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Net Asset Value Discounts for Asian-Pacific Real Estate Companies: Long-Run Relationships and Short-Term Dynamics

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Abstract This study investigates the time series behavior of real estate company net asset value discount/premium (NAVDISC) in eight Asian-Pacific securitized real estate markets from 1995 to 2003. We postulate that if there is a stable NAVDISC for real estate companies in the long-run, then there should be a long-run cointegrating relation between their stock prices (Ps) and net asset values (NAVs). Employing panel data cointegration econometrics that comprises three approaches; panel unit root test, heterogeneous panel cointegration test and dynamic panel error-correction modeling (ECM), we find that long run NAVDISCs persist in individual Asian-Pacific securitized real estate markets and the regional market. All the NAVDISCs exhibit mean reversion and that the respective disequilibrium errors fluctuate around the mean values. Moreover, NAV is an important factor that statistically explains the price variations in real estate stock prices regardless of their speed of mean-reversion in the NAV discount /premium.

Keywords Asia-Pacific securitized real estate markets · Net asset value discount/ Premium · Panel unit root · Panel cointegration · Dynamic panel error-correction modeling

Introduction

Similar to closed-end funds and real estate investment trusts (REITs), real estate company stock prices deviate considerably from their net asset values (NAV). NAV in a property context represents the underlying value of the real estate assets of a property stock. This value is generally similar to the direct value of underlying real estate values less liabilities. The premium or discount of real estate stocks (NAVDISC) is calculated by taking the difference between the current stock price

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(P) and NAV and dividing it by the NAV. The higher the NAV to the P results in the real estate stock trading at a discount (i.e., NAVDISC is a discount); the lower the NAV to the P results in the real estate stock trading at a premium (i.e., NAVDISC is a premium). Adoption of this NAV approach implies that stock prices and NAVs are linked since at a fundamental level, real estate company stock prices should reflect their underlying real estate asset values (Adam & Venmore-Rowland, 1989). Since Asian-Pacific real estate markets have been investigated less thoroughly in the past, consequently in this paper, we investigate whether the Asian-Pacific real estate company stock prices are significantly related to their NAVs in the long run, and if so, estimate how fast the dynamic adjustments take place.

With recent studies (Conover, Friday, & Sirmans, 2002; Steinert & Crowe, 2001; Worzala & Sirmans, 2003) highlighting the diversifications benefits of including international listed real estate in a mixed asset portfolio, considerable attention has been given to various aspects of real estate company performance in Asia. Given the increasing level of international investment in Asian real estate companies in recent years, it is timely to investigate whether NAV, as the traditional basis for valuation of real estate companies, is linked to share price both in the long-run and short-term. As shall be seen, this long-term relation is essentially the "NAVDISC". Such analysis will reveal whether real estate company performance is linked in the long run to the performance of the underlying real estate market and its short-term fluctuations and has great implication for performance measurement and return–volatility relationships. Furthermore, NAV as the principal basis for real estate company valuation may have to be reassessed if real estate company stock prices have no or insignificant relationship with their NAVs. This is a significant contribution as there has been very little work in the USA, the UK or Asian countries regarding the fundamental factors of real estate company valuation. Moreover, no other study has considered this NAVDISC issue on an Asian wide basis.

Unlike earlier studies, we employ panel stationarity tests, panel cointegration procedures and panel dynamic error-correction modeling to investigate whether a long run contemporaneous cointegrating relation exists between real estate company stock prices (P) and net asset values (NAV) by simultaneously testing for panel cointegration between P and NAV values of listed real estate firms in eight Asian-Pacific securitized real estate markets (Australia, Hong Kong, Japan, Singapore, Malaysia, Indonesia, Philippines and Thailand) based on individual panels and whole panel. This panel approach allows us to assess the average equilibrium long-run relation and a short-run dynamic behavior of the real estate companies' NAVDISC across the individual Asian-Pacific securitized real estate markets. As in closed-end funds and REITs, our overall results are that long run net asset discounts persist in the individual Asian-Pacific real estate markets. All the NAVDISCs display mean reversion with the respective disequilibrium errors fluctuate around the long-term means. Moreover, NAV is an important factor that statistically explains the price variations in real estate stock prices regardless of their speed of mean-reversion in the discount / premium.

To establish a background for the study, Theory of Real Estate Stock Valuation presents a short account of the theory of real estate stock valuation. A brief review of the relevant literature is presented in Literature Review. In Sample and Data Characteristics and Research Methodology, we describe the data set and present the panel unit root, panel cointegration and dynamic panel ECM methodologies. Results reports and discusses the results. The final section concludes the paper.

Theory of Real Estate Stock Valuation

The present value of future cash flows is the major valuation principle of finance. With regard to firm valuation, finance literature states the value of a firm's common stock to the investor is equal to the present value of its future dividends. Similarly common stock valuation models can focus on other corporate performance variables such as future earnings or the values of its individual assets and liabilities (i.e., NAVs).

Depending on the nature of the firm's business and analysts' preference, valuation can thus focus solely on one of these attributes (i.e., dividends, earnings or NAVs). A good example is the valuation of real estate stocks which are valued in stock market whereas the underlying properties are appraised in the real estate market. This unique characteristic has led Adams and Venmore-Rowland (1989) to argue that real company valuation is generally related to the value of the underlying properties (i.e., NAVs) and less to earnings and dividends. Hence real estate stocks are likely to provide a return that should not differ significantly from the return on the underlying real estate assets over a relatively long period.

The main justification for a NAV basis of valuation, rather than an earnings or dividend basis, rests on the growth potential of the assets (real estate assets) held. It has been argued by many that a real estate company value derived using an industry standard price–earnings ratio or dividend yield is considerably less than the value of its underlying real estate assets which are anticipated to grow over time. On the contrary, it might also be argued that as movements in real estate company stock prices are more closely associated with the stock market fluctuations in the short term (Barkham & Ward, 1999), attention should thus be focused on more standard earnings/dividend stock market indicators.

Mathematically, given a time series of P and NAV data, the P-NAV relation for the jth real estate firm can be written as:

$$P_{jt} = \alpha_j + \beta_j(\mathrm{NAV})_{jt} + \varepsilon_{jt} \quad (1)$$

$$\text{for } j=1,2,\ldots..N \text{ and } t=1,\ldots\ldots.T.$$

Equation 1 recognizes that β on a particular real estate company can be different from that of another real estate firm. Further if the P-NAV relation is well specified, then α should be insignificantly different zero. In this case, the relation in Eq. 1 holds if a long-run cointegrating relation exists between P and NAV. Specifically, If P and NAV are cointegrated, then they tend to revert back to a long-term relationship (expressed by $\beta_j = \frac{P_{jt}}{NAV_{jt}}$) and short-term variations in the P-NAV ratios fluctuate around the long-run P-NAV ratio.

Similar to closed-end funds that commonly trade at a discount to NAV,[1] real estate companies normally stand at a discount to NAV as they represent a special class of closed-end fund (Liow, 2003). Moreover, it can be seen from the above that the P-NAV ratio contains the same information as the NAVDISC, but all P-NAV ratios are expressed as positive numbers. When the ratio is greater than one, real estate firms are trading at a premium; and when the ratio is less than one, they are trading at a discount. When the ratio equals 1, the price equals to NAV. The long-run relation between price and NAV is thus the NAVDISCs. Hence, by examining

[1] Examples of these studies include Bennett and Gronewoller (2002); Gasbarro, Johnson, and Zunwalt (2003); Lee, Shleifer, and Thailer (1991); and Movassaghi, Bramhandkar, and Shikov (2004).

the long-run relation between P and NAV, we are also testing if a "long-run" NAVDISC persists in the Asia-Pacific securitized real estate markets and estimating how fast the dynamic adjustments take place in the short-run.

Literature Review

The literature on corporate fundamental values and stock prices, real estate company valuation and panel cointegration econometrics provide a suitable empirical foundation for this study.

On the relation between corporate fundamental values and stock price performance, Fama and French (1988) proposed dividends per share (DPS) as being significant in explaining stock returns. Campbell and Shiller (1988) suggested DPS, dividend growth and long-term earnings per share (EPS) as being significant in explaining returns. Shiller (1989) noted that there were some apparent resemblances between dividends and stock prices. Santoni and Dwyer (1990) examined long-run data on stock prices and dividends and found that the two series did not diverge much. Additionally, shocks to prices did not cause the price and dividend series to drift apart as would be expected in the event of a stock market bubble. MacDonald and Power (1995) detected a cointegrating relation exists among US stock prices, dividends and earnings retention and established a dynamic error-correction model that considered the short-run adjustment process. Lee (1996) investigated the comovements of the logs of earnings, dividends and stock prices by testing for the number of common stochastic trends among the series. He found that the three USA series were cointegrated with a single cointegrating factor and that the dynamic relationship between the three variables was significantly affected by the equilibrium relationship. On the other hand, Rosenberg, Reid, and Lanstein (1985) found that average returns on U.S. stocks were positively related to the ratio of a firm's book value of common equity to its market value (BV/MV). Finally, Basu (1983) found that earnings–price ratio (E/P) can explain the cross section of average returns on the U.S. stocks.

None of the studies mentioned above is concerned with valuation of real estate company stock and their pricing in the stock market. This is probably because real estate stocks, being securities backed by real estate, differ from other common stocks in their basis of valuation. Specifically, Adams and Venmore-Rowland (1989) have pointed out that real estate company portfolio valuations are based more on their net asset values and less to earnings and dividends. A real estate company is thus similar to an investment trust and other closed-end funds except that the true NAV is much harder to ascertain. Empirically, Barkham and Ward (1999) found a stable long-term relationship between UK real estate company stock prices and NAV. The average real estate stock price was about 75 of average NAV. His study thus gives support for a NAV-based basis of valuation. Sing, Liow, and Chan (2002) detected long-run convergence relationships of stock prices with their fundamental values (EPS, DPS and NAV) for 60% of Singapore listed real estate stocks. Finally, Liow (2003) confirmed that NAV was a factor in real estate company valuation. However, the extent of mean reversion between real estate company stock prices and their NAVs was slow and the deviations between the two markets' valuation could be prolonged. To date, no study has considered this issue in international securitized real estate markets.

Since the 1990s, developments in panel data cointegration econometrics have sparked a lot of literature. According to Banerjee (1999), "*the emphasis of the* *literature on unit roots and cointegration in panel data has been the attempt to combine information from the time series dimension with that obtained from the cross-sectional...* (p. 607)." The main objective is to allow a more straightforward and precise inference to be made about the existence of unit roots and cointegration by considering the cross-section dimension (Banerjee, 1999). This panel approach is particularly appropriate for our study in which the time series for the data (i.e., price and NAV) have only 36 quarterly observations (see also Sample and Data Characteristics on "sample and data characteristics") but same data are available across a cross-section of real estate firms in the eight Asian-Pacific securitized real estate markets. Similar to the traditional cointegration approach, the cointegration econometrics of panel data have three major components. First, panel unit root tests are designed to evaluate the null hypothesis that each individual in the panel has integrated time series versus the hypothesis that all individual time series are stationary.[2] Second, panel cointegration techniques are used to test the cointegration for homogenous or heterogeneous panels. For example, Kao (1999) developed residual-based OLS estimators to study the null of non-cointegration for homogeneous panels. On the other hand, Pedroni (1995, 1999) proposed seven tests for non-cointegration in heterogeneous panels with multiple regressors, including heterogeneity in both the long-run cointegrating vectors and in the dynamics. His tests thus allowed for varying intercepts and varying time sloping. Third, another parameter of interest in the panel cointegration application is the speed of adjustment to the long-run. In this regard, dynamic panel error-correction methodologies that employed the mean group (MG) (Pesaran & Smith, 1995), pooled mean group (PMG) (Pesaran, Shin, & Smith, 1999) and dynamic fixed effect (DFG) (Anderson & Hsiao, 1981) estimators have been reported in the literature. Of them, the PMG estimator allows researchers to investigate long-run homogeneity without imposing parameter homogeneity in the short run. Hence the long-run coefficients are constrained as identical but short-run coefficients and error variances to differ across groups. On the other hand, the MG estimator is the least restrictive and is a simple unweighted mean of the coefficients. Finally, panel cointegration methodology has been successfully employed mainly in economic and finance studies such as test of real exchange rates (MacDonald, 1996), test of purchasing power parity hypothesis (Pedroni, 1999), monetary model and exchange rates (Oh, 1999), aggregate consumption and energy demand functions (Pesaran et al., 1999), investment-saving correlation (Ho, 2002) and audit pricing model (Chou & Lee, 2003). Similar applications in real estate research are limited to commercial mortgage-backed security prices (Ong & Maxam, 1997), house price fluctuations (Hort, 1998), long-run initial yield for offices (Ong, Lim, Yu, & Knor, 2002) and commercial rent modeling (Hendershott, MacGregor, & White, 2002).

Sample and Data Characteristics

Our research sample consists of real estate companies that are publicly traded in the stock markets of Asian-Pacific countries (Australia, Hong Kong, Japan, Singapore,

[2] Examples of panel unit root methods include Im, Pesaran, and Shin (1997); Levin and Lin (1993); Levin, Lin, and Chu (2002); Maddala and Wu (1999); and Quah (1994).

Indonesia, Malaysia, Philippines and Thailand).[3] The choice of this Asian-Pacific sample further enhances the contribution of this paper since these markets have been investigated less thoroughly in the past and is thus of significant interest to the world investors and policy makers. Overall, real estate is an important asset in these economies and it also plays a very crucial role in individuals' investment portfolio. Compared with the real estate markets in the US and the UK, real estate values in many Asian-Pacific countries are relatively high. Nevertheless, these markets are, though located in the same region, in different stages of development as revealed by some key macroeconomic and stock market indicators reported in Table 1. Japan is a significantly developed economy in Asia and also a world industrialized economy. Other markets like Hong Kong, Malaysia and Singapore are major economic forces in the region. There has been a long history of Japanese real estate companies. Australian securitized real estate sector is a leading player in global real estate. Similarly, Hong Kong and Singapore have track record of listed real estate companies that play a relative important role in the general stock indexes. Other Asian real estate markets (i.e., Indonesia, Philippines and Thailand) are classified as emerging and need to take a longer time to develop their institutional settings. Finally, REITs have been successfully introduced in Japan and Singapore; HK will likely to have its first REIT introduced in 2004–2005. With bullish sentiment about real estate investment opportunities in Asia, our study reinforces the increase potential importance of Asian listed real estate in investment portfolios for both local and international investors.

Using Datastream, we first obtained 309 real estate companies that had the full-period NAV and stock price (P) data from 1995 1Q to 2003 Q4 (i.e., 36 quarterly observations), the longest period for which NAV data were available from Datastream.[4] This period of 1995 to 2003 covers the boom and bust phases of the most recent real estate market cycle in Asia. Hence any potential bias due to the specific time period should be minimal. A further point to note is that our sample is not a clean "real estate investment" sample as Datastream also included real estate developers and related companies who would normally valued on an earnings basis not in relation to their NAV. To the best of our knowledge, many Asian-Pacific real estate firms are a combination of investment and development. Whilst we tried our best to check that the sample only included firms that were primarily investment companies, this is definitely one possible source of error in our data and analysis and interpretation of the results should be viewed with this data problem in mind.[5]

Next, only 248 real estate companies passed the Augmented Dickey-Fuller (ADF) test of $I(1)$.[6] The final number of real estate companies derived for each market was thus: 14 (Australia), 36 (HK), 7 (Indonesia), 108 (Japan), 36 (Malaysia), 20 (Philippines), 16 (Singapore) and 11 (Thailand). A quarterly database was created for

[3] Two other Pacific Rim markets, China and New Zealand are excluded from this study because the NAV series are not publicly available from the Datastream.

[4] In Datastream, the starting date of NAV data for many real estate firms is January 2005.

[5] We are very grateful to one anonymous reviewer for raising this issue. We sincerely hope that our responses are acceptable.

[6] Stationarity refers to a case where a time series has a constant mean and constant variance. On the contrary, if a series must be differenced once before becoming stationary, then it contains one unit root and is said to be integrated of order 1, denoted as $I(1)$. One important property of $I\ (1)$ variables is that linear combinations of these variables can be I (0), that is, stationary. If this is so then these variables are said to be cointegrated. We employ the ADF test and only those real estate companies that are I (1) in their NAV and stock price series are retained for subsequent panel investigations.

Table 1 Economic and stock market statistics (2003)

	Hong Kong	Singapore	Japan	Malaysia	Indonesia	Thailand	Australia	Philippines
GDP (US $ billion)[a]	156.67	93.56	4,648.19	103.16	211.07	149.79	588.03	78.144
Exchange rate (local per SD)[a]	7.787	1.7008	107.1	3.8	8,465	39.591	1.333	55.569
Lending rate (%)[a]	5	5.31	1.82	6.3	16.94	5.94	4.9	9.472
Consumer price[a]	92.9	101.1	98.1	104.3	130.1	102.3	110.5	112.541
Unemployment rate (%)[a]	7.9	5.4	5.3	3.5	NA	2.4	5.9	11.4
Stock market captilization (US $ million)[b]	463,108	101,900	2,126,075	123,872	29,991	46,084	380,969	39,021
Value traded (US $ million)[b]	210,622	56,129	1,573,279	27,623	13,042	47,612	294,658	3,103
Value traded (/market cap)[b]	0.45	1	1	0	0	1	1	0.08
No. of companies[b]	968	434	3,058	865	331	466	1,355	235
Average firm size (US $ million)[b]	478.4	235	695	143	91	99	281	166.05
Real estate stock % of stock market (%)[c]	11.44	8.49	1.27	2.68	0.20	3.72	8.95	16
P/E ratio of real estate stock[c]	22.60	21.60	35.50	14.20	NA	37.80	17.10	16.5
Dividend yield of real estate stock (%)[c]	2.47	2.58	0.94	2.96	NA	0.49	5.69	0.99

[a] Data from IMF country database, the other data are extracted from *Stock Market Factbook*

[b] *Standard & Poor's Emerging Stock Markets Factbook 2003* and IMF

[c] DATASTREAM

the 248 real estate firms as well as one averaged series for P and NAV of all markets. The variable NAV was defined by Datastream as the book value of tangible assets per share calculated by dividing shareholders' equity less intangible assets and preference capital by the number of ordinary shares. Barkham and Ward (1999) argue that property companies' NAV, derived from contemporaneous estimates of the market value of property assets, provide acceptable proxies for true NAVs. This is because UK property companies have their investment properties appraised annually by independent professional valuers. Moreover, the use of tangible (balance sheet) 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 revaluation of fixed assets and investment properties. Specifically, the Asian-Pacific real estate markets included this study, as in the UK and the Netherlands, do not have a strict historical cost system but one in which assets may be revalued. As such, real estate companies in these countries use a mixture of historical cost and current value accounting, showing most fixed assets at costs but revaluing investment properties. However it is a normal business policy for real estate companies to revalue their properties annually and carry them at market valuation as a larger part of the return to investors is created by the appreciation of real estate values. Consequently, bearing in mind that our Datastream NAV estimates are the only available published data for real estate stocks across the eight Asian-Pacific markets and issues of revaluation and accounting treatment, the published NAV metrics are public information available to all investors and provide acceptable proxies for the "current market value" of the tangible assets per share or "true" NAV. Whilst the NAV definition might be driving some of the results, any systematic bias should be smoothed out and should not affect significantly the results since the individual NAVs are analyzed cross-sectionally across a reasonably homogenous sample of Asian-Pacific real estate stocks.[7,8]

[7] Again, we are very grateful to the same reviewer (see note 5 above) in raising this concern. We sincerely hope that our responses are acceptable.

[8] Arising from the NAV definition adopted in this paper, another reviewer pointed out that the premium /discount to NAV and the premium/ discount to book value were different concepts. He suggested an equation to state that the current price of the stock should equal the current book value (BV) of the firm plus the present value of future earnings. Hence, the premium or discount relative to BV must be equal to the present value of the company's future economic profit. Three related questions were raised: (a) *What accounts for the long-run discount puzzle with respect to HK/Japan/Singapore real estate companies which hold large amounts of vacant land because of extremely high land value?* Our humble responses are that real estate company discount (similar to closed-end funds) is a puzzle. There are many potential factors (other than land holdings) to expect real estate company premiums/ discounts (see Barkham & Ward, 1999). These include tax, management quality, gearing, company risk, size, insider ownership, investor sentiment etc. Moreover, land values in these countries (for example, in Singapore) were affected downward after the Asian financial crisis and economic slowdown. Finally, other factors such as market expectation and the flow of funds also influence the pricing of real estate stocks. Specifically, investments in Asian real estate stocks were less attractive over the last few years due to excess market volatility and downward price pressure; (b) *Which would occur if the present value of the company's future economic profit is negative? Is the story simply that managers of real estate companies in the long-run destroy value?* Our humble responses are that the true economic performance of real estate investment and development companies tend to be understated (using economic-value added or market-value added) in the longer term (see Ooi & Liow, 2002)—hence accounts for negative future abnormal earnings /NAV discounts. On the other hand, managers of real estate companies can help create value (thereby reducing discounts) by enhancing the competitive advantages of their real estate holdings. However, it is beyond the scope of this study to test the estimation results with future abnormal earnings data of the companies. (c) We agree with the reviewer's viewpoint that there is a relation between changes in the NAV discounts and changes in firm risk (systematic and unsystematic). Finally, we wish to thank the reviewer for his comments and hope that our responses are acceptable.

Table 2 provides the yearly mean, maximum and minimum values of market capitalization (MV), net asset value (NAV) and price–earnings ratio (P/E) for the eight securitized real estate markets over the full period. As can be seen, the range of MV is between US$159.6 million (Malaysia) and US$1521.3 million (Hong Kong). In addition, Hong Kong real estate firms also top the NAV criterion with an average of US$1629.4 (in thousands) over the 9-year period. Finally, real estate firms in Malaysia and Indonesia report the highest and lowest average P/E ratings of 161.11 and 11.17 respectively over the study period.

Behavior of Net Asset Value Discounts/Premiums (NAVDISCs)

Table 3 reports on the average quarterly performance of the NAVDISCs and price–NAV (P/NAV) ratios for the eight markets. Figure 1 displays the time series changes of the two variables over 1995–2003. NAVDISC is defined as NAV per share less share price, expressed as a percentage of NAV per share. Hence NAVDISC can be positive (discount) or negative (premium).

Whilst the average quarterly performance of the Hong Kong securitized real estate market trades at a 32.1% NAV "discount" over the last nine years (36 quarters), the remaining seven markets report a quarterly NAV "premium" of between 2.2% (Singapore) and 970.8% (Thailand) over the same period. Further analyses reveal that the high average NAVDISC values for Thailand, Indonesia and (to a lesser extent) Philippines should be viewed with caution as some real estate companies in these markets have reported excessive stock market volatility during and after the Asian financial crisis. There are considerable variations over time and across companies in the NAVDISC performance. Except for three markets (Australia, Japan, and Thailand) whose real estate stocks trade consistently at a "premium" to their underlying NAVs, real estate stocks in Singapore, Philippines and Hong Kong are struck by a NAV "discount" in 23, 24 and 35 quarters respectively. In term of NAVDISC volatility as measured by its standard deviation, Thailand is the most volatile market and is followed by Indonesia, Malaysia and Philippines; with Singapore and Hong Kong have the least fluctuations in their NAVDISC performance. The corresponding P/NAV ratios are also reported in the same Table. Additionally, Table 4 reveals about 52.6% of the real estate firms trade mostly or consistently at a NAV "discount", another 30.6% of the real estate firms trade mostly or consistently at a NAV "premium", with the remaining 18.2% of the firms' shares fluctuate between both a "premium" as well as a "discount" to their NAVs. Our results are closely in agreement with the literature on closed-end fund prices that fluctuate considerably from NAV. The real estate stock premiums or discounts might represent a form of investor sentiment for Asian securitized real estate especially during the Asian financial crisis period where the various stock markets have experienced structural changes in their risk–return tradeoff. However, as in the case of closed-end funds or REITs, there are many potential reasons for real estate stock premiums or discounts; or why discounts should move to premiums or vice versa. Moreover it is much more difficult to account for the time variations in discounts and premiums.[9]

[9] For examples, Lee et al. (1991) claim that discounts on closed-end funds reflect (individual) investor sentiment. Clayton and MacKinnon (2003) argue that the average premiums or discounts represent a form of investor sentiments for REITs. Barkham and Ward (1999) find some support for UK property company discounts result from the interaction of noise traders and rational investors. Finally, it is beyond the scope of this research to explore the possible reasons as to why an average discount/premium was found for the individual markets.

Table 2 MV, NAV and P/E of Asian-Pacific real estate companies: 1995–2003

Number of real estate firms		Australia 14	Hong Kong 36	Indonesia 7	Japan 108	Malaysia 36	Philippines 20	Singapore 16	Thailand 11
MV	Mean	1,906.354	11,810.306	3,287,894.857	154,510.837	476.694	10,262.914	1,226.791	5,152.941
		(1,177.399)	(1,521.273)	(773.8069)	(1,374.283)	(159.642)	(320.585)	(784.320)	(168.049)
	Min	18.546	127.6	40,554	1,880	109.94	117.33	88.787	638.25
		(12.196)	(16.446)	(10.66)	(17.179)	(36.917)	(3.743)	(56.699)	(20.322)
	Max	6,614.2	147,030	11,425,000	2,791,800	1,404.9	99,488	6,334.6	29,783
		(4,248.1)	(18,924)	(2,448)	(24,289)	(508.44)	(3,003.3)	(4,043.9)	(954.44)
NAV	Mean	1,407.878	12,653.385	1,353,155.571	92,793.306	452.739	6,807.862	1,373.381	3,700.561
		(876.192)	(1,629.420)	(268.559)	(816.716)	(135.316)	(178.650)	(855.394)	(112.403)
	Min	31.26	221.93	44,499	1,928.3	31.105	271.82	100.72	655.68
		(20.303)	(28.594)	(8.930)	(17.073)	(10.069)	(6.256)	(62.149)	(17.303)
	Max	4,619.6	122,350	3,009,900	1,246,900	1,246.4	41,172	4,826.1	13,222
		(2,878)	(15,741)	(631.690)	(10,888)	(369.110)	(1,046.900)	(2,964)	(386.170)
P/E	Mean	19.99	18.81	11.17	88.52	161.14	32.50	36.02	38.01
	Min	13.28	3.82	5.81	4.87	2.10	7.57	7.74	9.71
	Max	45.01	85.9	20.71	826.52	4,793.21	205.24	140.96	147.53

Numbers in brackets are in U.S. currency, and those above are shown in local currency

MV is measured in million and NAV is measured in thousand

Compiled from Datastream

MV Average market capitalization, *NAV* net asset value, *P/E* price–earnings ratio

Table 3 Average quarterly performance of net asset value discounts/premiums and price-NAV ratios of Asian-Pacific real estate companies: 1995Q1 to 2003Q4

	Net asset value discounts/premiums (%)[a]		No. of quarters with NAV premium [%]	No. of quarters with NAV discount [%]	Price-NAV ratio
	Mean	Standard deviation			
AUS	−99.43	56.13	36 [100]	0 [0]	1.994
HK	32.10	17.28	1 [3]	35 [97]	0.679
IND	−632.02	579.27	34 [94]	2 [6]	7.320
JP	−54.36	43.70	36 [100]	0 [0]	1.544
MAL	−121.85	189.17	23 [64]	13 [36]	2.219
PHI	−41.76	132.59	12 [33]	24 [67]	1.418
SIN	−2.24	44.49	13 [36]	23 [64]	1.022
THAI	−970.79	720.54	36 [100]	0 [0]	10.708

[a] Net asset value discount/premium=(NAV−price) / NAV

− Premium, + discount

Research Methodology

To establish whether a long-run contemporaneous relation exists between real estate companies' P and NAV, we appeal to the concept of cointegration. Specifically, if there is an equilibrium relation exists between P and NAV, then these values should not drift two far apart, and their difference, or the disequilibrium error, should fluctuate around their mean values. This long-term relation is essentially the NAVDISC and the measurement of this relationship is referred to as cointegration. Moreover, the existence of cointegration allows the development of an error-correlation model that describes the systematic disequilibrium adjustment process in the short run. However, instead of examining the relation between P and NAV for individual real estate firms which has only 36 time series observations, panel cointegration test is run for all firms in each market separately (i.e., 8 "market" panels) as well as for all firms in one (Asian-Pacific) panel. This panel approach provides more powerful tests and estimates and permits us to increase the information available coming from the cross section of real estate firms. This is because the panel cointegration approach permits information embedded in the individual error terms from all panel members to be aggregated and tested as compared to the traditional cointegration approach where error terms for each member are tested one at a time. Furthermore, the use of panel unit root tests is particularly useful in analyzing industry-level and cross-market data (Levin et al., 2002).

The cointegration analysis of panel data consists of three steps: First, with pooled data, we test for a panel unit root rather than performing the conventional unit root tests. The test statistics proposed by Levin et al. (2002) and Im, Perasan, & Shin, (1997) are employed to test the null hypothesis of a panel unit root in the data. Second, we test for cointegration in panel data employing Pedroni's heterogeneous panel cointegration statistics (1995, 1999). Finally, dynamic ECM panel data models are estimated for short-run coefficients and the adjustments to long-run relationship

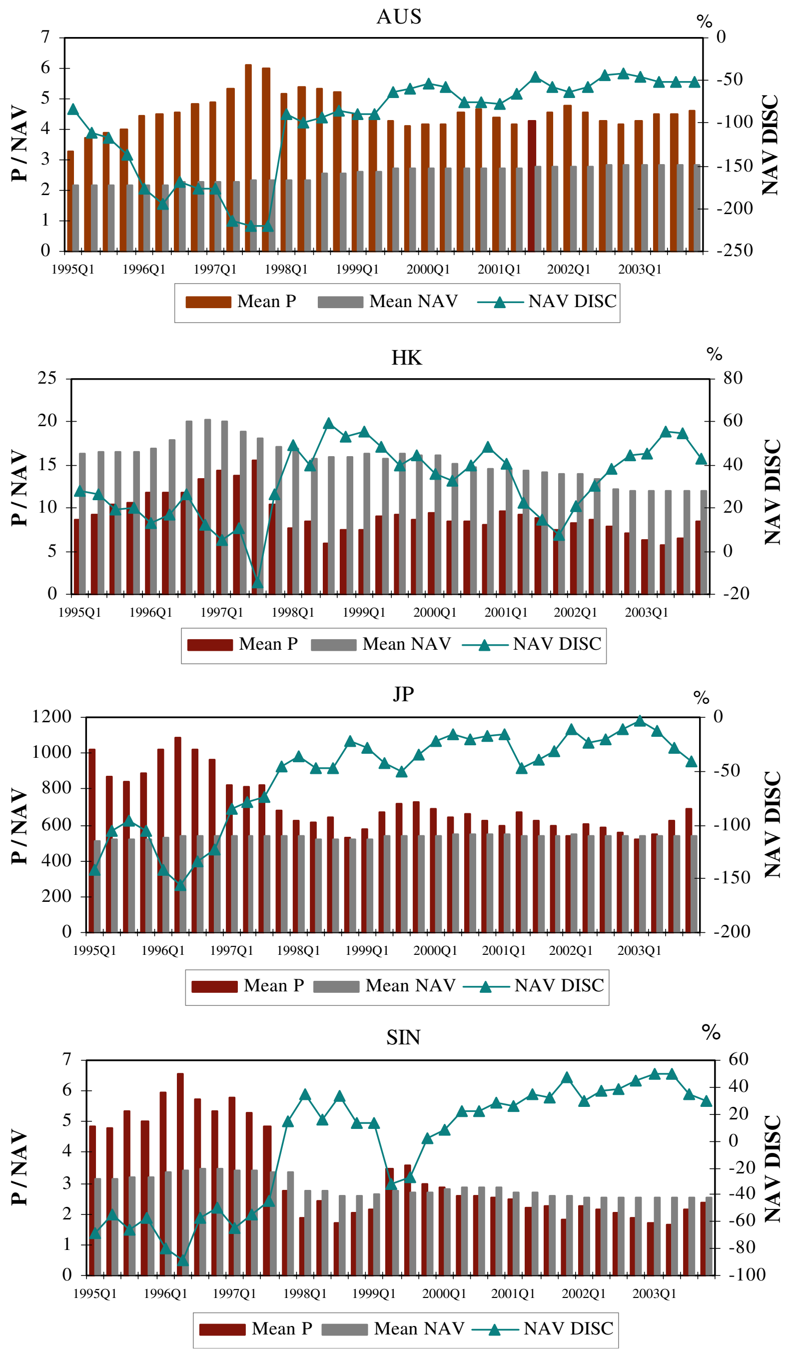

Fig. 1 Average NAVDISC, P and NAV performance. *NAVDISC* net asset value discount, *P* stock price

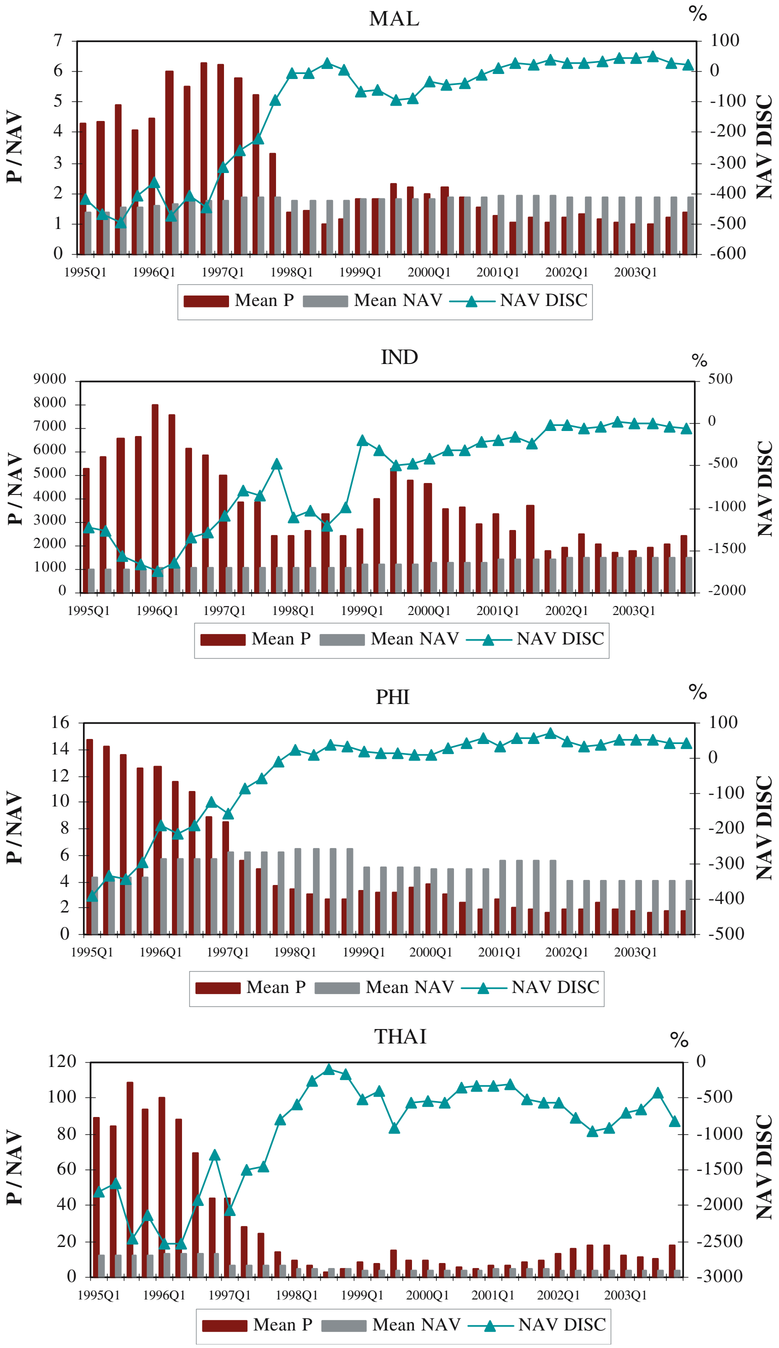

Fig. 1 (Continued)

Table 4 Analysis of quarterly NAV discount/premium of Asian-Pacific real estate companies: 1995Q1 to 2003Q4

	Number of real estate companies							
	AUS	HK	IND	JP	MAL	PHI	SIN	THAI
Consistently at NAV discount	1	19	0	2	0	1	4	0
Consistently at NAV premium	5	0	1	18	0	1	1	5
Mostly at NAV premium	4	3	4	20	9	1	1	3
Mostly at NAV discount	0	12	2	40	20	15	9	2
Fluctuating between NAV discount and premium	4	2	0	28	7	2	1	1

by jointly employing the Pooled Mean Group (PMG) (Pesaran et al., 1999) and Mean Group (MG) estimators (Pesaran & Smith, 1995). The readers are referred to the cited papers for further details and discussions of the various panel procedures. Here we only provide a brief review as follows.

The Panel Unit Root Tests

To provide consistent and convincing evidence, panel unit root test methods developed by Levin et al. (2002)[10] and Im et al. (1997) are applied to test the stationary property of P and NAV time series for a unit root for all real estate firms pooled in the respective "market" panels.

Levin-Lin-Chu Panel Unit Root Test

For a sample of N companies observed over T periods, the LLC panel based unit root test is a pooled ADF test represented by Eq. 2

$$\Delta y_{it} = \beta_i + \theta_t + \delta_i y_{i,t-1} + \alpha_{i,j}\sum_{j=1}^{p_i} \Delta y_{i,t-j} + \varepsilon_{it} \tag{2}$$

$$i = 1, 2, .., N;\ t = 1, 2, ..., T$$

where the two-way fixed effects (β_i and θ_t) are allowed. β_i is the individual-specific intercept and θ_t is the time trends to allow for the effect of common time-specific components shared across individual firms in the panel. The LLC panel-based unit procedures test the null hypothesis that each individual series is $I(1)$, or $H_0 : \delta_i$=0 for all i, versus the alternative that all the series considered as a panel are stationary, or $H_1 : \delta_i = \delta < 0$. It assumes that the individual processes are cross-sectionally independent. Given this assumption, the pooled OLS estimate of δ will have a standard normal distribution under the null hypothesis.

[10] It is a revised version of the earlier work of Levin and Lin (1993).

Im-Pesaran-Shin Panel Unit Root Test

The IPS unit root test is based on the average of ADF statistics across the panel. Given Eq. 2, the IPS evaluates the null hypothesis that all series in the panel are non-stationary process:

$$H_0 : \delta_i = 0 \text{ for all } i$$

against the alternative hypothesis that some of the series are stationary:

$$H_1 : \delta_i < 0,\ i = 1, ..., N_1;\ \delta_i = 0,\ i = N_1 + 1,\ N_1 + 2, ..., N.$$

The null hypothesis is tested with a *t*-bar statistic, which is constructed from the average ADF t-statistics. The group-mean *t*-bar statistic is computed as:

$$\bar{t}_{N,T} = N^{-1} \sum_{i=1}^{N} t_{i,T}(p_i) \tag{3}$$

where $t_{i,T}(p_i)$ is the individual t statistic for firm i with different lag length p_i.

Panel Cointegration Test

We use cointegration tests for a panel of real estate firms in individual markets instead of a time series approach. This method provides more powerful test estimates and allows us to increase the information available coming from the cross sections. Specifically, we appeal to the concept of panel cointegration proposed by Pedroni (1995) whereby each real estate firm is regarded as a member in a N×T panels, where T is the total number of quarters and N is the total number of real estate stocks in each "market" panel. Additionally, the tests proposed in Pedroni (1999) allow for the heterogeneity among individual members of the panel, including heterogeneity in both the long-run cointegrating vectors and varying dynamics. In its most general form, the hypothesized cointegrating regression is:

$$Y_{i,t} = \alpha_i + \theta_i t + \gamma_t + \beta_{1i} X_{1i,t} + \beta_{2i} X_{2i,t} + ... + \beta_{mi} X_{mi,t} + \varepsilon_{i,t} \tag{4}$$

$$\text{for } t = 1, ..., T; \quad i = 1, ..., N; \quad m = 1, ..., M$$

where T refers to the number of observations over time, N refers to the number of individual members in the panel, and M refers to the number of independent variables. α_i is the member-specific intercept, or fixed effects parameter, which is permitted to change across individual members. The deterministic time trends are captured by the term $\theta_i t$, though it may be omitted depending on the specific applications considered. The parameter γ_t allows for the possibility of common effects that are shared across individual members of the panel in any given period, which is comparable to the inclusion of time dummies. The main feature is that the slope coefficients β_{1I}, β_{2I},...β_{mi} are allowed to vary among individual members.

Pedroni (1999) constructs seven statistics to test the null hypothesis of no cointegration. Of the seven tests, four are based on pooling along the *within-dimension*, and the remaining three are based on pooling along the *between-dimension*. The *within-dimension* statistics (also referred to as *panel cointegration* *statistics*) pool the autoregressive coefficients across different members for the unit root tests on the estimated residuals while the *between-dimension* statistics (also called *group mean panel cointegration statistics*) are based on estimators that simply average the individually estimated coefficients for each member N.

Table 5 presents the seven statistics. Both the *within-* and *between-dimensions* present the panel version of the Phillips and Perron *rho* and *t*-statistics, as well as an ADF *t* test. The seventh test is a non-parametric *variance ratio* test only available in the panel cointegration statistics. Following an appropriate standardization, the statistics converge asymptotically to normal distributions with zero means but scaled variances that depend on the large sample properties of the test statistics (Pedroni, 1995). Furthermore, under the alternative hypothesis, the panel *variance ratio* converges to positive infinity and hence the right tail of the normal distribution is used to reject the null hypothesis of no panel cointegration within the data set. On the contrary, the other six test statistics rely on the left tail (large negative values) of the normal distribution to reject the null hypothesis of no panel cointegration within the sample.

Table 5 Pedroni's (1995) panel cointegration statistics

1. Panel variance ratio statistic	$Z_{\hat{v}_{N,T}} = T^2 N^{3/2}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1}$
2. Panel PP rho statistics	$Z_{\widetilde{\rho}_{N,T-1}} = T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{i=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{\varepsilon}_{i,t-1}\ddot{\mathrm{A}}\hat{\varepsilon}_{i,t} - \hat{\hat{\varepsilon}}_{i}\right)$
3. Panel PP t statistics	$Z_{t_{N,T}} = \left(\widetilde{\sigma}_{N,T}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{i=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{\varepsilon}_{i,t-1}\ddot{\mathrm{A}}\hat{\varepsilon}_{i,t} - \hat{\hat{\varepsilon}}_{i}\right)$
4. Panel ADF t statistics	$Z_{t_{N,T}}^{*} = \left(\widetilde{s}_{N,T}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{*2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{i=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{\varepsilon}_{i,t-1}^{*}\ddot{\mathrm{A}}\hat{\varepsilon}_{i,t}^{*}\right)$
5. Group PP rho statistics	$\widetilde{Z}_{\widetilde{\rho}_{N,T-1}} = TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1}\sum_{t=1}^{T}\left(\hat{\varepsilon}_{i,t-1}\ddot{\mathrm{A}}\hat{\varepsilon}_{i,t} - \hat{\hat{\varepsilon}}_{i}\right)$
6. Group PP t statistics	$\widetilde{Z}_{t_{N,T}} = N^{-1/2}\sum_{i=1}^{N}\left(\hat{\sigma}_{i}^{2}\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{\varepsilon}_{i,t-1}\ddot{\mathrm{A}}\hat{\varepsilon}_{i,t} - \hat{\hat{\varepsilon}}_{i}\right)$
7. Group ADF *t* statistics	$\widetilde{Z}_{t_{N,T}}^{*} = N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{s}_{i}^{*2}\hat{\varepsilon}_{i,t-1}^{*2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{\varepsilon}_{i,t-1}^{*}\ddot{\mathrm{A}}\hat{\varepsilon}_{i,t}^{*}\right)$

where $\hat{\hat{\varepsilon}}_i = \frac{1}{T}\sum_{s=1}^{k_i}\left(1-\frac{s}{k_i+1}\right)\sum_{t=s+1}^{T}\hat{\mu}_{i,t}\hat{\mu}_{i,t-s}\ \hat{s}_i^2 = \frac{1}{T}\sum_{t=1}^{T}\hat{\mu}_{i,t}^2,\quad \hat{s}_i^2 = \frac{1}{T}\sum_{t=1}^{T}\hat{\mu}_{i,t}^2,\quad \hat{\sigma}_i^2 = \hat{s}_i^2 + 2\hat{\hat{\varepsilon}}_i$

$$\widetilde{\sigma}_{N,T}^{2} = \frac{1}{N}\sum_{i=1}^{N}\hat{L}_{11i}^{-2}\hat{\sigma}_i^2,\qquad \hat{s}_i^{*2} = \frac{1}{T}\sum_{t=1}^{T}\hat{\mu}_{i,t}^{*2},\qquad \widetilde{s}_{N,T}^{*2} = \frac{1}{N}\sum_{i=1}^{N}\hat{s}_i^{*2}$$

$$\hat{L}_{11i}^{2} = \frac{1}{T}\sum_{t=1}^{T}\hat{c}_{i,t} + \frac{2}{T}\sum_{s=1}^{k_i}\left(1-\frac{s}{k_i+1}\right)\sum_{t=s+1}^{T}\hat{c}_{i,t}\hat{c}_{i,t-s}$$

and where the residuals $\hat{\mu}_{i,t}, \hat{\mu}_{i,t}^{*}$, and $\hat{c}_{i,t}$ are obtained from the following regressions:(4.13)

$$\hat{\varepsilon}_{i,t} = \hat{\varphi}_i\hat{\varepsilon}_{i,t-1} + \hat{\mu}_{i,t}\quad \hat{\varepsilon}_{i,t} = \hat{\varphi}_i\hat{\varepsilon}_{i,t-1} + \sum_{k=1}^{K_i}\hat{\varphi}_{i,k}\ddot{\mathrm{A}}\hat{\varepsilon}_{i,t-k} + \hat{\mu}_{i,t}^{*}\quad \ddot{\mathrm{A}}y_{i,t} = \sum_{m=1}^{M}\hat{b}_{mi}\ddot{\mathrm{A}}x_{mi,t} + \hat{c}_{i,t} \tag{4.13}$$

$$\hat{\chi} = \left(\chi_{N,T} - \mu\sqrt{N}\right)/\sqrt{v} \Rightarrow N(0,1)$$

where $\chi_{N,T}$ is the appropriately standardized (with respect to the dimensions N and T) form for each of the panel/group statistics, and μ and v are the expected mean and variance of the corresponding statistics

Dynamic Panel ECM Model

The existence of panel cointegration between P and NAV further allows the development of a panel ECM model (ECM) that describes the systematic disequilibrium adjustment process in the short run. Following the autoregressive distributed lag (ARDL) estimation procedure of Pesaran et al. (1999), we specify a dynamic panel data model in error correction form as shown in Eq. 5

$$\Delta P_{i,t} = \mu_i + QS + \psi_i\left(P_{i,t-1} - \alpha_i - \beta_i \text{NAV}_{i,t-1}\right) + \sum_{j=1}^{p-1} \delta_{1i,j}\Delta P_{i,t-j} + \sum_{j=0}^{q-1} \delta_{2i,t}\Delta \text{NAV}_{i,t-j} + \varepsilon_{i,t} \tag{5}$$

$$\text{for } t = 1, 2, .., T; \quad i = 1, 2, .., N$$

where μ_i represents the fixed effect; β_i represents the long-run relation between P and NAV, ψ_i denotes the adjustment speed to the long run equilibrium; $\delta=(\delta_1, \delta_2)'$ is the vector of the short-run coefficients and $QS = qs1{\sim}qs2{\sim}qs3$ are three quarterly seasonal dummies. The appropriate lag lengths p and q are determined using the Schwarz Bayesian Criterion (SBC).

We use the pooled mean group (PMG) estimator proposed by Pesaran et al. (1999) and the mean group (MG) estimator (Pesaran & Smith, 1995) to determine the long-run effects and the speed of adjustment to the long run of NAVISC in the dynamic panel data model. The PMG estimator involves both pooling and averaging. It allows the intercepts, short-run coefficients and error variances to differ freely across groups, but constrains the long-run coefficients to be the same. On the contrary, the mean of the estimates (MG estimator) allows researchers to estimate separate equations for each group and examine the distribution of the estimated coefficients across groups and produce consistent estimates of the average of the parameters (Pesaran & Smith, 1995). In addition, the effect of heterogeneity on the means of the coefficients can be determined by a Hausman-type test applied to the difference between the MG and the PMG estimators (Pesaran et al., 1999). The Hausman test statistic (h) is given by

$$h = \left(\hat{\theta}_{\text{MG}} - \hat{\theta}_{\text{PMG}}\right)' \left(\hat{V}\left(\hat{\theta}_{\text{MG}}\right) - \hat{V}\left(\hat{\theta}_{\text{PMG}}\right)\right)^{-1} \left(\hat{\theta}_{\text{MG}} - \hat{\theta}_{\text{PMG}}\right) \tag{6}$$

where $\hat{V}\left(\hat{\theta}_{\text{MG}}\right)$ and $\hat{V}\left(\hat{\theta}_{\text{PMG}}\right)$ are consistent estimators of the variances of the MG and PMG. Under the slope homogeneity hypothesis, the Hausman statistic is asymptotically distributed as a χ^2 variate with k degrees of freedom which is equal to the dimension of θ (coefficients of the long-run relationship). However there is no guarantee that $\hat{V}\left(\hat{\theta}_{\text{PMG}}\right) - \hat{V}\left(\hat{\theta}_{\text{PMG}}\right)$ will be positive definite, and in some case the test may not be applicable.

Results

Results of the panel unit root test, panel cointegration test and dynamic ECM modeling are reported in Tables 6, 7, 8 and 9, with Part A of the respective tables

Table 6 Results of panel unit root tests

	N	LLC ADF *t* statistic				IPS ADF *t*-bar statistic			
		P	NAV	ΔP	ΔNAV	P	NAV	ΔP	ΔNAV
Part A. Individual Asian-Pacific markets									
AUS	14	0.45	0.98	−11.50[a]	−8.56[a]	−1.01	1.08	−11.22[a]	−10.15[a]
HK	36	0.34	2.34	−20.22[a]	−24.75[a]	−1.15	1.10	−23.49[a]	−29.96[a]
IND	7	−1.09	0.61	−10.53[a]	−9.71[a]	−1.25	0.28	−14.74[a]	−12.70[a]
JP	108	0.60	4.18	−33.35[a]	−34.82[a]	−1.23	3.42	−42.16[a]	−42.91[a]
MAL	36	0.86	0.32	−23.75[a]	−19.25[a]	−1.09	−0.64	−28.33[a]	−22.08[a]
PHI	20	0.42	1.97	−16.67[a]	−13.57[a]	−0.57	1.61	−20.48[a]	−15.99[a]
SIN	16	0.47	1.40	−12.24[a]	−11.77[a]	−1.19	0.34	−13.89[a]	−13.66[a]
THAI	11	−0.38	0.02	−10.97[a]	−10.53[a]	−1.15	−0.51	−12.50[a]	−13.40[a]
Part B. Asian-Pacific market as a whole (regional)									
Overall	248	3.00	1.85	−38.03[a]	−43.73[a]	1.80	−1.26	−46.04[a]	−51.91[a]

The null hypothesis is there is unit root in the panel data

The critical values for the 10, 5 and 1% level are −1.29, −1.65 and −2.33 respectively

N Number of listed real estate companies pooled for each panel, *LLC ADF t statistic* adjusted *t* statistic which follows a standard normal distribution, *IPS-ADF t-bar statistic* standardized group mean *t*-bar statistic which follows a standard normal distribution

[a] Two-tailed significance at the 1% level

contains the results for the individual markets and Part B contains the equivalents for the regional Asian-Pacific real estate market (whole panel).

Cointegration Tests for Individual Markets

All price and NAV data series are transformed by taking the log so that the difference in the log of the variables can be interpreted as the relative price or NAV changes. Part A of Table 6 presents the LLC and IPS panel unit root statistics for the eight panels. The optimal lag is ascertained by searching from a maximum lag of six (quarterly data). Our evidence indicates that the null hypothesis of panel unit roots, i.e., $H_0 : \delta_i{=}0$ (for all i), is not rejected at the 1% level for all P and NAV series based on the LLC and IPS test statistics. On the contrary, the first difference in all P and NAV series are stationary at the 1% significance. We thus conclude that both P and NAV series have a panel unit root each for all real estate firms in the respective markets.

We proceed to test for panel cointegration in the eight heterogeneous panels. As indicated in Part A of Table 7, all seven test statistics are statistically significant at the 1% level for Australia, Hong Kong, Japan and Malaysia (except for Group *Rho* of Japan which is significant at the 10% level). The within- and between-dimension ADF *rho*, PP *t* and DF *t* are well to the left and the variance ratio is to the right. The results for Indonesia, Thailand and Singapore are weaker. For Indonesia and Thailand, their two ADF *t* statistics are statistically insignificant. Additionally, the variance ratio for the Singapore panel is small and is statistically insignificant at any conventional probability levels. In the case of Philippines, none of the seven tests is able to reject the null hypothesis of no panel cointegration. In a nutshell, our panel study favors cointegration. Except for Philippines, an equilibrium relation exists between real estate company stock prices (P) and their net asset value (P) in other

Table 7 Panel cointegration test between P and NAV

	N	Panel statistics				Group statistics		
		V	PP *rho*	PP *t*	ADF *t*	PP *rho*	PP *t*	ADF *t*
Part A. Individual Asian-Pacific markets								
AUS	14	2.62[a]	−3.52[a]	−3.32[a]	−3.40[a]	−2.48[a]	−3.16[a]	−3.38[a]
HK	36	4.18[a]	−4.54[a]	−4.13[a]	−2.38[a]	−2.39[a]	−3.35[a]	−2.44[a]
IND	7	1.67[b]	−2.25[a]	−2.30[a]	−1.18	−1.74[b]	−2.37[a]	−0.91
JP	108	2.74[a]	−3.65[a]	−4.74[a]	−3.47[a]	−1.58[c]	−4.17[a]	−4.25[a]
MAL	36	2.42[a]	−4.17[a]	−4.66[a]	−4.06[a]	−4.18[a]	−5.60[a]	−5.21[a]
PHI	20	−0.40	−0.23	−1.00	−0.44	0.87	−0.49	0.17
SIN	16	1.04	−2.03[b]	−2.38[a]	−0.68	−1.32[c]	−2.52[a]	−0.77
THAI	11	2.57[a]	−2.06[b]	−1.61[c]	−0.61	−1.78[b]	−1.41[c]	−1.03
Part B. Asian-Pacific market as a whole (regional)								
Overall	248	3.52[a]	−5.10[a]	−10.09[a]	−10.74[a]	−0.24	−9.28[a]	−13.20[a]

The null hypothesis is that there is no panel cointegration between P and NAV for the respective panels

For the panel variance ratio, the critical values for the 10, 5 and 1% levels are 1.29, 1.65 and 2.33; for the other six statistics, the critical values are −1.29, −1.65 and −2.33 for the 10, 5 and 1% levels respectively

N Number of listed real estate companies pooled for each panel, *V* non-parametric variance ratio statistic, *PP* Phillips and Perron, *rho* non-parametric PP rho statistic, *PP t* non-parametric PP t statistic, *ADF t* parametric ADF *t* statistic

[a] Panel cointegration test statistic rejects the null of non-cointegration at the 1% significance level

[b] Panel cointegration test statistic rejects the null of non-cointegration at the 5% significance level

[c] Panel cointegration test statistic rejects the null of non-cointegration at the 10% significance level

seven Asian-Pacific securitized real estate markets. Consequently for each market, there is a "long-run" NAVDISC of different magnitudes. Moreover, this NAVDISC exhibits mean reversion that can be described by the systematic disequilibrium adjustment process in the short run.

The MG and PMG results of the seven dynamic panel ECM models (Philippines is excluded as no evidence of panel cointegration is found) are presented in Part A of Tables 8 and 9. Specifically, the unrestricted MG estimators and restricted PMG estimators of the long-run coefficient β_i, the short-term adjustment value ψ_i as well as the short-run coefficients are, respectively, reported. In addition, the Hausman test and Likelihood Ratio test results are also estimated to compare the difference between the MG and PMG estimators.

Although there are some disparities in the magnitude of the long-run and short term coefficients across different markets, there are four key findings. First, the MG and PMG estimates of long-run coefficients are both positive and statistically significant at least at the 10% level for Hong Kong, Indonesia, Japan, Malaysia, Singapore and Thailand. The range of the long-term estimates is between 0.258 and 0.688 (MG estimates) and between 0.323 and 1.088 (PMG estimates) respectively. The only exception is Australia where only its PMG estimate of the long-term coefficient is statistically significant at the 10 per cent significance level. Second, all the error-correction terms (ψ_i) are significantly negative at least at the 10 per cent level. The range is between −0.384 and −0.665 (MG estimates) and between −0.341

and −0.660 (PMG estimates). The estimated coefficients thus imply that approximately between 34 and 66% of the previous discrepancy between the actual and desired (long-run) NAVDISC is corrected in each quarter in the securitized real estate markets. As the capital markets are forward looking and incorporate not only current information but expectation in prices; whilst the private real estate market is to some degree backward looking due to the use of comparable evidence in valuations. This issue is important since even with contemporaneous measurement of prices and NAVs, the two variables are effectively measuring different time periods and hence account for any short-term divergence. Third, change in NAV, except for Malaysia and Thailand, is a significant factor in influencing positively real estate company stock returns. On the contrary, short-run changes in lagged NAV have no or little effects on real estate stock returns. Finally, imposing long-run homogeneity reduces the standard errors of the long-run coefficients, but does not change the estimates very much. This is confirmed by the Hausman test statistics (which is χ^2 (1) under the null hypothesis of no difference between the MG and PMG estimators) of between 0.03 and 0.48 for six markets (Hong Kong, Indonesia, Japan, Malaysia, Singapore and Thailand). Additional support is given by the likelihood ratio test results that, except for Thailand, reject the restriction on homogeneity of long-run coefficients at conventional significance levels.

In summary, the hypothesis of no panel cointegration between real estate company stock prices and their NAV is rejected except for Philippines and to a lesser extent, Australia and Thailand. Moreover, the MG and PMG tests for the existence of a long-run relation and short-term dynamic adjustment confirm that for the individual Asian-Pacific real estate markets, there is a "long-run" NAVDISC of different magnitudes and that the speeds of returning to equilibrium (i.e., mean reversion) are also different. [11,12] We proceed next to test for an Asian-Pacific panel cointegration model that includes all 248 real estate companies for the eight markets.

Overall Panel Cointegration Model

This section summarizes the estimation outcome of including all 248 Asian-Pacific real estate companies as one panel. As can be seen from Part B of Table 6, both LLC and IPS test statistics confirm that the P and NAV series have a panel unit root each at the 1 per cent significance level. The panel cointegration results reported in Part B of Table 7 show that, except for the group PP *rho*, the remaining four panel test statistics (the variance ratio, PP *rho*, PP *t* and ADF *t*) and two group test statistics (PP *t* and ADF *t*) are all statistically significant at the 1% level. Hence, real estate company stock prices are cointegrated with their NAVs and this implies that there is an average "long-run" NAVDISC for the aggregate Asian-Pacific real estate market and that the NAVDISC displays mean reversion. Finally, the MG and PMG estimates of the long-run coefficient (β), speed of error correction (ψ) and other short-run coefficients appear in Tables 8 and 9. The β estimates suggest an average

[11] We also run the tests for all individual real estate companies (results not presented here). Overall, we find that about 25 to 50% of real estate firms in each market have significant long-run and short-term coefficients of NAVDISC at the 10% significance level.

[12] All seven panel models pass four diagnostic tests x^2_{SC} (test of serial correlation), x^2_{FF} (test of correct function form), x^2_{NO} (test of normality) and x^2_{HE} (test for heteroscedasticity).

long_run net asset value "premium" (i.e., NAVDISC is negative) of up to 22%. Also, both MG and PMG estimates of the error-correction term (ψ) are significant at the 5 per cent level. As expected, the signs on the two error correction terms are negative, indicating a reversion back to the long-term relation given a temporary disequilibrium. The estimated ψ values imply that about 31% (average of MG and PMG values) of the disequilibrium error in NAVDISC is corrected in each quarter.

Summary

In all, the statistical significance of the panel cointegration models (seven individual and one overall) suggest that in Asian-Pacific securitized real estate markets, NAVDISCs persist in the individual markets and that they also change over time. Moreover, the respective NAVDISCs exhibit mean reversion since P and NAV are cointegrated. Hence they should not drift too far apart and the disequilibrium errors should fluctuate around the respective mean values. The existence of panel cointegration between P and NAV further implies that changes in NAVs are transmitted to the variations in Ps in the short-term and would be further adjusted by an ECM to the equilibrium level. From this panel cointegration study, it thus appears that Asian-Pacific real estate stock prices are rational with respect to their net asset values in that prices converge back to the fundamental values of their real estate assets in the long run. Our results also indicate that NAV is an important factor that statistically explains the stock price variations for many Asian-Pacific real estate markets regardless of their mean-reverting behavior in NAVDISC. At stock selection level, the results also imply that it is possible to explain the price changes of real estate company stocks by observing changes in their real estate asset and portfolio values proxied by NAVs.

Conclusion

This study provides the first panel investigation of the time series behavior of real estate company NAVDISC in eight Asian-Pacific real estate markets from 1995 to 2003. We postulate that if there is a stable NAVDISC in the long-run, then there should be a long-run cointegrating relation between P and NAV. Since the quarterly P and NAV time series data are limited to 36 observations but are available across a cross section of real estate firms, we appeal to panel data cointegration econometrics that comprises three approaches, i.e., panel unit root test, heterogeneous panel cointegration test and dynamic panel ECM to investigate the long-run equilibrium as well as short-term term dynamics of NAVDISC of real estate firms for all individual markets as well as for the Asian-Pacific securitized real estate market as a whole. As more and more Asian economies are interested in developing REIT type of securitized real estate products, our study reinforces the increased potential importance of Asian-Pacific securitized real estate in an investment portfolios for both local and international investors.

We find that real estate company stock prices deviate from their NAV. All the P and NAV series meet the panel data stationarity requirement necessary for use of panel cointegration and panel ECM procedures. The panel cointegration test has, except for Philippines and (to a lesser extent) Australia, accepted a long-term stable (linear) relation between P and NAV in other Asian-Pacific markets. Further panel

Table 8 Dynamic ECM Panel Data Model (with MG and PMG Estimates): Individual Asian-Pacific Markets

Estimators	Parameters	AUS	HK	IND	JP	PHI[a]	MAL	SIN	THAI
MG	Long-run coefficient β_I	0.404 (1.25)	0.585[a] (1.96)	0.258[a] (1.80)	0.665[b] (2.67)	1.152[c] (3.39)	0.350[b] (2.57)	0.688[b] (2.09)	0.275[a] (2.02)
	Error correction ψ_I	−0.538[c] (−7.07)	−0.569[c] (−12.10)	−0.665[c] (−5.82)	−0.384[c] (−22.99)	−0.376[c] (−6.38)	−0.481[c] (−11.93)	−0.484[c] (−11.68)	−0.466[c] (−8.38)
	Short-run coefficients								
	dUP (−1)	0.038 (1.52)	0.012 (0.77)		0.043[c] (3.56)	−0.018 (−0.81)	0.069[c] (2.89)	0.057[b] (2.29)	0.027 (1.00)
	dUP (−2)	0.019 (1.00)	−0.013 (−1.00)		0.013[a] (1.67)	0.014 (1.00)	−0.031[a] (−1.73)	0.010 (1.00)	
	DNAV	0.126[b] (2.24)	0.169[c] (2.51)		0.161[c] (5.65)	0.256 (1.44)	0.135 (1.55)	0.358[b] (2.45)	0.072 (1.24)
	dNAV (−1)		0.005 (1.00)		0.028 (1.56)	−0.131[b] (−2.18)	0.010 (0.32)	0.038 (1.30)	0.048 (1.00)
	dNAV (−2)				−0.017[b] (−2.18)	−0.109[a] (−1.75)	0.024 (1.42)		0.033 (1.00)
PMG	Long-run coefficient β_I	1.437[c] (18.99)	0.637[c] (19.72)	0.323[c] (4.73)	0.503[c] (27.60)	2.275[c] (15.76)	0.443[c] (18.49)	1.088[c] (9.30)	0.227[c] (3.46)
	Error correction ψ_I	−0.408[c] (−4.40)	−0.409[c] (−7.99)	−0.660[c] (−5.76)	−0.488[c] (−16.51)	−0.295[c] (−4.66)	−0.407[c] (−9.28)	−0.341[c] (−6.62)	−0.449[c] (−7.69)

Short-run coefficients								
dP(−1)	0.029[a] (1.66)	0.018[b] (2.33)		0.042[c] (3.54)	−0.015 (−0.71)	0.073[c] (2.89)	0.040 (1.42)	0.026 (1.00)
dP(−2)	0.005 (1.00)	−0.004 (1.00)		0.014[a] (1.78)	0.013 (1.00)	−0.029[a] (−1.74)	0.007 (1.00)	
DNAV	0.132[b] (2.22)	0.231[c] (2.52)		0.206[c] (5.56)	0.265[a] (1.65)	0.097[a] (1.84)	0.374[b] (2.36)	0.068 (1.21)
dNAV (−1)		0.005 (1.00)		0.035[b] (2.06)	−0.110[b] (−2.29)	0.005 (0.17)	0.039 (1.30)	0.051 (1.00)
dNAV (−2)				−0.011[b] (−2.08)	−0.110[a] (−1.73)	0.023 (1.43)		0.039 (1.00)
Hausman test [p value]	10.84 [0.00]	0.03 [0.86]	0.27 [0.60]	0.42 [0.52]	13.32 [0.00]	0.48 [0.49]	1.70 [0.19]	0.16 [0.69]
LR test [p value]	86.072 [0.00]	378.760 [0.00]	11.019 [0.09]	705.300 [0.00]	69.403(0.00)	108.911 [0.00]	77.011 [0.00]	11.173 [0.34]
Number of real estate firms	14	36	7	108	20	36	16	11

The Philippines market is included in the estimation for completeness (see Table 7)

The figures in brackets of the PMG and MG estimators are t statistics

The t statistics of long-run and short-term coefficients follow standard normal distributions. The critical values for 10, 5, and 1% are −1.29, −1.65 and −2.33, respectively

LR Likelihood ratio

[a] Two-tailed significance at the 10% level

[b] Two-tailed significance at the 5% level

[c] Two-tailed significance at the 1% level

Table 9 Dynamic ECM Panel Data Model [with MG and PMG Estimates]: Asian-Pacific Market as a Whole (Regional)

	N	Parameters	MG	PMG
Overall	248	Long-run coefficient β_I	1.222[a] (5.64)	1.205[a] (50.48)
		Error correction ψ_I	−0.385[a] (−31.21)	−0.241[a] (−28.49)
		Short-run coefficients		
		dUP (−1)	0.111[a] (10.53)	0.089 [a] (10.15)
		dUP (−2)	−0.015[a] (−3.35)	−0.015[a] (−3.41)
		dNAV	1.230[a] (18.68)	1.437[a] (18.80)
		dNAV(−1)	0.051[a] (3.39)	0.043[a] (3.53)
		dNAV(−2)	−0.080[a] (−4.84)	−0.078[a] (−4.87)
		Hausman test [*p* value]	0.01 [0.94]	
		LR test [*p* value]	933.210 [0.00]	

The figures in brackets of the PMG and MG estimators are *t* statistics

The *t* statistics of long-run and short-term coefficients follow standard normal distributions. The critical values for 10, 5, and 1% are −1.29, −1.65 and −2.33, respectively

LR Likelihood ratio

[a] Two-tailed significance at the 1% level

cointegration evidence detected for the entire sample strongly suggests that P and NAV are generally cointegrated in the regional Asian-Pacific real estate market. Moreover, the panel dynamic ECM results are supportive of the error-correction formulation: the correction is highly significant, correctly signed and shows partial adjustment with the coefficients being less than unity. Additionally, short-run changes in NAVs are significant in capturing the dynamics of the changes in real estate company stock prices. Hence NAV is an important factor in real estate company valuation. The panel results reported in this study thus complement those of Barkham and Ward (1999), Sing et al. (2000) and Liow (2003) who detect linear or non-linear mean reversion relations in NAV performance divergence for UK and Singapore real estate companies.

Although the evidence does support that Asian-Pacific real estate company stock prices and their NAVs are cointegrated, an extension of the study to cover other fundamental values in influencing real estate company stock prices in a multivariate context is required to compare the strength of equilibrium relationship in the long term as well as the speed of adjustment in the short run. Institutional investors would then pay more attention to those stocks with stronger fundamental values. In addition to NAV, other proxies for corporate fundamental values include earnings, dividends and economic value added. Finally, similar panel cointegration studies can also be extended to European securitized real estate markets that have a more developed market structure and different risk–return profiles in order to compare and contrast the existence and dynamics of a "long-run" regional NAVDISC and its systematic disequilibrium adjustment process in the short run. This will definitely enrich the international real estate literature with respect to the valuation and pricing of securitized real estate vehicles in the global market.

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