises of three variables, namely: the REIT prices, the relative size of the bubble in the property market and the bubble size in the stock market. The optimal lag for the VAR model is chosen using the lag order selection criteria based on Akaike's information criterion (AIC). Note that before the VAR approach is used, we test for unit roots in the three variables and for co-integration between them. If we find the variables to be co-integrated, we opt for the Vector Error Correction Model (VECM) approach, consistent with Granger (1986), which states that including cointegrated variables in a VAR model would lead to misspecification. The VECM model, on the other hand, would be more efficient as it can capture deviations from the long-run equilibrium.

With the VAR system, we can then determine whether the stock market or the underlying property market bubbles affect REIT prices by simply carrying out Granger causality tests. For further analysis, we apply a variance decomposition function to the system to determine what proportion of shocks to the relative size of either the property or the stock market's bubbles cause variation in REIT prices.

3. Data

In this study, the S&P 500 Composite index is selected as a proxy for the stock market as it is the consensus choice for the stock market benchmark. Quarterly S&P 500 real prices and dividends are obtained from Robert Shiller's webpage.[4] For more information on the data, see Shiller (2000).

For the underlying property market prices, we use data on average purchase / sales prices of houses provided by Davis et al. (2008) for the Lincoln Institute of Land Policy. The house prices are extracted from the S&P/Case-Shiller national house price index, which was previously called the Case-Shiller-Weiss index. This index is calculated using the repeat sales method of index calculation and it tracks the value of single-family home prices. The data on rents is also provided by the same source and does not account for income taxes.[5]

FIGURE 1: Stock prices from 1972 to 2009

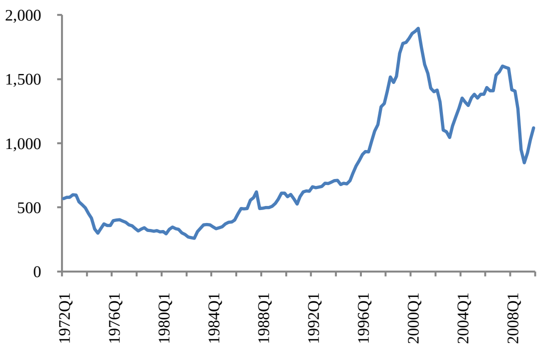
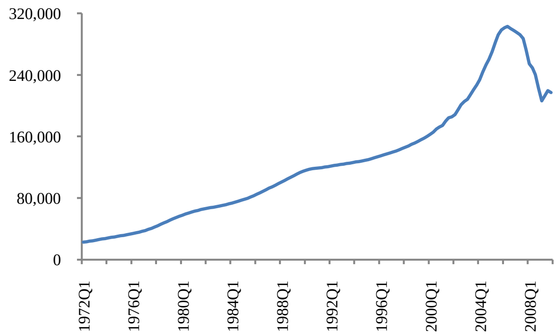


FIGURE 2: House prices from 1972 to 2009



Pre-2000, although the stock market was far more volatile than the real estate market, there were similarities in the patterns of the two markets as both markets grew significantly. The stock market witnessed more cycles than the property market, with more pronounced peaks and troughs over the years. This could have been due to the presence of periodically collapsing bubbles. Early 2000s, stock prices declined significantly as a result of the collapse in the technology stocks bubble. House prices, on the other hand, kept on growing at a faster

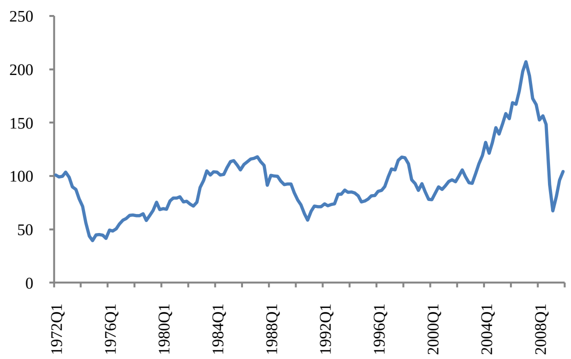
[4] Data is available at: http://www.econ.yale.edu/~shiller/data.htm

[5] More information on the construction of the data can be found at Land and Property Values in the U.S., Lincoln Institute of Land Policy, http://www.lincolninst.edu/resources/

than average rate. However, between 2006 and 2009, both markets witnessed sharp falls in value. The stock market fell by 25.7% whilst house prices declined by 32.5%. This may have been as a result of the subprime market meltdown.

The price dynamics of the All-REIT index (a proxy for the REIT market) is shown in Figure 3. Like the stock market, the REIT industry is more volatile than the housing market. It witnessed two major crashes. The first major crash occurred at the beginning of the 1970s, where rising inflation and subsequent increases in the interest rate negatively affected mortgage lending activities. This had an adverse effect on the REIT industry. The second major crash, caused by the downturn in the subprime market, occurred between 2006Q4 and 2009Q4. The value of the REIT industry fell by 47.4%.

FIGURE 3: REIT prices from 1972 to 2009



4. Models for estimating fundamental values

To test for periodically collapsing bubbles using the van Norden and Schaller approach, the first step is to determine the fundamental price of the asset. In this section, we discuss the measures of fundamental values for the housing market and the stock market at any given time period.

In calculating the fundamental value of stock prices and REIT stock prices, we use the dividend multiple approach. Assuming that log dividends follow a random walk with a drift process, van Norden and Schaller (1999) show that fundamental price of a stock is equal to the average price-dividend ratio multiplied by the dividend at the selected time period:

$$P_t^f = \frac{\overline{P}}{\overline{D}} D_t \tag{17}$$

and so, the non-fundamental or bubble component of the stock is given by the simply subtracting the actual price of the stock from its fundamental component, as shown in (18):

$$B_t = P_t^a - \frac{\overline{P}}{\overline{D}} D_t \tag{18}$$

There is no general agreement on the measurement of fundamental house prices in the real estate market. Given the direct influence of several macroeconomic variables on the real estate market, some researchers use a regression-based measure, relating the fundamental value of house prices to disposable incomes, mortgage rates and the level of unemployment.[6] However, Nneji et. al (2011) show that rents provide better fundamental measures than disposable incomes in countries with easy access to credit facilities, like the U.S. (historically at least), where the ability of individuals to acquire mortgages did not depend on their disposable income. Also, from the real estate investor's point of view, rent is analogous in cash flow terms to dividends for investors in the stock market. Therefore, we use rents to determine the fundamental value of the underlying property market. Using the aforementioned methodology used in calculating the stock market's fundamental value (see equations 17 – 18), the fundamental value of the housing market at a given period is simply the mean price-rent ratio multiplied by the rent at that period.

5. Results and Findings

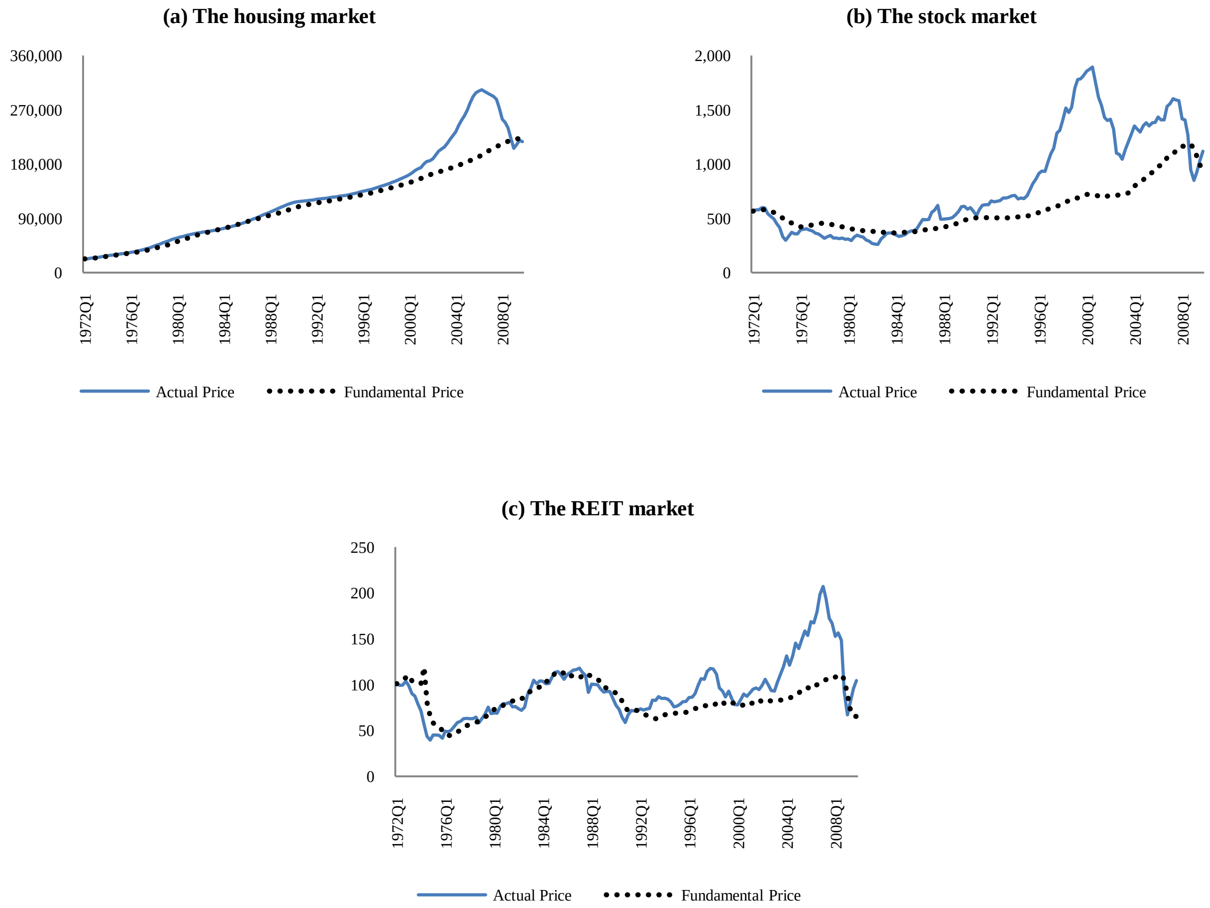
In this section, we first test for the presence of bubbles in the REIT market, the stock market and the housing market. Using the techniques discussed in Section 4, we compute the fundamental values for both markets.

A comparison of the observed prices against the fundamental prices, in both markets is given in Figure 4. It is clear that there have been periods of over-valuation and under-valuation in all the markets, since 1972. Up until around 1999, which saw house prices accelerate at a faster rate than the fundamental price, house prices were roughly similar to its fundamental value. Average house prices rose by around 41% between 2002 and 2006. This upward trend

[6] This approach is similar to the Roche (2001) measure of non-fundamental house prices. Roche uses the residual from the regression of house prices on mortgage rate, disposable income and a demographic variable as a proxy for the non-fundamental price.

stopped in 2006, and prices plummeted soon after. By 2008, house prices fell significantly below its fundamental value for its first time in the examined period. The stock market, on the other hand was, on average, undervalued between 1972 and mid-1980s. Stock prices rose at a far-faster rate than its fundamental value, eventually peaking in 2001. There was a subsequent decline of 31% by 2003, following the collapse of “Dot-com” bubble. The period 2007 – 2009 also saw significant decreases in stock prices. The REIT market’s dynamics, post-1993, is more similar to the housing market’s dynamics than that of the stock market. Prior to the introduction of the UPREIT legislation in 1993, the REIT market witnessed short periods of under-valuation and over-valuations. However, after 1993, REIT prices, on average, grew at an abnormally faster rate than its fundamental value. Like the stock market and the unsecuritised real estate market, there was a large fall in prices at the tail end of the 2000s.

FIGURE 4: Actual Price vs Fundamental Price



5.1 Test for periodically collapsing speculative bubbles

Given the fundamental values computed, we apply the van Norden and Schaller speculative bubble test to determine whether deviations of the observed prices from their fundamentals occurred as a result of the presence of periodically collapsing speculative bubbles. The result from this test is given in Table 2.

TABLE 2: Result from the van Norden and Schaller speculative bubble model

$R^s_{t+1} = \beta_{s,0} + \beta_{s,1} b_t + u_{s,t+1}$ with probability $q(b_t)$

$R^c_{t+1} = \beta_{c,0} + \beta_{c,1} b_t + u_{c,t+1}$ with probability $1 - q(b_t)$

$P(R_{t+1} \mid S) = q(b_t) = \Phi \;\; \beta_{q,0} + \beta_{q,1} |b_t|$

Coefficients	Housing Market Estimates	Stock Market Estimates	REIT Market Estimates
$\beta_{s,0}$	1.0151	1.0176*	1.0031*
$\beta_{s,1}$	0.0616*	0.0943 *	0.1466*
$\beta_{c,0}$	0.9285*	0.9921*	0.9869*
$\beta_{c,1}$	0.0227*	-0.0563*	0.0217*
$\beta_{q,0}$	2.5428*	0.3875	1.5091*
$\beta_{q,1}$	-8.9012*	-1.1589*	-6.0270*
σ_s	0.0097	0.0347*	0.0485*
σ_c	0.0172*	0.0826*	0.1196*

LIKELIHOOD RATIO TEST OF RESTRICTIONS

	Housing Market		Stock Market		REIT Market	
Restrictions	**Test statistic**	**p-values**	**Test statistics**	**p-values**	**Test statistics**	**p-values**
$\beta_{s,0} \neq \beta_{c,0}$	17.9809	0.0000	4.7465	0.0294	3.0154	0.0825
$\beta_{c,1} < 0$	12.3254	0.0000	2.2130	0.1369	0.1668	0.6830
$\beta_{s,1} > \beta_{c,1}$	8.7270	0.0031	6.0705	0.0137	2.1305	0.1444
$\beta_{q,1} < 0$	32.6343	0.0000	0.8768	0.3491	3.9429	0.0471

BUBBLE MODEL MISSPECIFICATION TEST AGAINST STYLISED ALTERNATIVE MODELS						
	Housing Market		**Stock Market**		**REIT Market**	
Restrictions	**Test statistic**	**p-values**	**Test statistics**	**p-values**	**Test statistics**	**p-values**
Fads	126.0644	0.0000	20.2522	0.0000	33.0814	0.0000
Mixture-normal	127.6175	0.0000	20.5658	0.0000	35.9852	0.0000
Volatility regime	121.6480	0.0000	17.0025	0.0019	32.8911	0.0000

Note that * implies that the estimate is significant at a 5% level

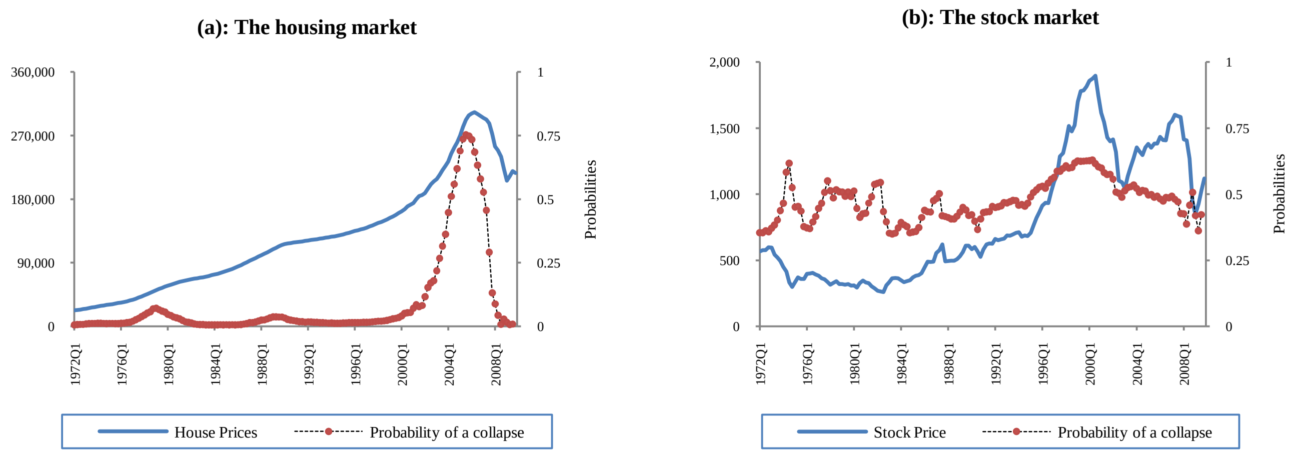
From Table 2, it is clear that most of the parameter estimates are statistically significant at a 5% level. The estimates of $\beta_{s,0}$, which represent the mean returns of both the stock and housing markets in the surviving regime, are statistically significant. In the surviving regime, the average quarterly return in the housing market is 1.51% compare to the 1.76% in the stock market. Whereas, in the collapsing regime, the mean quarterly return is -7.15% and -0.79% for the housing and stock market, respectively. In the REIT market, the average quarterly return in the surviving regime is 0.3% compared to 1.31% in the collapsing regime. In all the markets, $\beta_{q,0}$ is greater than zero, implying that the probability of being in the surviving regime when the size of the bubble is zero, is positive. Also, the coefficient of $\beta_{q,1}$ is less than zero in the three markets. This implies that the larger the size of the bubble, the higher the probability of the bubble collapsing in the following period. The standard deviation of the returns in the collapsing regime is greater than that of the surviving regime, in the three markets. This implies that returns are more volatile in the collapsing regime than in the survival regime, which is consistent with speculative bubble theory. Note that the REIT market's volatility, in both regimes, exceeds volatility in both the stock market and the housing market, which implies that the REIT market is generally more volatile than the stock market.

Roughly 70% of the total number of likelihood ratio tests for coefficient restrictions is significant at a 10% level. Therefore, there is enough evidence to suggest that periodically collapsing bubbles are present in all three markets. More proof of the presence of this class of bubbles is shown in the tests of the bubble model against other stylised alternative models of returns. In the three markets, the likelihood ratio tests reject the fads, mixture-normal and volatility regime models at the 1% level. Given all these findings, there is enough evidence to suggest that periodically collapsing speculative bubbles existed in all three markets between 1972 and 2009, implying that returns can be forecasted by observing the deviation of prices from their fundamental values.

Figures 5a – c show the plots the probabilities of being in the collapsing regime, $P(R_{t+1} | C) = 1 - \Phi \ \beta_{q,0} + \beta_{q,1} |b_t|$, in each of the markets against their observed price using the parameter estimates from the regime-switching model. In the housing market, the probability of being in the collapsing regime increases significantly prior to the downturn of the market in 2006. Also, for the REIT market, the probability of a collapse jumped shortly before the dip in REIT prices in the 1970s.[7] The probability also rose shortly before the market downturns of the late 1990s and 2006. The model, however, does not fit the dynamics of the stock market well enough. One would have expected the probability to rise shortly before the market collapsed at the end of the 2000s.

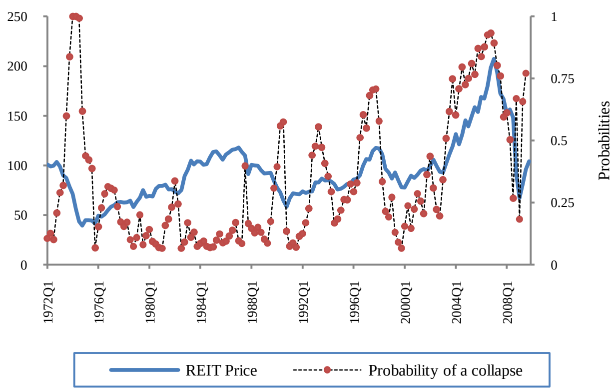
However, generally, it is clear that probability of a collapse fares well in tracking the trends in both the unsecuritised and securitised real estate markets.

FIGURE 5: The probability of being in the collapsing regime



[7] REIT prices fell significantly in the early 1970s due to the large increases in interest rates and construction costs. This led to large number of mortgage defaults, which had an adverse impact on REIT industry

(c): The REIT Market



5.2 Is there a spillover of bubbles from the unsecuritised real estate market and the stock market to the REIT market?

In the previous sub-section, we established that both the real estate market and the stock market witnessed periodically collapsing speculative bubbles between 1972 and 2010. In this part of paper, we discuss whether there is a spillover of bubbles from the stock market and/or the real estate market to the REIT market bubbles. As explained in Section 2.3, we employ the VAR or the VECM approach (depending on whether the variables are cointegrated or not). The endogenous variables to be included in the model are the relative sizes of the REIT market, the stock market and the unsecuritised real estate market bubble.

Before we test for spillovers, it is imperative to test for whether the variables are stationary. To do so, we implement the Augmented Dickey-Fuller (ADF) test procedure and the results are shown in Table 3:

TABLE 3: Unit root test with null hypothesis of non-stationarity in the variable

Variables	Lag length	ADF test statistic	Test critical values		
			1% level	5% level	10% level
REIT Bubble	2	-3.0387	-3.4748	-2.8810	-2.5772
Housing Bubble	5	-1.7225	-3.4758	-2.8814	-2.5774
Stock Bubble	10	-1.6909	-3.4775	-2.8821	-2.5778

The lag length is chosen based on the optimal Akaike's information criteria.

The ADF tests show that all the variables, except for the REIT bubble, are non-stationary at a 5% significance level as the critical values are less than the test statistics and so they could be cointegrated. Therefore, we employ Johansen's test to check for possible cointegrating relationship between the variables. The result of the cointegration test is given in Table 4. From the table, it is clear that the null hypothesis that the number of cointegrating vectors is zero is not rejected. Therefore, the trace test indicates that the variables are not cointegrated.

TABLE 4: Test for cointegration using the Johansen procedure

Null hypothesis	Trace statistic	0.05 Critical value	p-values
$r = 0$	23.0824	29.7971	0.2420
$r \leq 1$	8.8261	15.4947	0.3817
$r \leq 2$	3.0620	3.8415	0.0801

Note that $r = 0$ tests the null hypothesis that the number of cointegrating vector is equal to zero. While $r \leq$ x tests the null hypothesis that the cointegrating vector is less than x, where x is either 1 or 2.

The fact that the variables are not cointegrated implies that we must use the VAR model to check for spillovers. A Granger-causality test is then implemented on the VAR model to determine whether the size of the stock market and real estate bubbles cause changes in the REIT prices, therefore the VAR model has three endogenous variables: the bubbles of the housing market (HB), the stock market (SB) and the REIT market (RB).

For the VAR model, we select the optimal lag length based on the AIC. Here, the lag length that minimises the AIC criterion is six, implying that the VAR model we use to examine the relationship between REIT prices and the bubbles sizes has six lags. The Granger causality test result on the VAR model is given in Table 5:

TABLE 5: Granger causality test with the change in REIT (RB) bubble being the dependent variable

Null hypothesis	Chi-Sq	p-values
Changes in the housing market bubble do not Granger cause changes in REIT bubble	12.6369	0.0492
Changes in the stock market bubble do not Granger cause changes in REIT bubble	5.7137	0.4560

From Table 5, it is clear that the size of the housing market bubble Granger cause prices of the REIT stocks. This implies that the housing market bubble provides information about the future size of the REIT market bubble. The stock market bubble, on the other hand, does not influence the size of the REIT market bubble. Based on the Granger-causality test, we conclude that speculative bubbles spillover from only the unsecuritised real estate market to the securitised real estate market.

To determine whether the size of the REIT market bubble is influenced by the unsecuritised real estate market bubble in the short-run and the long-run, we decompose the forecast error variance of REIT bubbles. This provides information on the proportion of changes in the REIT market bubble that is caused by unexpected innovations to the sizes of the real estate market and stock market bubbles. We decompose the forecast error variance of REIT bubbles up to eight quarters (2 years) ahead and the output is shown in Table 6:

TABLE 6: Variance decomposition of REIT prices (in percentages)

Quarters ahead	REIT market bubble	Real estate market bubble	Stock market bubble
1	100.0	0.0	0.0
2	98.4	1.5	0.1
3	98.2	1.7	0.1
4	96.8	3.1	0.1
5	92.6	7.0	0.4
6	90.0	9.6	0.4
7	89.8	9.6	0.6
8	89.4	9.5	1.1

Referring to the table, 9.5% of the variations in the REIT market bubble are caused by unexpected innovations in the unsecuritised real estate market bubble, over eight quarters, while 89.4% of the changes in the REIT market bubble are due to its own shocks. Unexpected changes to the size of the stock market bubble have very little bearing on the REIT market bubble.

The underlying residential property market's impact is more prevalent in the long run. Hence, it is fair to conclude that the spillover of bubbles from the underlying property market to the

REIT market occurs mainly in the long run (after six quarters). This conclusion somewhat complements results from previous research such as He (2000), who finds that changes in the underlying residential property market predict changes in REIT returns. It also tallies with Nishizaki (2007) findings that declining house prices in the U.S. causes performances in REIT stocks to fall in the long run.

Based on these findings, the next sub-section focuses on examining whether a profitable trading strategy for the All-REIT index could be created from observing the unsecuritised real estate market.

6. REIT trading rules analysis

Using the parameters estimated in the van Norden and Schaller regime switching model, it is possible to compute the conditional probability of a crash occurring in the next time period. The term "crash" refers to a period of negative returns of more than two standard deviations below the average return. Therefore, the probability of a crash simply refers to the probability of return being unusually low in the next quarter, conditioned on the relative size of the bubble. Equation (19) is the mathematical expression of the probability of a crash occurring in the next period:

$$P(R_{t+1} < x)_t = P(R_{t+1} \mid S)_t \phi\left(\frac{x - \beta_{s,0,t} - \beta_{s,1,t} b_t}{\sigma^s_{u,t}}\right) + P(R_{t+1} \mid C)_t \phi\left(\frac{x - \beta_{c,0,t} - \beta_{c,1,t} b_t}{\sigma^c_{u,t}}\right) \quad (19)$$

where $x = \mu_t - 2\sigma_t$, the average gross return is μ until time t, and σ_t represents the volatility of the previous period's returns before time t. Note that the probability of observing an unusually high return relative in the next quarter can also be determined.

This section investigates whether it is possible to yield abnormal profits from the out-of-sample forecasts of the probability of a crash from van Norden and Schaller model.[8] To perform this investigation, we split our data into two sub-samples. The first sub-sample covers the period 1972Q1 to 1999Q4. Using this sub-sample, we obtain initial parameter estimates from the van Norden and Schaller model. These estimates are used to compute the conditional probabilities of a crash occurring in the market for the second sub-sample,

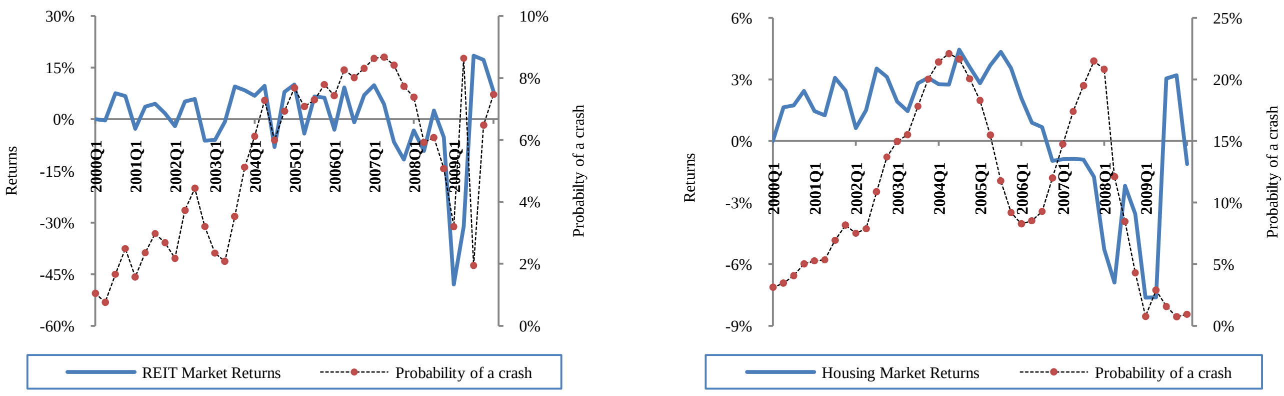
[8] Trading rules based on the out-of-sample forecasts from van Norden and Schaller model was introduced by Brooks and Katsaris (2005). They examined the profitability of trading S&P using trade signals from the model's forecasts.

starting from the next quarter, 2000Q1. At the end of each quarter, the sub-sample is updated by one observation. The model is then re-estimated and the probability of a crash occurring in the following period is obtained. This rolling window estimation is continued until 2009Q4. The periods used for testing the trading rule are between 2000-2007 and 2000-2009. The period 2000 – 2007 covers a highly bullish period in the REIT industry, while, post-2007, saw prices free-fall. Hence, by investigating the bullish and bearish periods respectively, we evaluate the importance of incorporating the dynamics of the unsecuritised real estate market in forecasting returns in the REIT market.

Figures 6a and b represent the graphs of the returns against the forecasted probabilities of unusually large declines in both the REIT and housing market between 2000Q1 and 2009Q4. From both graphs, we can see that the probability of a crash occurring in both markets rise shortly before a declines in returns. In the REIT market, the probability increased to its maximum for the period, 8.68%, two quarters before returns decreased in 2007. The probability rose again to 8.64% at the tail end of the period, as returns declined subsequently. In the housing market, the probability of a crash peaked at the start of 2004, after which returns fell significantly by the second quarter of 2006. The probability increased again shortly before further declines in returns, post-2007. This shows that the model performs extremely well in forecasting returns in both markets. Hence, it may be possible to form trading rules based on these probability forecasts.

FIGURE 6: Returns vs the forecasted probabilities of a crash in the market

(a) The REIT market **(b) The housing market**



These computed probability forecasts from the rolling estimation of the regime switching model are used to create trading rules. Similar to Brooks and Katsaris (2005), we form a trading rule that triggers a sale of the REIT index if the forecasted probability of a crash at any given time is greater than a threshold- the 80th percentile of its historical values.[9] When the investor liquidates his/her position in the REIT market, he/she should re-invest his entire wealth in a riskless asset (treasury bills) until the forecasted probability is less than the threshold.

The first trading strategy, referred to as strategy A, involves applying the aforementioned rule to the forecasted probability of a crash occurring in the REIT market. Here, the 80th percentile of the historical probability of a crash is 4.68%. The second trading strategy, strategy B, is based on our findings of bubble spillover from the unsecuritised to the securitised real estate markets and this involves applying the same trading rule to a weighted average of the REIT and housing markets' forecasted crash probabilities.[10] For this strategy, the 80th percentile threshold is 4.34%. These trading strategies are compared to a buy-and-hold strategy of the REIT index only (strategy C). The fourth strategy, strategy D, involves investing solely in T-bills during the entire period. The results from the trading rules are shown in Tables 7.

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[9] The 80th percentile is chosen as we feel it is the optimal threshold for that period in time. This is because the market was far too bullish at the start of the decade, and so any rational investor would expect a forthcoming bearish period in the market and so setting a relatively low threshold, the investor is likely to avoid getting caught in the downturn period. Therefore, reducing the threshold ensures that the investor is not in the market for very long. Note that the results do not differ if the threshold is increased to the 90th percentile of the historical distribution.

[10] This weighted average is based on the variance decomposition analysis in section 5.2, where we find 9.5% of the changes in the size of the REIT market bubble is caused by unexpected innovations in the unsecuritised real estate market and 89.4% caused by its . Therefore, the weight split is 90% for the REIT forecasts and 10% for the unsecuritised real estate market.

From Table 7, it is clear that the buy-and-hold strategy, by far, outperforms the other three strategies only in the first sub-period, 2000 – 2007. This is not surprising especially as that was one of the most bullish periods in the REIT industry ever. Investing in riskless asset, although the least volatile, ranks bottom during this period. Strategies A and B also yield significant positive returns albeit far less than strategy C.

TABLE 7: The comparison of the trading rule to traditional buy-and-hold strategies (2000Q1 – 2007Q4)

Strategies	Number of trade roundtrips	Mean Quarterly Return	SD	Skewness	Sharpe Ratio
2000Q1 – 2007Q4					
A: Prob. of crash: REIT	1	1.57%	3.30%	0.06	0.15
B: Prob. of crash: Mixture	1	1.23%	1.78%	2.23	0.14
C: Buy & Hold REIT	1	3.04%	6.18%	-0.61	0.22
D: Invest in riskless asset	-	0.84%	0.44%	0.14	-
2000Q1 – 2009Q4					
A: Prob. of crash: REIT	3	-0.21%	11.26%	-5.12	-0.08
B: Prob. of crash: Mixture	3	0.23%	11.34%	-5.06	-0.04
C: Buy & Hold REIT	1	-0.13%	14.09%	-3.06	-0.06
D: Invest in riskless asset	0	0.73%	0.48%	0.32	-

Note that the number of trades refers to the frequency of buy/sell orders in the strategies. Like Brooks and Katsaris (2005), we assume transaction costs on trades to be 0.5%. The mean returns are adjusted for transaction costs. SD refers to the standard deviation of returns in the strategies. Skewness measures the asymmetry of the returns' probability distribution. The Sharpe ratio provides information of the risk-adjusted performance of the strategies and it is computed by dividing the mean excess return by the standard deviation of the excess return.

However, this is not the case if the data includes the post-2007 period. In contrary to the first sub-period, the buy-and-hold strategy fails to yield positive returns, as the REIT market witnessed a significantly large crash towards the end of the decade. The REIT industry value fell by over 45% between 2007Q1 and 2009Q4. Based on the Sharpe ratio and the mean return criteria, strategy A least performs between 2000 and 2009. The mean return from this strategy is a lot less than strategy C, which ranks second from bottom. More importantly, strategy B, which involves trading based on the combined forecasted probabilities of the securitised and unsecuritised real estate market, outperforms strategies A and C, even though its probability distribution of its returns using has a relatively strong negative skew. On the contrary, strategy D, which involves investing in riskless asset, is the only strategy that yields a positive return. As expected, there is very little skew in the probability distribution of returns in riskless asset.

It is also not surprising that the buy-and-hold strategy fails to perform strongly, as the REIT market witnessed a significantly large crash towards the end of the 2000s. The REIT industry value fell by over 45% between 2007Q1 and 2009Q4. Based on the Sharpe ratio and the mean return criteria, strategy A least performs between 2000 and 2009. The mean return from this strategy is a lot less than strategy C, which ranks second from bottom. More importantly, strategy B, which involves trading based on the combined forecasted probabilities of the securitised and unsecuritised real estate market, outperforms strategies A and C, even though its probability distribution of its returns using has a relatively strong negative skew. On the contrary, strategy D, which involves investing in riskless asset, is the only strategy that yields a positive return. As expected, there is very little skew in the probability distribution of returns in riskless asset.

Given these findings, there is significant evidence to suggest that the unsecuritised real estate market can be used in formulating a relatively robust trading rule for the securitised real estate market. This result shows that analysing the housing market is likely to yield risk-adjusted profits from investing in REITs, regardless of whether the market is bullish or bearish. This somewhat supports our findings that bubbles spillover from the unsecuritised real estate market to the REIT market.

7. Summary and Conclusions

Ever since the inception of the REIT industry and its increased popularity in the early 1990s, many researchers have studied topics related to the influence of the underlying property and stock market prices on REIT price dynamics. This paper sheds more light on this debate by examining the impact of the size of speculative bubbles in the residential real estate market and the stock market, on speculative bubbles in the REIT market.

Using a regime switching test for periodically collapsing speculative bubbles, we find significant evidence of this class of bubbles in all three markets between 1972 and 2009. Then, with the help of a VAR model and a Granger causality test on the VAR model estimates, we show that speculative bubbles spill over from the residential property market to the REIT market only. The bubbles in the stock market do not spill into the securitised real estate market. Further analyses on the sensitivity of REIT bubbles to unexpected innovations in the bubble sizes of both markets show that the impact of unexpected changes in the size of the housing market bubble becomes even more influential, over time. This may be due to a lag in the adjustment of REIT prices in reflecting the underlying property market.

To conclude, the findings of this paper are extremely relevant to researchers. Prior to this study, many papers had focused on examining the relationship between REITs, stocks and the underlying property market by observing price patterns only. However, with the recurring presence of periodically collapsing bubbles between the 1970s and the late 2000s, we examine the relationship between the three markets by observing bubble contagion. Given our findings of speculative bubble spillover from the underlying property market to the REIT market, a hybrid trading rule for the REIT stocks is constructed using a mixture of the out-of-sample forecasts of the probabilities of a crash occurring in both the securitised and the residential property markets. This trading strategy outperforms a similar strategy that is based solely on the REIT market's forecasted probabilities. It also beats the buy-and-hold strategy in the bearish period. This provides more proof of the strong relationship between the unsecuritised and securitised real estate markets. Therefore, this paper is also of great importance to fund managers who that focus on REIT stocks.

Even though the focus of the paper is on evaluating bubble spillovers to the REIT market, there is scope for further research, specifically on the investigation of more advanced trading strategies for REITs by observing the dynamics of the underlying property market. One could evaluate the integration of property derivatives with these trading strategies in hedging downside risks for real estate portfolios.

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