Journal of Real Estate Finance and Economics, 27:2, 235–255, 2003

Property Company Stock Price and Net Asset Value: A Mean Reversion Perspective

KIM HIANG LIOW
Department of Real Estate, National University of Singapore, 4 Architecture Drive, 117566, Singapore
E-mail: rstlkh@nus.edu.sg

Abstract

This study investigates the relationship between property company stock prices (P) and their net asset values (NAV) from a mean reversion perspective. In contrast to U.K. evidence, we find that there is absence of a long-term stable relationship between the two series. However, the variance ratio tests and multi-period regressions suggest that both P and NAV series have exhibited transitory components. In addition, there is some evidence of mean reversion behavior of Singapore property stock prices toward the property companies' NAVs over the past 15 years from 1985 to 1999, both at individual company level and in the sector as a whole. The results also reveal that NAV, as a traditional proxy to fundamental value, is significant in capturing the dynamics of the changes in property stock prices. Hence NAV is relevant in property company valuation. However the extent of mean reversion between the property stock prices and NAVs is slow and deviations between the two markets' valuation could therefore be prolonged.

Key Words: property stock price, net asset value, mean reversion, valuation, Singapore

1. Introduction

There are two common types of indirect or securitized real estate investment vehicles available to investors. The first type is the Real Estate Investment Trusts (REITs) in the United States. The second type of securitized real estate investment, popularly known in countries such as the United Kingdom, Hong Kong and Singapore, consists of shares of property companies quoted on a stock market. Specifically listed property companies have become an increasing important property investment vehicle in Asia and internationally.

Property investment companies can be characterized as pools of professionally managed income producing properties in which investors can participate in their financial results. For these companies, there is normally a close correlation between the value of the property portfolio and the value of companies' shares that are priced in relation to the net asset value (NAV) rather than on a price-to-earnings. The NAV in this context represents the underlying value of the real estate assets owned along with other assets, adjusted for liabilities and other claims on the company. The main argument is that at a fundamental level, property company share prices must reflect their underlying real estate investment value. One important question arising from this linkage is the nature and extent of the relationship between property stock price and NAV both in the long-run and short-term. This study seeks to empirically address this question.

There has been very little research on the relationship between share prices and fundamental values in securitized real estate despite the significant contribution listed property companies contribute to the market capilalization of Asian stock markets and an increased securitization of the real estate asset class globally (Steinert and Crowe, 2001). This paper aims to examine the relationship between stock prices and NAVs of listed property companies and investigate the extent to which property company stock prices reflect their NAVs, one of the meaningful issues in the closed-end fund literature that addresses the relationship between NAV values and share prices (see Section 2 on NAV literature). The findings have important investment implications as they will reveal whether property stocks are likely to provide a return that can differ significantly from the return on the underlying real estate assets over a relatively long period or in the short-term.

We use Singapore as a case study as she is one of the major Asian tiger economies and has a reasonably long-established track record of listed property companies. Compared with the real estate markets in the United States and the United Kingdom, real estate values in Asian countries (including Singapore) are relatively high. Hence real estate (direct and securitized) has become the most favored investment target within Asia and the real estate market is closely tied to capital markets. Specifically, Singapore real estate accounts for over 50 percent of the nation's wealth and productive capital. In particular, the office space market is very important as it is one of the Asia's leading regional financial centers and hence the preferred real estate class of institutional investors. The market value of the Singapore listed property sector was 10–20 percent of the stock market capitalization in the period 1990–2000. In addition, there is significant real estate influence on certain industrial and commerce sectors. Many local banks and insurance companies have significant property exposure in the office and residential property markets. As the bulk of research in securitized investment vehicles has been undertaken in the United States and the United Kingdom and little is known about the pricing and dynamics of foreign securitized real estate, studies in other developing investment markets, such as those of emerging economies in Asian countries, are expected to generate comparative evidence.

Prior studies have identified two popular corporate fundamental variables that predict share price movements or returns. For example, Fama and French (1988) propose dividends per share (DPS) as being significant in explaining stock returns. Campbell and Shiller (1988) suggest DPS, dividend growth and long-term earnings per share (EPS) as being significant in explaining returns. As NAV is the principal basis for valuation of property companies, the hypothesis is that property stock prices mean revert or converge towards their NAV. Mean reversion, technically known as the Ornstein–Uhlenbeck process, has been used extensively in the finance literature to examine the stochastic behavior of interest rate and stock price, which drifts apart in the short-term but reverts or converges back to its long-term mean over time. The term has also been used to describe the process of stock prices reverting to the fundamental value of the stock (Chiang et al., 1995). In the present context, presence of mean reversion reflects that property stock prices may take long temporary swings away from their NAV but they would revert in the long-run. Our analysis draws upon the methodologies adopted in studies in the general stock market by employing linear cointegration and non-linear mean-reversion modeling. The empirical evidence suggests that although property company performance is linked in the long-run to the performance of the underlying property market as measured by the NAV, the linkage is nevertheless weak and non-linear. The movement of the stock price towards the NAV is slow and divergence between the two markets could be prolonged.

The remainder of this study consists of six parts. Section 2 reviews important literature addressing the relationship between NAV and prices and thus provides the motivation for this study. Section 3 reviews the relevant empirical literature in relation to the research question. The data and mean-reversion methodology are described in Sections 4 and 5. The empirical results are presented in Section 6. Section 7 concludes the paper.

2. NAV literature

This section provides a brief review on important literature addressing the relationship between NAV and share prices. A starting point is the article by Adams and Venmore-Rowland (1989) who point out that property company valuation is generally related to the value of the underlying properties and less to earnings and dividends. Hence a property company is similar to an investment trust and other closed-end funds[1] except that the true NAV is much harder to ascertain. This is because shares are valued in the stock market whereas properties are appraised in the property market. Similar to closed-end funds that commonly trade at a discount to NAV, property companies tend to stand a discount to NAV as they represent a special case of a closed-end fund. Although the extant literature has recognized the existence of NAV discounts in property company valuation, there is lack of empirical research on the nature and extent of the relationship between property company stock prices and NAVs both in the long-run and short-term. For example, could it be possible that property stock prices and NAVs are related though the relationship might be nonlinear, or could any possible relationship between property stock prices and NAVs be due to extent of mean reversion? This study addresses this concern.

There is further research in the closed-end funds literature that aims to understand the main causes of the NAV discounts. The ''rational'' approach seeks to link the discounts to NAV to company specific factors such as management quality, tax liability and the type of stocks held by the fund (Barkham and Ward, 1999). In the property company context, Adams and Baum (1989) discuss a number of potential factors that cause the discount/premium in property investment companies: management quality, taxation, liquidity, risk (which include gearing, volatility, and divisibility), uncertainty as to true NAV, take-over threat and market inefficiencies. However, no empirical evidence of these ''unpriced'' factors was provided by the authors. The ''noise trader'' approach applied by Lee et al. (1991), on the other hand, postulates that the operation of the noise traders provides an additional risk that is reflected in the value and returns of stocks, and that stock prices will be settled below NAVs in equilibrium. Finally Barkham and Ward (1999) provide evidence to suggest that both approaches are useful in explaining U.K. property company discounts.

The third issue is related to the usefulness and portfolio implications of closed-end discounts. Brauer(1988) examines the informational content of closed-end fund discounts. He finds that these discounts can contain useful information about future returns in addition to that captured by the benchmark capital asset pricing model. Bonser-Neal et al. (1990) expand on Brauer's work (1988) by examining premiums paid for closed-end country funds and their relationship to investment restrictions and market segmentation. Their results suggest that some foreign markets are at least partially segmented from the U.S. capital markets. For these countries, the cost of capital for investment projects would then depend on the country in which the funds are raised. In response to the increasing importance of listed property companies in the Asian economies, similar research questions can be constructed to examine information content and the investment applications of NAV discounts across different Asian capital markets with differences in legal form, their governance structure and their tax considerations. However, no such research studies have been found in the literature.

3. Empirical evidence

Since the 1980s, a number of studies have suggested that stock prices followed a mean reversion process (Campbell and Shiller, 1988; Poterba and Summers, 1988; Lo and MacKinlay, 1988; Fama and French, 1988). The mean reverting stock prices are predictable in the long-run because there is a strong tendency of the short-term random stock prices to converge to a long-term mean. For example, Fama and French (1988) found that the predictability of stock return variance was larger than expected in the U.S. stock market for the period 1926–1985. The predictable variances for the 3–5 year stock returns were estimated to be about 40 percent for portfolios of small firms and 25 percent for portfolios of large firms. They also observed strong negative autocorrelations in stock returns, which were evidence of mean reversion. The negative autocorrelation of stock returns, which implies mean reversion in stock prices, was also found by Poterba and Summers (1988).

In parallel to this development, researchers and market-watchers are also interested as to the extent of mean reversion of stock prices towards their fundamental values such as EPS, DPS (Fama and French, 1988; Campbell and Shiller, 1988). For example, Dividends to price ratio (Fama and French, 1988) and earnings to price ratio (Campbell and Shiller, 1988) were found to have contributed to increased explanatory significance in the long-term stock price variations. Chiang et al. (1995) study mean reversion behavior by modeling the fundamental value of a stock as a stochastic process. The stock price is modeled as a mean reverting Ornstein Uhlenbeck process towards the fundamental value. They then derive a mean reversion model that links changes in stock prices and returns to corporate fundamental values (earnings and dividends). In general, their results suggest that mean reversion presents in their models and that both changes in EPS and DPS are significant in explaining changes in stock prices and returns. In another study, Chiang et al. (1997) model the relationship between earnings, dividends and stock prices using a logarithmic mean reversion model. Their results are similar in that the deviations of stock prices from the fundamental values could exist for prolonged periods.

To the best of our knowledge, there is only one study in the real estate literature that employs mean reversion methodology. Okunev and Wilson (1997) develop a similar logarithmic mean reversion model to investigate whether real estate and stock market prices are integrated. Their linear cointegration results reveal that real estate and stock markets are segmented, whereas the nonlinear mean reversion model suggest that the two markets are fractionally integrated. Hence there is a relationship between the stock and real estate markets but the link is weak and nonlinear.

In the property company context, Barkham and Ward (1999) analyze the long-run relationship between U.K. property company stock prices and NAV and find a stable long-run equilibrium relationship (average property stock price is about 74.8 percent of average NAV) and an error correction mechanism to correct for divergence from this relationship. Hence this gives support for a NAV-based valuation basis. Additionally, they also identify considerable noise around this relationship both over time and across companies and suggest the poor short-term performance of NAV as a predictor of share prices. However, the extent of mean reversion between NAVs and stock prices was not investigated by the authors.

In view of the very limited quantity of research in NAV performance divergence in a real estate context, the present study continues the enquiry in property company valuation. However, it can be differentiated from the prior literature in at least two major aspects. First since property companies are regarded as a special case of closed-end funds, the results of this study can expect to add to the body of literature with regard to the dynamics of NAV discounts in closed-end funds. This is a significant contribution as there has been very little work in either the United States, the United Kingdom or the Asian countries on the subject of property company (or REIT) discounts.[2] Second the present study represents an extension of the application of the mean reversion methodology originated in finance to a special class of stocks—real estate. The traditional NAV model of property company valuation implies that property stock prices and NAVs are linearly linked. Instead, the mean reversion methodology offers an alternative perspective of a possible non-linear relationship between prices and NAVs and provides fresh insights into the extent of divergence of the valuations in the property and stock markets.

4. Data

This study covers a period of 15 years from 1985 to 1999. The sample comprises 16 listed property companies that have the full-period monthly NAV and share price data.[3,4] The variable NAV, as defined by the Singapore Stock Exchange, is the book value of tangible assets per share calculated by dividing the paid-up capital and reserves less intangible assets and preference capital by the number of ordinary shares. The use of tangible book value as a proxy for the appraised NAV can be justified in the context of the local institutional accounting framework that is broadly based on historical cost convention modified by the revaluation of fixed assets and investment properties.[5] All the 16 property companies have their investment properties appraised annually and carry them at market valuation. This is reasonably expected since a large part of the return to investors is created by the appreciation of property values. It is thus important that property companies hold their investment properties at open market value rather than historic cost. On the method

Table 1. List of the 16 property companies included in the study.

Code	Company Name	Year of Listing on the SGX	Market Value (S$ million) for FY 1999	Total Asset Value (S$ 000) for FY 1999	Total Property Value (S$'000) for FY 1999	Average NAV DISC (1985–1999)* (%)	Capital Structure (Average Debt Ratio 1990–1999)
BONV	Bonvests Holdings Ltd	1973	205.04	565,451	395,862	18.9	0.332
BUKI	Bukit Sembawang Estates Ltd	1968	230.40	275,632	252,329	− 254.7	0.362
CHIE	China Everbright Pacific Ltd	1981	1,298.18	2,925,602	2,789,920	7.9	0.326
CHMI	Chemical Industries (Far East) Ltd	1963	57.38	385,966	284,790	6.9	0.310
CITY	City Developments Ltd	1963	7,809.96	11,117,418	9,896,541	− 167.7	0.548
FCAP	First Capital Corporation Ltd	1978	952.35	2,971,424	1,739,373	− 0.5	0.523
HONF	Hong Fok Corporation Ltd	1981	221.85	1,271,403	1,125,657	53.8	0.411
JMPH	Jack Chia-MPH Ltd	1972	132.01	659,703	331,058	1.5	0.544
KEPL	Keppel Land Ltd	1973	1,928.74	5,368,900	4,552,942	6.0	0.336
LCDV	LC Development Ltd	1973	129.25	158,357	98,069	53.7	0.666
MARC	Marco Polo Developments Ltd	1981	869.50	1,261,628	913,476	− 34.4	0.399
MCLL	MCL Land Ltd	1967	568.54	1,131,978	950,493	13.0	0.122
OPHH	Orchard Parade Holdings Ltd	1968	382.34	1,462,042	916,292	14.5	0.655
SLND	Singapore Land Ltd	1963	1,506.08	3,322,471	2,729,598	21.8	0.201
TLBL	Ayala International Holdings	1963	151.50	181,469	144,533	33.2	0.286
UOLL	United Overseas Land Ltd	1973	921.82	3,060,863	2,449,369	28.3	0.306

Notes. *For each company, the NAV discount is calculated on the following basis: NAV discount = 100(NAV-P)/NAV. Hence, + ve value indicates discount; − ve value indicate premium.
Source. Derived from the Singapore Stock Exchange journals and various issues of annual reports and accounts.

of valuation, between 6 and 7 firms used yearly external independent appraisals while the remaining companies used professionally qualified directors' or in-house valuations complemented by an external appraisal once every 3 years.[6] Hence the employed NAV metric appears to provide acceptable proxies for the ''current market value'' of the tangible assets per share or true NAV.[7]

Table 1 provides the names of the 16 companies, their listing date, total asset value, property portfolio value, market value, average net asset value discount and capital structure (debt/total assets). Figure 1 plots the historical trends of average monthly share prices and NAVs of the sample companies in the study period. Casual observations suggest that the there is absence of a statistically linearity relationship between prices and NAVs.

5. Methodology

The relationship between property stock price and NAV is comprehensively investigated using linear Johansen (1988) cointegration test and mean reversion methodology. First, the

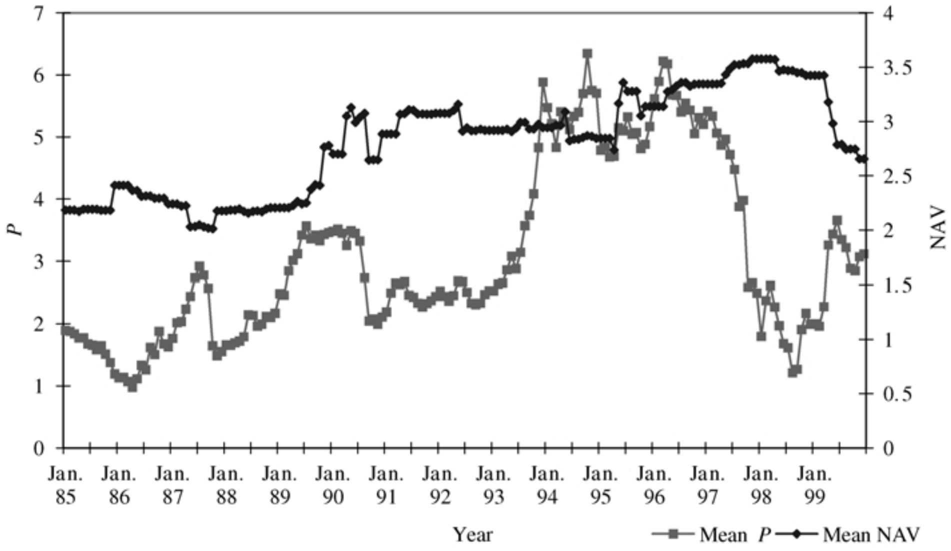

Figure 1. Movement of Singapore property stock price and NAV.

well-established approach to testing for long-run (linear) relation between at least two time series is Johansen's (1988) full maximum likelihood technique (FIML). The mean reversion methodology covers three tests which have appeared in the finance literature. Specifically the variance ratio test and multi-period regression are employed to ascertain possible mean reversion behavior in the stock price and NAV series. Then stock price is modeled as a mean reverting Ornstein Uhlenbeck process towards the NAV. The three empirical tests are briefly explained below.

5.1. Variance ratio test

The variance ratio method (Lo and MacKinlay, 1988; Poterba and Summers, 1988) is popular in uncovering the mean-reversion structure of individual variables. If the logarithm of the stock price follows a random walk, the change in variance should be proportional to the change in horizon, i.e., the variance of annual returns should be 12 times as large as the variance of monthly returns.

The main purpose of estimating a variance ratio is to estimate the size of the random walk or permanent component. For example, if asset value follows a random walk, the variance of the q-period returns should equal q times the variance of the one-period returns and the variance ratio should equal one. For a pure trend stationary process, the variance ratio approaches zero. However, the variance ratio estimate is not strictly bounded by zero and one. A variance ratio of less than one implies negative serial correlation, while a variance ratio of greater than one implies positive serial correlation. Accordingly, the expected value of $VR(q)$ is one for any investment horizon q under the assumption of a random walk; values above one indicate positive autocorrelations; and finally values below one indicate negative autocorrelations, such as the mean reversion model.

For monthly returns, the variance ratio is denoted by:

$$VR(q) = \left(\frac{\text{var}(R_t^q)}{q} \Big/ \frac{\text{var}(R_t^{12})}{12} \right), \tag{1}$$

where $VR(q)$ is the variance ratio under the random walk hypothesis, R_t denotes the monthly return on month t and R_t^q represents the sum of the monthly returns during t and the previous $(q-1)$ months. R_t^{12} denotes the normalized annual returns.

Finally, the null hypothesis of a random walk is rejected if this statistic is significantly different from unity. If some of the price variation is due to transitory factors, autocorrelations at some lags will be negative and the variance ratio will fall below one for investment horizons longer than 1 year and the return on asset value is regarded to display mean-reversion behavior.

5.2. Multi-period regression test

The second method to test the mean-reverting behavior of stock prices and NAVs is the auto-regression method which has been suggested by Fama and French (1988) to be more powerful than the variance ratio test. Essentially, this method involves regressing multi-period returns on lagged multi-period returns to ascertain whether the null hypothesis of serially independent returns could be rejected.

Let $R_{t,t+q}$ represents the actual return of asset value for the period t to $t+q$, then

$$\begin{aligned} R_{t,t+q} &= X_{t+q} - X_t = (w_{t+q} - w_t) + (z_{t+q} - z_t) \\ &= (\eta_{t+q} + \eta_{t+q-1} + \cdots + \eta_{t+1}) + (z_{t+q} - z_t). \end{aligned} \tag{2}$$

The random walk component produces white noise $(\eta_{t+q} + \eta_{t+q-1} + +\eta_{t+1})$. The transitory component, z_t, cannot be observed directly. The multi-period return regression method can be used to detect this unobserved component.

Suppose that η_t from the random walk process is independent of φ_t from the AR1 process of the transitory component. Then, the slope in the regression of $(z_{t+q} - z_t)$ on $(z_t - z_{t-q})$ is given by:

$$\rho(q) = \frac{\text{cov}(z_{t+q} - z_t, z_t - z_{t-q})}{\sigma^2(z_{t+q} - z_t)}, \tag{3}$$

where $\rho(q)$ can be interpreted as the first-order autocorrelation of q-period changes in z_t.

Fama and French (1988) have shown that the slope $\rho(q)$ is the ratio of the variance of the expected change in z_t to the variance of actual change, which is:

$$\rho(q) = \frac{\operatorname{cov}(z_{t+q} - z_t, z_t - z_{t-q})}{\sigma^2(z_{t+q} - z_t)} = \frac{-(1-\phi^q)^2\sigma_z^2}{\sigma^2(z_{t+q} - z_t)} = \frac{-\sigma^2(E_t z_{t+q} - z_t)}{\sigma^2(z_{t+q} - z_t)}. \tag{4}$$

If changes in the random-walk and transitory components of an asset value are uncorrelated, then the slope, $\beta(q)$ will be:

$$\beta(q) = \frac{\operatorname{cov}(R_{t,t+q}, R_{t-q,t})}{\sigma^2(R_{t-q,t})} = \frac{\rho(q)\sigma^2(z_{t+q} - z_t)}{\sigma^2(z_{t+q} - z_t) + \sigma^2(w_{t+q} - w_t)}. \tag{5}$$

$\beta(q)$ in expression (5) measures the proportion of the variance of q-period returns that can be explained by the mean reversion process of a slowly decaying value component z_t. The equation further helps predict the behavior of the slope for increasing values of q. If asset value does not have a transitory component, the slope will be zero for all q. If price does not have a random-walk component, then $\beta(q) = \rho(q)$ and the slope will approach -0.5 for large values of q. The prediction about the slope $\beta(q)$ is more complicated if the asset value has both random walk and transitory components. The mean reversion of the transitory component tends to push the slopes toward -0.5 for long return horizons, while the variance of the white noise component $(w_{t+q} - w_t)$ tends to make the slope towards zero. Thus, if asset values have both random-walk and slowly decaying transitory components, the slope in regression of $R_{t,t+q}$ on $R_{t,t-q}$ might form a U-shaped pattern, starting around zero for short horizons, becoming more negative as q increases, and then moving back toward zero as the white-noise variance begins to dominate at long horizons.

To regress the cumulative returns of asset value from t to $t+q$ on the return from $t-q$ to t, the following multi-period return regression model is employed:

$$R_{t,t+q} = \alpha(q) + \beta(q)R_{t-q,t} + \varepsilon_{t,t+q}, \tag{6}$$

where q is the investment horizon. $R_{t,t+q}$ is the q year holding period return starting in year t, $R_{t-q,t}$, is the lagged q year holding period return starting in year $t-q$, and $\varepsilon_{t,t+q}$ is the corresponding residual error term.

5.3. Mean reversion of property stock prices (P) toward their net asset values (NAV)

Following Chiang et al. (1995), first NAV is modeled as stochastic process. Then property share price is modeled as a mean reverting Ornstein Uhlenbeck process towards the NAV.

Under the assumption that NAV may be described by a Geometric Brownian motion:

$$\frac{\mathrm{dNAV}(t)}{\mathrm{NAV}(t)} = \mu\,\mathrm{d}t + \sigma\,\mathrm{dNAV}(t), \tag{7}$$

where $\mathrm{dNAV}(t) =$ the instantaneous change of NAV, μ is the instantaneous drift term, σ is the standard deviation per unit time of the return, and $\mathrm{d}z\mathrm{NAV}(t)$ is a Wiener process with mean zero and unit variance.

Next, the instantaneous change in property stock price (P) is proposed to be dependent upon the difference between NAV and the P. The larger the difference between these them, the stronger will be the restoring force of the movement of P towards NAV. As in the literature, it is assumed that the instantaneous change in P is described by the following process:

$$\mathrm{dP}(t) = \lambda_c[\mathrm{NAV}(t) - \mathrm{P}(t)]\,\mathrm{d}t + \delta_{\mathrm{c}}\,\mathrm{d}z_{\mathrm{c}}(t), \tag{8}$$

where $\mathrm{dP}(t)$ is the instantaneous change in property stock price, $\mathrm{NAV}(t)$ is the net asset value at time t, λ_c is the speed of adjustment coefficient, δ_c is the standard deviation of $\mathrm{dP}(t)$ per unit time, $\mathrm{d}z_c(t)$ is a Wiener process with mean zero and unit variance.

Equation (8) suggests that changes in the property stock prices and net asset values move together in time. However, a movement in net asset value may not be instantaneously transmitted to the share price but adjusts partially. The speed of adjustment coefficient λ_c determines how quickly a movement in net asset value is transmitted to the share price. For mean reversion to exist, it requires $\lambda_c > 0$. When $\lambda_c = 0$, then equation (15) reduces to a random walk, and if $\lambda_c < 0$, then $\mathrm{dP}(t)$ will move away from the mean and will not be mean reverting. Further, if $[\mathrm{NAV}(t)\text{-}\mathrm{P}(t)]$ is negative (P is above its NAV) then the expected change in P will be negative and hence P will regress back towards NAV in the subsequent period. The greater the difference between $\mathrm{P}(t)$ and $\mathrm{NAV}(t)$ the greater the restoring force back to equilibrium. For example, if $\lambda_c = 1.0$ this means the change in P will converge back to NAV in one period; On the other hand, if $\lambda_c = 0.2$ the change in P is only 20 percent of the difference between $\mathrm{P}(t)$ and $\mathrm{NAV}(t)$ which suggest that movements of P towards the NAV will be slow and hence the divergence between the two series may be large and prolonged.

Equation (8) further becomes:

$$\begin{aligned}\mathrm{P}(t)\left(1 + \frac{\mu}{\lambda_c}\right) = {}& \mathrm{NAV}(t) - e^{-\lambda_c t}\mathrm{NAV}(0) + \left(1 + \frac{\mu}{\lambda_c}\right)e^{-\lambda_c t}\int_0^t \mathrm{e}^{\lambda_c s}\delta_c\,\mathrm{d}z_c(s) \\ & - e^{-\lambda_c t}\int_0^t \sigma e^{\lambda_c s}\mathrm{NAV}(s)\,\mathrm{d}z_m(s).\end{aligned} \tag{9}$$

Equation (9) shows that the property stock price (P) is directly related to the NAV together with a time dependent term and also error terms which represent the accumulation of stochastic shocks to the share price and net asset value. Specifically, for $0 < \lambda_c < 2$, the impact of the discrepancies and errors would fade with time. It is expected in the long run that P should equal the expected NAV, as the time dependent term will tend to zero in the case of mean reversion for larger t.

By substituting $t + \Delta t$ for t into equation (9) then subtracting $\mathrm{P}(t)$, the discrete time change in the property stock prices is given by:

$$\Delta \mathrm{P}(t) = \mathrm{P}(t+\Delta t) - \mathrm{P}(t) = \frac{\Delta \mathrm{NAV}(t)}{K_c} + (1 - e^{-\lambda_c \Delta t})\left(\frac{\mathrm{NAV}(t)}{K_c} - \mathrm{P}(t)\right) + e^{-\lambda_c(t+\Delta t)} \int_t^{t+\Delta t} e^{\lambda_c s} \delta_c \, \mathrm{d}z_c(s) - \frac{e^{-\lambda_c(t+\Delta t)}}{K_c} \int_t^{t+\Delta t} \sigma e^{\lambda_c s} \mathrm{NAV}(s) \, \mathrm{d}z_m(s). \tag{10}$$

It can be seen from equation (10) that the change in the property stock price (P) is mean reverting towards the NAV, but is also dependent upon the change in NAV. The difference between $\mathrm{P}(t)$ and $\mathrm{NAV}(t)$ is amplified by the speed of adjustment coefficient of $(1 - e^{-\lambda_c \Delta_t})$. For mean reversion, the speed of adjustment coefficient $(1 - e^{-\lambda_c \Delta_t})$ becomes larger for increasing λ_c. On the other hand, for low values λ_c, one would expect the change in the net asset value variable to dominate the mean reversion model.

Finally, regression (10) can be simplified as:

$$\Delta \mathrm{P}(t) = \alpha \, \Delta \, \mathrm{NAV}(t) + \beta \mathrm{P}(t) + \gamma \, \mathrm{NAV}(t) + \varepsilon_t, \tag{11}$$

where the speed of adjustment coefficient λ_c is computed through $\beta = e^{-\lambda_c \Delta_t} - 1$

6. Results

6.1. *Evidence of long-term relationship between Stock Price* (P) *and NAV*

Initially, tests are undertaken on the possible linear relationship between the average property stock price (P) and the average NAV of the sample companies. As in Barkham and Ward (1999), no adjustment for leverage is required since the two series represent shareholders' fund and are based on approximately the same level of leverage.

The tests comprise two major steps. First, the two time series are first examined for their stationarity on the level and first difference using the standard Augmented Dickey–Fuller (ADF) unit root tests. The tests are necessary, as the finding of a unit root in any of the series indicate non-stationarity, which has implications for modeling the bivariate and multivariate relationship in the system. The ADF unit root test results are first evaluated. The ADF statistics for the two series in the second difference are lower than the critical values for 5 and 1 percent level of significance. Since the two series are integrated of the same order, it is possible that a linear combination of the P series and NAV series may be stationary. The second step is to employ Johansen's FIML technique (1988) to test whether property share prices and NAV series are connected though long-term relationship. The

FIML approach provides a unified framework for estimating and testing of cointegrating relationship in the context of autoregressive error correction models. The test provides long-likelihood ratio test statistics for determining the number of cointegrating vectors *r* using the maximal eigenvalue procedure. The results suggest that the two series are not cointegrated as the likelihood test statistic of 19.17 is, respectively, below the 99 and 95 percent critical value of the tests (24.60 and 19.96). Hence there is absence of a stable long-run equilibrium relationship between Singapore property stock prices and NAV. This is different from the Barkham and Ward study (1999) which suggests a long-term equilibrium discount of about 25 percent between the U.K. property shares and the property company NAVs.

We then proceed to apply the mean reversion model to examine whether P and NAV could be related even though the relationship might be nonlinear. In parallel to the argument put forward by Okunev and Wilson (1997), one possible reason for the Johansen cointegration test to produce no evidence of integration is that the relationship between property stock price and net asset value may be non-linear rather than linear, or it could be due to the extent of weak mean reversion. The results comprise three parts.

6.2. Results of the variance-ratio test

The relative variability of average returns on *P* and NAV over different time horizons using the variance ratios are reported in Tables 2 and 3, respectively. Figure 2 presents the evidence graphically. The variance ratio should converge to unity if the returns on *P* and NAV are uncorrelated through time. If the variance ratio is less than one for investment horizons longer than 1 year, then returns on P and NAV will be due to some transitory factors and exhibits mean-reversion behavior.

The variance ratio test indicates that the monthly returns on both P and NAV display

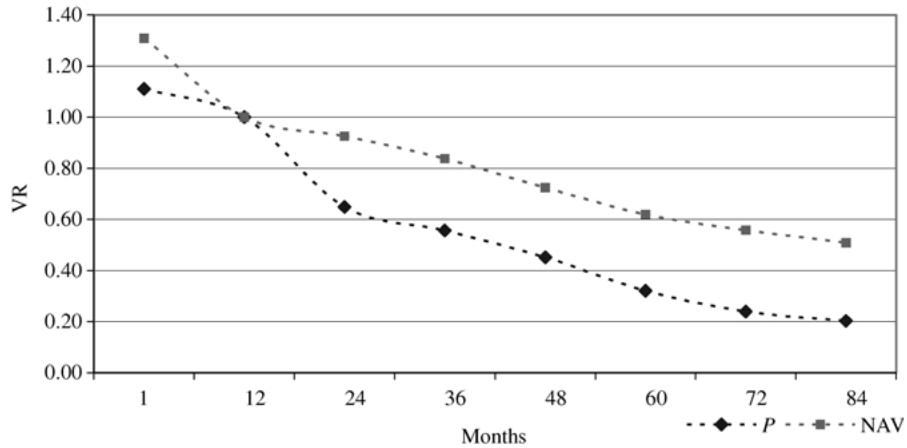

Figure 2. Average variance ratios.

Table 2. Variance ratios of monthly property stock price: 1985–1999.

	Return Measurement Interval (Months)						
Company	1 Month	24 Months	36 Months	48 Months	60 Months	72 Months	84 Months
BONV	1.08	0.48	0.39	0.28	0.17	0.1	0.08
BUKI	0.69	0.92	0.83	0.67	0.45	0.29	0.23
CHIE	1.04	0.62	0.54	0.42	0.28	0.17	0.16
CHMI	1.28	0.73	0.65	0.58	0.52	0.49	0.43
CITY	1.2	0.58	0.47	0.37	0.24	0.19	0.14
FCAP	0.68	0.57	0.5	0.41	0.34	0.28	0.23
HONF	1.64	0.97	0.82	0.58	0.41	0.33	0.3
JMPH	1.34	0.51	0.35	0.32	0.21	0.14	0.11
KEPL	1.04	0.6	0.47	0.41	0.28	0.22	0.19
LCDV	1.25	0.47	0.3	0.25	0.23	0.19	0.16
MARC	1.28	0.55	0.41	0.35	0.21	0.15	0.12
MCLL	1.13	0.43	0.38	0.31	0.2	0.16	0.12
OPHH	0.93	0.78	0.75	0.69	0.58	0.42	0.32
SLND	1.07	0.88	0.78	0.62	0.36	0.24	0.2
TLBL	1.07	0.76	0.77	0.61	0.45	0.34	0.3
UOLL	1.06	0.54	0.49	0.34	0.19	0.14	0.12
Average	1.111	0.649	0.557	0.452	0.32	0.239	0.202

Note. The variance ratios are the percentage of the monthly variance of one-year returns, which are calculated by $VR(q) = (12/q)*\text{var}(Rq)/\text{var}(R12)$, where Rq denotes returns over a q-period return horizons.

Table 3. Variance ratios for monthly net asset value: 1985–1999.

	Return Measurement Interval (Months)						
Company	1 Month	24 Months	36 Months	48 Months	60 Months	72 Months	84 Months
BONV	1.26	0.74	0.6	0.51	0.44	0.38	0.25
BUKI	1.19	1.14	0.82	0.53	0.51	0.63	0.66
CHIE	1.05	1.09	0.91	0.6	0.33	0.2	0.19
CHMI	1.37	0.96	0.79	0.57	0.35	0.19	0.1
CITY	1.35	0.79	0.93	1.07	1.13	1.11	1.02
FCAP	1.08	0.92	0.85	0.71	0.7	0.73	0.75
HONF	1.54	1.2	1.21	1.06	0.91	0.86	0.88
JMPH	0.95	0.88	0.77	0.59	0.34	0.21	0.22
KEPL	1.19	1.09	0.93	0.77	0.71	0.8	0.84
LCDV	1.17	0.84	0.72	0.61	0.51	0.43	0.36
MARC	1.06	0.57	0.45	0.42	0.45	0.41	0.35
MCLL	2.04	0.92	0.76	0.64	0.52	0.46	0.44
OPHH	1.75	1.12	1.27	1.31	1.21	0.98	0.71
SLND	1.25	0.62	0.64	0.54	0.55	0.46	0.41
TLBL	1.59	0.65	0.51	0.58	0.34	0.27	0.2
UOLL	1.09	1.27	1.24	1.06	0.9	0.8	0.79
Average	1.309	0.926	0.838	0.724	0.619	0.558	0.509

Note. The variance ratios are the percentage of the monthly variance of one-year returns, which are calculated by $VR(q) = (12/q)*\text{var}(Rq)/\text{var}(R12)$, where Rq denotes returns over a q-period return horizons.

similar trend—negative serial correlation at longer horizon, while positive return autocorrelation is reported for return horizons shorter than 2 years. For return horizon shorter than 1 year, the average variance ratios of P and NAV are 1.111 and 1.309, respectively. As the return horizon is lengthened, for example, in two-year horizons, the variance ratio is, on average, only 0.649 times (for P) and 0.926 time (for NAV) as large as the monthly variance of one-year return. Moreover, the variance ratios for P and NAV are decreasing as the return horizon is lengthened to 7 years. Finally, with some exceptions in the variance ratio results for the NAV series, the results for the individual companies are consistent with the average results.

6.3. Results of the multi-period return regression test

6.3.1. Property share price

Table 4 reports the slopes of the regression lines of $R_{t,t+T}$ on $R_{t-T,t}$ for return horizons from 1 to 7 years using the individual companies' stock prices and average stock prices. As predicted by the hypothesis, property stock prices have exhibited transitory components. Specifically, the slopes are, on average, negative except for the 7-year return horizon. The average slope reach minimum negative value (-1.091) for the 3-year return horizon and become less negative for the return horizons from 4 to 6 years. The average values of the slopes for the 4- to 7-year return horizons are, respectively, -0.877, -0.763, -0.688 and 0.685. Except for the small negative slope for the 1- and 2-year horizon (-0.081 and -0.155), the slopes for the 4- to 6-year return horizon are large in magnitude and statistically significant at the 1 percent level. The slope locus (Figure 3) exhibits

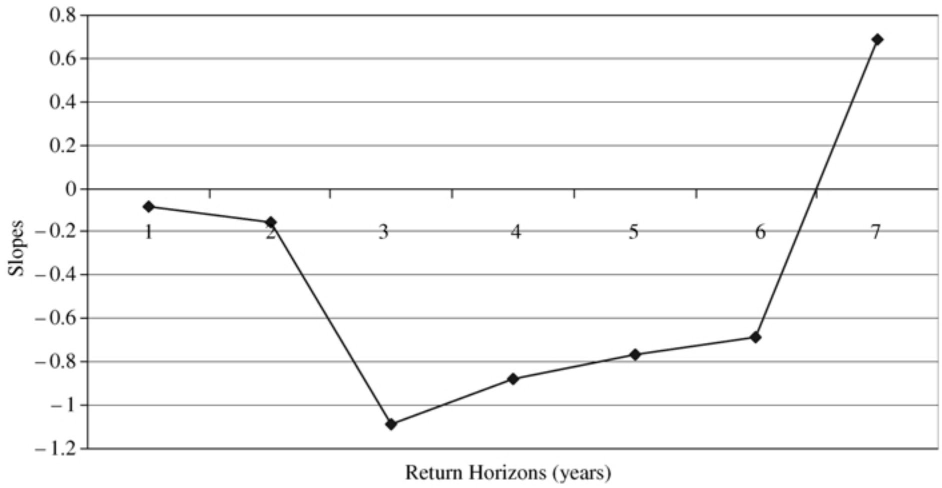

Figure 3. Slope locus for property share prices.

Table 4. Multi-period return regression test results—slopes, $\beta(q)$, for property stock price.

	Return Horizons (Year)						
Company	1	2	3	4	5	6	7
BONV	– 0.13*	– 0.33*	– 0.90*	– 0.63*	– 0.54*	– 0.27*	– 0.13
BUKI	– 0.04	– 0.02	– 1.17*	– 1.66*	– 1.75*	– 1.09*	0.6
CHIE	– 0.04	– 0.24**	– 1.01*	– 1.82*	– 1.97*	– 0.76*	– 3.3
CHMI	– 0.26*	0.52*	0.02	– 0.41**	– 0.61**	– 0.32	0.07
CITY	– 0.42*	– 0.11**	– 0.61*	– 0.70*	– 0.001	– 0.08	0.49
FCAP	– 0.45*	0.1	– 0.37*	– 1.12*	– 1.21*	– 1.06*	– 0.09
HONF	– 0.02	– 0.42*	– 0.35*	– 0.02	0.28*	– 0.71*	– 2.40**
JMPH	– 0.48*	– 0.27**	– 0.67*	– 1.31*	– 1.44*	– 0.33**	4.28
KEPL	– 0.36*	– 0.04	– 0.57*	– 0.005	0.16	0.13	0.6
LCDV	– 0.52*	– 0.40*	– 0.23*	– 0.05	– 0.52*	– 1.36*	– 0.41
MARC	– 0.47*	– 0.31*	– 0.72*	– 0.58*	– 0.29	– 0.24**	– 0.28
MCLL	– 0.59*	0.12	– 0.57	– 0.65*	– 0.56**	– 0.63	0.43
OPHH	– 0.19*	0.27**	0.09	0.07	– 1.95*	– 1.23*	0.14
SLND	– 0.06	– 0.14	– 0.73*	– 0.47*	0.04	0.02	0.78
TLBL	0.002	– 0.13	– 0.67*	– 0.88*	– 1.35*	– 0.73*	– 4.65
UOLL	– 0.46*	– 0.20**	– 0.99*	– 0.75*	– 0.28	– 0.43*	0.66
Average	– 0.081*	– 0.155	– 1.091*	– 0.877*	– 0.763**	– 0.688*	0.685

Notes. * Two-tailed significance at the 1 percent level. ** Two-tailed significance at the 5 percent level. The standard errors of the slopes have been adjusted for residual autocorrelation.

approximately the U-shaped pattern which is consistent with the hypothesis that property stock prices exhibit mean-reversion bahavior. Finally, the slopes for the individual companies are largely negative. Except for two firms, the remaining 14 property companies reach their respective minimum negative slope for the 3- to 5-year return horizons. Hence, property stock prices have a random walk and a transitory component. The random walk component eventually becomes dominant as the return horizon is lengthened.

6.3.2. Net asset value

Results for the slopes of the regression lines of $R_{t,t+T}$ on $R_{t-T,t}$ for return horizons from 1 to 7 years using the individual companies' NAVs and average NAV are reported in Table 5. Again the NAV variable has displayed transitory components. The slopes are, on average, negative except for the 7-year return horizon. The average values of the slopes for the 1- to 7-year return horizons are, respectively, -0.031, -0.449, -0.700, -0.246, -0.479, -1.228, and 1.055. Except for the small negative slope (-0.031) for the 1-year horizon, the slopes for the 2- to 6-year return horizon are large in negative magnitude and statistically significant at the 1 percent level.

The slope locus (Figure 4) exhibits approximately the W-shaped pattern in which the

Table 5. Multi-period return regression test results—slopes, $\beta(q)$, for NAV.

	Return Horizons (Year)						
Company	1	2	3	4	5	6	7
BONV	– 0.12**	– 0.08	– 0.32*	– 0.84*	– 0.88*	– 0.62*	– 5.38*
BUKI	0.12	– 0.66*	– 0.42*	– 0.33*	– 0.91*	– 1.06*	– 0.82*
CHIE	0.09*	– 0.41*	– 0.74*	– 0.48*	– 0.16	– 0.66*	– 0.84*
CHMI	– 0.04	– 0.40*	– 0.88*	– 1.15*	– 0.69*	– 0.97*	– 0.90*
CITY	– 0.30*	0.43*	0.50*	0.36**	– 0.05	0.16	– 0.12*
FCAP	0.04	– 0.25	– 0.25*	0.09	0.02	– 0.28**	0.16
HONF	0.32	– 0.28	– 0.60*	0.04	0.34*	– 1.06*	5.12*
JMPH	– 0.07	– 0.34*	– 0.73*	– 0.35*	0.08	– 0.34	0.248
KEPL	0.39*	– 0.49*	– 0.61*	– 0.38*	– 0.68*	– 1.19*	– 2.40*
LCDV	– 0.07	– 0.24*	– 0.39*	– 0.39*	– 0.74*	– 0.58*	– 0.14
MARC	– 0.43*	– 0.31*	– 0.25*	– 0.48*	– 0.73*	1.43	Nil
MCLL	– 0.01	– 0.34*	– 0.43*	– 0.24*	0.03	– 0.13	– 24.26
OPHH	0.12	0.18*	– 0.11	– 0.63*	– 1.18*	– 0.68*	– 25.03
SLND	– 0.33*	0.01	– 0.33*	– 0.38*	– 0.32*	0.12*	0.01
TLBL	– 0.33**	– 0.06	– 0.37	– 2.24*	– 4.46*	– 2.62*	– 8.30*
UOLL	0.28*	– 0.42*	– 0.69*	– 0.1	0.66*	– 0.69*	– 2.18*
Average	– 0.031	– 0.449*	– 0.700*	– 0.246*	– 0.479*	– 1.228*	1.055**

Note: *Two-tailed significance at the 1 percent level, **Two-tailed significance at the 5 percent level. The standard errors of the slopes have been adjusted for residual autocorrelation.

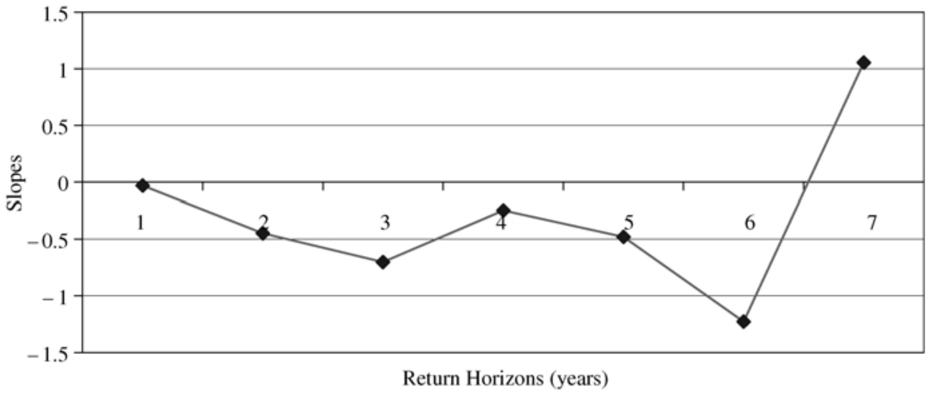

Figure 4. Slope locus for NAV.

average slope initially starts with a less negative value (– 0.031). Then the mean reversion of the transitory component attempts to cause the locus to a low of – 0.700 at the 3-year return horizon. From this point onward, the random walk component recovers some ground but nevertheless fails to become dominant. As the return horizon is lengthened, the average slope reaches its minimum negative value (– 1.228) for the 6-year horizon and becomes positive for return horizons beyond 6 years. Again, this W-shaped pattern is consistent with the hypothesis that the NAV series exhibit mean-reversion behavior. Finally, the slopes for the individual companies are largely negative. Of the 16 companies, 50 percent displays a U-shaped pattern locus slope, another five property companies exhibit a W-shaped pattern locus slope and the remaining three firms' NAV fail to exhibit mean-reversion behavior.

6.4. *Mean reversion of property stock price towards NAV*

The summary statistics for investment horizons 1–7 years for changes in property stock prices based on equation (11) are reported in Table 6.

For the 1-year investment horizon, the change in NAV is not statistically significant. When the investment horizon is extended to 2, 3, 4 and 5 years, change in NAV, lagged P and lagged NAV become statistically significant at the 5 percent level. However, the coefficients for the change in NAV and lagged NAV are negative for the 4- and 5-year investment horizon, which are different from expectation. As the investment horizon lengthens to 6 and 7 years, change in NAV is still significant and the other two independent variables become statistically insignificant. Finally, the model's explanatory power changes with the investment horizon. Specifically, the explanatory power increases from

Table 6. Modeling changes in property stock prices as a function of NAV.

$$\Delta P(t) = \alpha \Delta NAV(t) + \beta P(t) + \gamma NAV(t) + \varepsilon_t.$$

Horizon	Coefficients (Without Adjustments)					Coefficients (With Adjustments)†				
(Year)	α	β	γ	DW	R^2(%)	α'	β'	γ'	DW	R^2(%)
1	0.1	−0.45*	0.52*	0.1	19.70	0.11	−1.06*	0.06	1.97	94.37
	(0.39)	(−6.80)	(7.34)			(0.33)		(0.16)		
2	0.83*	−1.03*	1.22*	0.06	44.40	0.13	−0.35*	0.49**	1.96	96.78
	(4.71)	(−9.77)	(10.57)			(0.4)	(−12.33)	(1.45)		
3	0.19*	−1.42*	1.77*	0.09	69.20	0.44***	−0.40*	1.17*	1.96	97.74
	(1.29)	(−17.15)	(17.9)			(1.82)	(−8.29)	(4.43)		
4	−0.76*	−1.69*	−2.25*	0.28	85.20	0.36***	−0.49*	1.02**	1.98	97.70
	(−5.05)	(−30.56)	(−32.15)			(1.34)	(−9.87)	(2.48)		
5	−0.63**	−1.27*	−1.79*	0.09	47.60	0.2	−0.50*	0.18	1.97	96.65
	(−2.05)	(−10.87)	(−11.53)			(0.53)	(−8.30)	(0.38)		
6	1.84*	−0.13	0.22	0.11	11.50	0.16	−1.13*	0.02	1.97	94.60
	(5.7)	(−0.75)	(1.17)			(0.30)	(−10.98)	(0.01)		
7	2.31*	0.19	−0.13	0.17	23.90	−0.09	−0.73*	−0.53	1.98	93.17
	(7.84)	(−1.29)	(−0.89)			(−0.17)	(−3.68)	(−0.89)		

Notes. Figures in parentheses are *t* statistics. *, **, *** Two-tailed significance at the 1, 5 and 10 percent level, respectively. †Adjustments are made by adjusting white heteroskedasticity and AR(1) & MA (1) error terms.

19.7 percent for 1-year horizon to 85.2 percent for a 4-year horizon. As the investment horizon lengthens further, the model's R^2 decreases. These results are similar but not directly comparable to the work of Campbell and Shiller (1988) and Fama and French (1988), as their studies investigate DPS and/or EPS.

The estimation results suffer from significant heteroscedasticity and serial correlation in the residuals. These problems might partially cause the change in NAV and lagged NAV coefficients to be negative for the 4- and 5-year investment horizons. The regressions are therefore corrected for heteroscedasticity via White (1980) technique and serial correlation with ARMA (1) formulation. The adjusted results are reported on the right portion of Table 6. As expected, the coefficients for the change in NAV and lagged NAV become positive and the model's explanatory power increases to 97.7 percent for the 4-year investment horizon. The estimations are further repeated for the 16 property firms. Overall, the results reported in Table 7 parallel those of aggregate analysis. Again, the average explanatory power of the individual regressions increases with investment horizon. The R^2 value reaches the highest of 56 percent for the 4-year investment horizon. Of the 16 firms, changes in the property stock prices are positively related to the changes in NAV for 15 companies for the 3-year investment horizon. Finally, the speed of adjustment λ_c is general significant. Table 8 shows the values of λ_c for investment horizons of one to seven years are, respectively, 38, 23.3, 16.5, 20.3, 16, 13.8, and 3.3 percent. This suggests

Table 7. Summary results for modeling changes in property stock prices as a function of NAV for the 16 sample companies.

$$\Delta P(t) = \alpha \Delta NAV(t) + \beta P(t) + \gamma NAV(t) + \varepsilon_t.$$

Horizon	Coefficients			R^2	
(Year)	α	β	γ	Range	Average (%)
1	− 0.98 to 1.30* [10]†	− 0.47 to − 0.13 [16]	0.03 to 1.51 [14]	0.05 to 0.46	23
2	− 0.22 to 2.36 [13]	− 1.57 to − 0.08 [15]	− 0.05 to 3.37 [14]	0.09 to 0.72	36
3	− 0.10 to 8.52 [15]	− 1.66 to − 0.32 [16]	0.09 to 4.07 [16]	0.18 to 0.81	48
4	− 0.07 to 17.40 [13]	− 1.98 to − 0.39 [16]	0.09 to 4.25 [16]	0.22 to 0.82	56
5	− 0.43 to 8.70 [14]	− 1.84 to − 0.22 [16]	0.05 to 4.19 [15]	0.14 to 0.82	45
6	− 0.14 to 1.70 [14]	− 1.23 to − 0.11 [15]	0.13 to 6.91 [15]	− 0.09 to 0.77	34
7	− 6.52 to 1.15 [10]	− 1.74 to 3.75 [13]	− 0.28 to 2.11 [12]	− 0.39 to 0.79	30

Notes. * Indicates range of the estimation for the 16 companies.
† Number of companies with significant value (two-tailed significance at the 5 percent level).

Table 8. Estimation of the speed of adjustment (λ) for the individual companies.

Return Horizons	Average	Range for the 16 Companies
1	0.3804	0.1343–0.6395
2	0.2326	0.042–0.3911
3	0.1649	0.1283–0.2025
4	0.2033	0.1236–0.4161
5	0.1599	0.0497–0.2929
6	0.1382	0.0202–0.3148
7	0.0327	− 0.2227–0.1722
Grand average	0.1874	—

Note. The speed of adjustment λ is computed through $\beta = (e^{-\lambda\Delta_t} - 1)$.

that changes in the property stock prices are, in the longer term, mean reverting at an average rate of 18.7 percent per year.

7. Conclusion

Property company portfolio valuations are typically measured on their NAVs which are dependent on real estate market condition. Adoption of the traditional NAV based valuation implies that stock prices and NAVs are (linearly) linked. The Johansen cointegration test has rejected a long-term stable (linear) relationship between the two series. This is in contrast to the presence of a linear relationship between the U.K. property company stock prices and their net asset values. However, there is some evidence of mean reversion behavior of Singapore property stock prices towards the property company NAVs over the past 15 years from 1985 to 1999, both at individual company level and in the sector as a whole. Our evidence reveals that NAV, as a traditional proxy to fundamental value, is significant in capturing the dynamics of the changes in property stock prices. Hence NAV is a factor in property company valuation. The mean reversion results further suggest that property stock prices are nonlinearly linked to NAVs, but the extent of mean reversion between the two markets is slow and deviations between the two markets' valuation could therefore be prolonged. Our evidence indirectly complements that of Okunev and Wilson (1997) who detected a weak and non-linear relationship between the stock and real estate markets.

One major implication arising from this study is that, as a result of this weak relationship between property company stock prices and their NAVs, direct and indirect investments in property are, at best, weak substitutes for each other. Hence there appears a need to rely less on NAV as the principal basis for property company valuation. In particular, problems relating to valuation methodology, valuation variance, valuation accuracy and valuation smoothing continue to cast uncertainty as to the true NAV and give rise to disparity between stock prices and the underlying asset value. Further studies are required to examine other valuation measures such as standard earnings/dividend stock market indicators, economic value added (EVA) and other approaches based on arbitrage pricing theory (Ross, 1976) and to assess their comparative advantages in property company valuation.

Acknowledgments

The author is grateful to Ms Zhang Hongye for providing assistance in data processing and the helpful comments from an anonymous referee. Responsibility for errors and omissions remains with the author.

Notes

1. There are two distinct forms of investment funds: open-end funds and the closed-end funds. An open-end fund operates on the basis that its capital base can vary according to the demand for its units of shares. Hence it issues unit on demand and must redeem outstanding units on demand at the NAV per share of the fund. A closed-end fund operates in the same manner as any commercial company except that instead of investing in physical assets, it invests in the shares of other companies and carries on the business of trading its securities. However, after the shares are initially issued all trades take place between individual shareholders in the open market thorough the forces of supply and demand, and hence the price need not equal the NAV. Property companies closely resemble closed-end funds. They periodically issue new shares to raise capital but they are not obliged to redeem these shares. Investors have to trade in the open market in order to liquidate their position.
2. In the Asian capital markets, Liow's study (1996) was the only published work that sought to investigate the time-series behavior and dynamics of property company discounts in the Singapore context.
3. In Singapore, the term ''property company'' refers to an enterprise which derives a large proportion of its income from selling properties or from renting them out. The Singapore Exchange Ltd (SGX) further requires that property companies must not hold more than 50 percent of its portfolio in property leases of less than 30 years. There are three major differences in income and dividend distribution characteristics between the Singapore property companies and U.S. REITs. First, the funds from operation (FFO) concept, which is commonly used to measure the performance of U.S. REITs, is not applicable to Singapore property stocks. Second, Singapore listed property companies do not adopt the compulsory distribution of more than 90 percent of taxable income policy as imposed on U.S. REITs. Third, property companies in Singapore do not qualify for any tax breaks on operating incomes, and dividends are normally distributed on after-tax basis to shareholders.
4. The original sample includes 19 property companies which were listed on the Stock Exchange as of 31 December 1999. Subsequently three companies were excluded from the study because they did not reflect their investment properties at full market valuation (see also notes 5, 6, and 7).
5. In the United States of America, corporations are not permitted to revalue their real estate assets. However, Singapore, as in many other countries such as, the United Kingdom, The Netherlands, Australia, and New Zealand, does not have a strict historical cost system but one in which assets may be revalued. As such, many property companies use a mixture of historical cost and current value accounting: showing most fixed assets at costs but revaluing investment properties (Liow, 2000).
6. Paragraph 47 of Singapore accounting standard No. 25 allows investment properties to be carried out in the balance sheets either at cost or at valuation. The 16 sample companies included in this study have consistently have their property assets reflected at valuation annually. The accounting standard further requires that a policy for the frequency of revaluation should be adopted and the entire category should be revalued at the same time. The valuation (appraisal) would normally be carried out annually by professionally qualified directors or in-house appraisers and at least once in every 3 years by independent professional external appraisers.
7. We wish to thank the referee for raising a concern that the NAV metric employed in the study might not be adequate. We hope that we have provided clearer explanations of the real estate appraisal practices in

Singapore. Our choice of the NAV metric can be defended mainly on two grounds. The NAV metric is the only published data that could be used for time-series analysis. Additionally, the investment properties of the 16 sample companies are reflected at annual valuation although some companies use in-house valuations in-between a 3-year external independent valuation cycle. Hence the NAVs are unlikely to be outdated on average by 3 years. Of course, there is great doubt about the accuracy and independence of property company portfolio valuations. Hence the findings of the study have to be interpreted with this data limitation in mind.

References

Adams, A., and P. Venmore-Rowland. (1989). ''Property Share Valuation,'' *Journal of Property Valuation* 8(2), 127–142.

Adams, A., and A. Baum. (1989). ''Property Securitization: Premium or Discount?'' *Investment Analyst* (91), 31–38.

Barkham, R. J., and C. W. R. Ward. (1999). ''Investor Sentiment and Noise Traders: Discount to Net Asset Value in Listed Property Companies in the U.K.,'' *Journal of Real Estate Research* 18(2), 291–312.

Bonser-Neal, C., G. Brauer, R. Neal, and S. Wheatley. (1990). ''International Investment Restrictions and Closed-End Country Fund Prices,'' *Journal of Finance* 45(2), 523–547.

Brauer, G. A. (1988). ''Closed-End Fund Shares' Abnormal Returns and the Information Content of Discounts and Premiums,'' *Journal of Finance* 43(1), 113–127.

Campbell, J. Y., and R. L. Shiller. (1988). ''Stock Prices, Earnings, and Expected Dividends,'' *Journal of Finance* 43(2), 661–676.

Chiang, R., I. Davidson, and J. Okunev. (1997). ''Some Further Theoretical and Empirical Implications Regarding the Relationship Between Earnings, Dividends and Stock Prices,'' *Journal of Banking and Finance* 21, 17–35.

Chiang, R., P. Liu, and J. Okunev. (1995). ''Modeling Mean Reversion of Asset Prices Towards their Fundamental Value,'' *Journal of Banking and Finance* 19, 1327–1340.

Fama, E. F., and K. R. French. (1988). ''Permanent and Temporary Components of Stock Prices,'' *Journal of Political Economy* 96(2), 246–273.

Johansen, S. E. (1988). ''Statistical Analysis and Cointegrating Vector,'' *Journal of Economic Dynamics and Control* 12, 231–254.

Lee, C. M. C., A. Shleifer, and A. R. H. Thaler. (1991). ''Investor Sentiment and the Closed-End Fund Puzzle,'' *Journal of Finance* 46(1), 75–109.

Liow, K. H. (1996). ''Property Companies' Share Price Discounts and Property Market Returns: The Singapore Evidence,'' *Journal of Property Finance* 7(4), 64–77.

Liow, K. H. (2000). ''Corporate Financial Reporting of Singapore Property Companies: Issues and Evidence,'' *Journal of Financial Management of Property and Construction* 5(3), 149–158.

Lo, A., and A. MacKinlay. (1988). ''Stock Market Prices do not Follow Random Walks: Evidence from a Simple Specification Test,'' *Review of Financial Studies* 1(1), 41–66.

Okunev, J., and P. J. Wilson. (1997). ''Using Nonlinear Tests to Examine Integration between Real Estate and Stock Markets,'' *Real Estate Economics* 25(3), 487–503.

Poterba, J. M., and L. H. Summers. (1988). ''Mean Reversion in Stock Prices—Evidence and Implications,'' *Journal of Financial Economics* 22(1), 27–59.

Steinert, M., and S. Crowe. (2001). ''Global Real Estate Investment: Characteristics, Optimal Portfolio Allocation and Future Trends,'' *Pacific Rim Property Research Journal* 7(4), 223–239.

White, H. A. (1980). ''Heteroskedasticity—Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity,'' *Econometrica* 48, 55–68.