Are Real Estate and Securities Markets Integrated? Some Australian Evidence

Patrick Wilson
John Okunev
Guy Ta

ISSN: 1036-7373
UNIVERSITY OF TECHNOLOGY, SYDNEY

SCHOOL OF FINANCE AND ECONOMICS

WORKING PAPERS SERIES

ARE REAL ESTATE AND SECURITIES MARKETS INTEGRATED? SOME AUSTRALIAN EVIDENCE

by

Patrick Wilson, John Okunev and Guy Ta

October, 1994
ARE REAL ESTATE AND SECURITIES MARKETS INTEGRATED? SOME AUSTRALIAN EVIDENCE

Introduction

The question of whether real estate and securities markets are integrated is an important one. Activity on both the real estate and stock markets form significant elements in business cycle fluctuations. A common approach has been to study the separate influences of each of these markets on business cycle activity. The study of price volatility on the stock market has a rich history with recent research tending to focus on (a) the use of single equation time series models in the identification of speculative bubbles [cf. Diba et.al. (1988a, 1988b), Cameron (1989), Dezhbakshs et.al. (1990), Evans (1991), Topol (1991)] as well as (b) tests of the mean reversion hypothesis and its use in predicting stock market volatility [cf. Poterba et.al. (1988), Conrad et.al. (1989), Cecchetti et.al. (1990), Randolph (1991), Engel et.al. (1991), Jegadeesh (1991), Kim et.al. (1991)].

Research on real estate price fluctuations is less extensive than stock market analysis. However, real estate price fluctuations of between 20 and 30 percent in Australia in the 80s (Oliver, 1993) along with similar fluctuations in the US in both the 70s and 80s [Green and Hendershott (1993), Case and Shiller, (1988)] and even greater volatility in some Asian property markets [Fu et. al. (1994)] has generated a flurry of research activity on the movement in, and determinants of, real house prices. There are a number of different strands to this research. One is the structural model approach in which equations purporting to represent supply and demand factors are estimated as part of a simultaneous equation system [Topel and Rosen (1988), DiPasquale and Wheaton (1990)]. In these models house price movements depend on the simultaneous multiple relationships defined by the system. Another approach is the reduced form single equation models. Here there is less concern with the structural relationships in the system and the models attempt to explain house price movements in terms of a combination of supply and demand factors. [Abraham and
Hendershott (1992), Peek and Wilcox (1991). A third approach seeks to examine the
degree of integration that may exist between the real estate and financial assets
markets. Such models attempt to explain price movements either in terms of
deviations from market fundamentals [Oliver (1993) or in terms of asset substitution
between real estate and financial markets [ Liu et. al. (1990), Ross and Zisler (1991),
Fu, Leung and Lo (1994) and Koh and Ng (1994)].

It has long been recognised that the myriad market activities generating the business
cycle are interrelated. It is believed that disturbances in market fundamentals in a
given market generates movements of capital into and out of the affected market.
If various markets are integrated it is expected that a high degree of asset
substitution will take place, such substitution having a significant impact on price
fluctuations in the relevant markets. Recent literature has recognised the need to
understand and measure the degree of market integration and research has focussed
on techniques to do this. Studies have attempted to measure the degree of
integration between money and bond markets [Dumas and Jacquillat (1990), Errunza
and Padmanabhan (1992)], real assets markets [Madura and Whyte (1991)],
international real estate investment trusts [Asabere et.al. (1991)] and real estate and
financial assets markets [Liu et.al. (1990), Ross and Zisler (1991), Fu et.al. (1994), Koh
and Ng (1994)].

There are differing degrees of integration between the real estate and financial
markets, for example:

(i) No integration - in which case the markets are segmented;

(ii) Partial integration - here taken to mean the physical real estate and financial
markets are segmented, but real estate markets such as Real Estate Investment Trusts
and Secondary Mortgage Markets are integrated;

(iii) Real Estate and Financial Assets Markets are integrated.
The definitions of integration and segmentation adopted by Liu et.al (1990) will be used here viz:

Integration exists if the only risk that is priced for both real estate and stocks is the systematic risk relative to the overall market index. No additional premium is therefore associated with real estate market risk. Investors thus earn the same risk adjusted expected return on stocks and (residential) real estate.

Segmentation arises if the only risk that is priced for real estate is systematic risk relative to the (residential) real estate market. Investors, therefore, do not necessarily earn the same expected return on (residential) real estate and stocks. [Liu et.al.(1990) p.261]

Using the property and equity markets operating in Sydney, Australia, this study will examine the question of whether the housing and apartment markets and the equity markets are integrated. Conventional co-integration techniques and an Arbitrage Pricing Theory (APT) paradigm will be used to address the issue of market integration i.e. if the markets are integrated one would expect the existence of long run equilibrium relationships between the stockmarket and the real estate markets.

MARKET INTEGRATION AND THE CAPM

Much empirical work on asset reallocation is based on the Capital Asset Pricing Model (CAPM), and the CAPM is typically the most common starting point for investigations on whether segmentation exists. In this model the mean and standard deviation of each security's distribution summarises an investor's expectations of the return available on that security. The investor is also required to make an estimation of the covariability of all the securities considered systematically, in their various combinations, in pairs. Sharpe (1964) and Lintner (1965) demonstrate that, based on the CAPM, the expected return on a risky asset can be shown to be:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$  \hspace{1cm} (1)
Here:

\[ E(R_i) = \text{the expected return on the } i^{th} \text{ risky asset} \]

\[ R_f = \text{the return on a risk free asset (generally assumed to be the return on long term Government bonds)} \]

\[ E(R_M) = \text{the expected return on the market portfolio} \]

\[ \beta_i = \text{the measure of risk associated with an investment in a risky asset, } i, \text{ where } \]

\[ \beta_i \text{ is defined as } \beta_i = \frac{\sigma_{iM}}{\sigma^2_M} \]

Here \( \sigma_{iM} \) is the covariance between the returns on the \( i^{th} \) risky asset and the market portfolio (this measures the risk of an asset held as part of the market portfolio) and \( \sigma^2_M \) is the variance of returns on the market portfolio (this measures the risk of the market portfolio).

A simple modification (subtracting the risk free rate from both sides and assuming that, on average, the expected rate of return on an asset is equal to its realised rate) to equation 1 produces a measure of relative performance and the estimating equation becomes:

\[ R_{it} - R_{ft} = \alpha_i + \beta_i (R_{Mt} - R_{ft}) + e_{it} \quad (2) \]

where \( e_i \) is a measure of the asset's unsystematic risk.

The \( \alpha_i \) in equation 2 is Jensen's Abnormal Performance Index [Jensen (1968)] for a portfolio. According to Jensen a statistically significant positive value for \( \alpha_i \) can be viewed as evidence of superior risk-adjusted performance in comparison to the overall market, whereas a significant negative value is indicative of inferior performance. Research by Asabere, Kleiman and McGowan (1991) found Jensen's \( \alpha_i \) for Real Estate Investment Trusts (REITS) to be both positive and statistically significant.

4
Liu et. al. (1990) investigated the extent to which commercial real estate markets are segmented from capital markets in the context of the CAPM. Using a test developed by Jorion and Schwartz (1986), these authors found evidence to suggest that the commercial real estate market is segmented from the stockmarket. However, in the Liu et. al. study, the evidence was contingent on whether the real estate returns were computed from appraised values or from imputed sales values, so the evidence was unclear as to whether the commercial real estate market and the Stock Market were segmented. The Jorion and Schwartz test is essentially one of using the CAPM to determine whether there is any additional risk premium associated with the return on a commercial real estate portfolio over and above the systematic risk premium associated with the overall market portfolio.

Fu et. al. (1994) applied Granger (1969) causality tests to quarterly data of residential property prices in Hong Kong and the Hang Seng Index of the Hong Kong Stock Market. These authors found that changes in Stock Prices led changes in property prices, but not vice-versa. The authors suggested that the results indicated that gains on the Hong Kong Stock Market appeared to result in a portfolio adjustment of residential property holdings. Although such results appear to support market segmentation it is important to bear in mind that the study period was relatively short - from 1984 to 1993. Except for a correction in 1987, the Stock Market generally rose throughout this period (as did the property market).

Oliver (1993) studied the influence of speculation on residential real estate prices in Australia. Oliver tended to agree with the findings of Case and Shiller (1988) that investors in residential real estate viewed the investment as one of low risk. Oliver argued that due to such factors as high transaction costs, thin markets, heterogeneous commodity (no two parcels of real estate are exactly the same) and so on... a high degree of integration between residential real estate markets and capital markets is unlikely (our interpretation of Oliver's argument), although special considerations such as the sharemarket crash of October 1987 may cause investors to adjust their holdings of real estate relative to equities.
USE OF THE APM IN STUDYING MARKET INTEGRATION

In terms of an Australian study there are two difficulties associated with the CAPM approach:

(a) There are relatively few REITS operating on the Australian Securities Market and

(b) Those REITS that are operating have had a relatively short history.

Thus, data considerations have been a major factor in our current analysis of the physical real estate market rather than a market for REITS.

An alternative approach to the investigation of the degree of integration of real estate and general securities markets is to study the problem in the context of the Arbitrage Pricing Model formulated by Ross (1976) using physical real estate markets\(^1\). The APM works on the 'law of one price' concept i.e. two portfolios or securities that have the same risk cannot sell at a different expected return. Should a difference exist it would pay arbitrageurs to enter the market and buy the portfolio with the higher return, financing this by selling short all or part of the portfolio with the lower return. This would guarantee a profit with zero investment and zero risk (i.e. a zero investment-zero risk portfolio [Elton and Gruber (1991)]).

For the APM the expected rate of return on an asset \(i\) (or portfolio of assets, \(p\)) is given by:

\[
E(R_i) = R_f + \beta_{i,1}(E(R_1) - R_f) + \beta_{i,2}(E(R_2) - R_f) + \ldots + \beta_{i,n}(E(R_n) - R_f) + e_i
\]  \hspace{1cm} (3)

Where:

\(R_f\) = the risk-free interest rate
\(\beta_{i,k}\) = the return sensitivity of asset \(i\) to variable \(k\), \hspace{1cm} \text{where } k = 1, \ldots, n
\(R_k - R_f\) = the risk premium for the \(k^{th}\) variable
\(e_i\) = the error term for asset \(i\)
The APM implies that the expected return on an asset depends on a number of variables, although the model does not specify these variables. The APM is an extension of the Industry Index/Multi-index stock price model proposed by King (1966) and more recently by Chen, Roll and Ross (1986) and others.

RESEARCH METHODOLOGY

Since the Multi-index model/APM extension does not identify which RHS variables to specify, a common approach in the literature has been to use factor analysis to identify all of the factors influencing the returns of a specific asset, or a portfolio of assets (although Chen, Roll and Ross (1986) have tested a specific set of economic variables - inflation, the term structure of interest rates, risk premia and industrial production). In this paper we are concerned with investigating whether the physical real estate and financial asset markets are integrated rather than with identifying the set of factors influencing the returns to real estate assets (the factors that are priced by the market). In that case there are only two asset classes (RHS variables) of interest to us: the general market for financial assets and the general market for physical real estate assets. The aim here is to consider specific asset sub-classes (portfolios of assets) within the real estate sector viz: specific location apartments, general location apartments and general location housing.

The APM framework is a useful vehicle for examining the degree of integration between the real estate and financial markets. Using a general stock market index and a specific (property) industry index the APM for, say, portfolios of residential units may be specified as:

\[ E(R_i) = R_f + \beta_{1i} (E(R_M) - R_f) + \beta_{2i} (E(R_p) - R_f) + \epsilon_i \]  

Where:

\[ E(R_i) = \text{expected return on portfolios of: specific location apartments - } a; \text{ general location apartments - } u; \text{ general location housing - } h; \]

\[ E(R_p) = \text{expected return on general property index - here an index of property transfers is taken as a proxy for the general property market index;} \]
and other variables are defined as above.

Assuming integration between the physical real estate and general financial markets, the APM states that the return on, say, a portfolio of apartments will depend on the return in both the general equities market and the return in the general property market.

Subtracting the risk-free rate from both sides of equation 4 we have:

\[ E(R_t) - R_t = \beta_{tt,1}(E(R_M) - R_t) + \beta_{tt,2}(E(R_p) - R_t) + e_t \] (5)

As in the case of the CAPM if we assume that, on average, the expected rate of return on an asset is equal to the realised rate, then we will have the following estimating equation:

\[ R_t - R_t = \alpha_t + \beta_{tt,1}(R_M - R_t) + \beta_{tt,2}(R_p - R_t) + e_t \] (6)

The underlying assumption is that the arbitrageurs are able to price physical (and locational) differences in real estate and to estimate expected returns. Such arbitrageurs then explore the risk/return attributes of assets across different asset markets for profit opportunities and buy and sell accordingly. The activity of such arbitrageurs reduces or eliminates market segmentation and ensures the construction of an 'efficient' portfolio of assets.

**POTENTIAL OUTCOMES**

Following the work of Perron (1988) and Nelson and Plosser (1982), we analyse the logarithm of the price series instead of the level to account for the fact that there is a tendency for the dispersion of the series to increase with the absolute level (cf. Perron, p.318). If the markets for individual property assets, general property assets and the general equities markets are integrated in the manner defined by Liu et al. (1990) then, over the long term, we would expect prices in each property asset class
to be co-integrated with prices in the general securities and general property markets. By the definition of co-integration this would require (a) the price series in each market to be integrated to the same order and (b) the existence of a linear combination of the series which is integrated to a lower order than the individual series squared.

Also, if the markets are integrated then examination of the $\alpha_i$ and $\beta_i$ in the returns relationship shown by equation 6 provide information on the relative performance of given types of property assets in comparison with the equities market and general properties market. For instance, since the $\alpha_i$ represent Jensen’s Abnormal (Differential) Performance Index then, if a given $\alpha_i$ is positive and significant, it implies that the market for the particular type of asset (apartments, housing etc.) has had superior risk adjusted performance in comparison with the securities and general property markets (and vice-versa for negative $\alpha_i$). The $\beta_i$ represent the responsiveness (sensitivity) of the returns on the given asset to changes in the returns to the given general market indicator (equities or general property). If the markets are integrated then we would expect the $\beta_i$ to be significant - we would expect the returns on the given asset to be sensitive to changes in returns in the other markets.

Hence, in the present analysis, two tests are of interest to us:

(i) co-integration tests between the price series for each type of property asset (LHS variable) with the general securities market price series and the general property market price series as RHS variables - if the markets are integrated we would expect the LHS and RHS variables to be co-integrated as defined above;

(ii) significance tests

   (a) on the $\alpha_i$ - if the real estate and financial markets are integrated then the $\alpha_i$ provide an indication of relative performance and

   (b) on the $\beta_i$ - if the markets are integrated then returns on the given asset should be responsive to changes in returns on the other markets.
DATA OVERVIEW

For the above tests we utilise the following quarterly data series:

MA - price series index for specific location apartments (defined below), 1975 to 1993. Returns symbolised by $R_m$;

UI - price series index for general location two bedroom apartments, 1979 to 1993. General location refers to the Sydney Metropolitan Area (SMA). Returns symbolised by $R_{ui}$;

HI - price series index for general location (SMA) three bedroom housing, 1972 to 1993. Returns symbolised by $R_h$;

AI - price series index for the All Ordinaries over the required period. General market returns symbolised by $R_m$;

PI - price series index for general property. Here a proxy was employed based on an index of property transfer expenses. General property returns symbolised by $R_p$;

$R_f$ - risk free interest rate represented by the 10 year bond rate. As we are looking for evidence of long run equilibrium relationships in the markets it is reasonable to use the long term bond rate as representative of the risk free rate.

The following graphs show the behaviour of each of the price series for the LHS asset variables (MA, UI, HI) in comparison with price series for the equity and general property markets over the study period (AI, PI). Figures one, two and three depict movements in the price indices for specific location apartments (MA), general location apartments (UI) and general location housing (HI) - each of these will be defined below.
Because of the heterogeneous nature of property it is difficult to examine and compare the returns on specific (property) assets in the same way that we would examine and compare the returns on specific securities. We can partially circumvent this problem by adopting a pseudo-portfolio approach. For example, the Lower and Upper North Shore and Eastern Suburbs areas of Sydney are generally regarded as being the most desirable residential areas in the Sydney Metropolitan Area due to: accessibility to harbour or beach front recreational facilities, accessibility to the CBD, high proportion of population in upper income brackets, high proportion of the population with above average educational qualifications, and so on... In a broad sense, therefore, properties located in these areas can be regarded as being part of the 'upper end' of the Sydney property market. The specific apartment 'portfolio' index used in the present study was based on a large number (over 7,000 in all) of apartments sold in these areas over nearly twenty years. This data was obtained from MIRVAC LTD\(^4\). The 'portfolio' contained apartments of different size (ranging from one to three bedroom), different age and different views. The common general thread was location in broadly desirable areas. The sales data was aggregated on a quarterly basis and, for the purpose of calculating property returns, a 'typical' asset was selected solely on the basis of median price. It is assumed that an arbitrageur is able to price physical and locational characteristics and estimate expected returns.
Our second apartment 'portfolio' may be conceived of as a portfolio of two bedroom units sold anywhere in the Sydney Metropolitan Area (SMA). The data for this was obtained from the EAC and the Real Estate Institute of New South Wales (REINSW). As with our first 'portfolio' the data was aggregated on a quarterly footing and the 'typical' two bedroom apartment sold was again selected on the basis of median price.

Our third property 'portfolio' may be conceived as that comprising three bedroom houses sold anywhere in the SMA. Again this data was obtained from the REINSW and the 'typical' housing asset was also selected on the basis of median price.

UNIT ROOT TESTS

Before tests of co-integration can be undertaken it is essential to test if all variables are integrated to the same degree. Phillips-Perron (PP) Unit Root tests were undertaken on all variables. The PP Unit Root tests were preferred to the Dickey-
Fuller (DF) Unit Root tests for the following reasons (i) the PP tests do not require an assumption of homoscedasticity of the error term [Phillips (1987)] and (ii) since lagged terms for the variable of interest are set to zero there is no loss of effective observations from the series [Perron (1988)]⁶. The PP tests are based on the Augmented Dickey-Fuller regression:

\[ \Delta V_t = \alpha_0 + \alpha_1 V_{t-1} + \alpha_2 T + \sum_{j=1}^{p} \gamma_j \Delta V_{t-j} + \epsilon_t \]  

(7)

Where: \( V \) is the variable of interest

\( T \) is a trend variable

but: \( p \) (the number of lags) is set equal to zero and a non-parametric correction is used for serial correlation (in preliminary DF tests the number of lags for \( \Delta V_t \) to ensure the errors were uncorrelated ranged from 3 to 5)

The PP Unit Root Tests on the logarithm of the price series (table I) showed that the index time series for specific apartments, general apartments, housing, stock market and property market were all I(1) i.e they were all integrated to the same order (our first requirement for co-integration).

<table>
<thead>
<tr>
<th>Variable(levels)</th>
<th>T-Statistic</th>
<th>Critical Value (10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spec.apts.</td>
<td>-3.122</td>
<td>-3.13</td>
</tr>
<tr>
<td>Gen.apts.</td>
<td>-1.577</td>
<td>-3.13</td>
</tr>
<tr>
<td>Housing</td>
<td>-2.011</td>
<td>-3.13</td>
</tr>
<tr>
<td>Equities</td>
<td>-2.089</td>
<td>-3.13</td>
</tr>
<tr>
<td>Property</td>
<td>-0.715</td>
<td>-3.13</td>
</tr>
<tr>
<td>Housing</td>
<td>-10.015</td>
<td>-3.13</td>
</tr>
<tr>
<td>Equities</td>
<td>-6.753</td>
<td>-3.13</td>
</tr>
<tr>
<td>Property</td>
<td>-8.047</td>
<td>-3.13</td>
</tr>
</tbody>
</table>

A useful bi-product, for our purposes, of the use of logarithms is that the difference
in logarithms will produce (approximately) the returns defined in our earlier equations. That is,

\[
\log P_{i, t} - \log P_{i, t-1} = \log \frac{P_{i, t}}{P_{i, t-1}} = \frac{P_{i, t} - P_{i, t-1}}{P_{i, t-1}}
\]

(8)

where \( P_i \) is the price(index) in period \( t \).

As shown in table I the logarithm of the series were stationary after differencing i.e the returns were stationary.

Each of the returns variables (less the risk free rate) for specific location apartments, general location apartments and housing are plotted below against the equities and general properties markets. The most striking feature of figure 4 is the greater volatility in returns to the specific location apartments compared with the stock market and the general property market. In a somewhat similar vein, Ross and Zisler (1991) in a study of the US market found that the returns on Equity Real Estate Investment Trusts (EREIT) that were heavily concentrated in retail (37%) and apartments (20%) were much more volatile than property indicators that showed a good distribution across office (47%), retail (20%) and industrial (28%) but which were poorly represented in apartments (3%) and hotels (2%). These authors also found that the EREIT returns were much more volatile than the Standard and Poor 500 equity market indicator. The volatility of specific location apartments shown in figure 4 is not matched by the relative volatility for general apartments and general housing shown in figures 5 and 6. By comparison the stock market returns were more volatile in each of these cases. This visual impression is borne out by table II which compares the variance of the distributions of returns over the study periods. This table uses a standard F-ratio to compare the volatility of the given return series. In each case the larger variance series in shown on the LHS. Comparisons were only made for the three periods shown by figures 4, 5 and 6.
Figure 4

APARTMENT RETURNS
LESS RISK FREE RATE

Figure 5

RETURNS TO GENERAL UNITS
LESS THE RISK FREE RATE
Table II

Volatility Comparisons

<table>
<thead>
<tr>
<th>Larger Variance</th>
<th>Smaller Variance</th>
<th>Sample Size</th>
<th>$F_{calc}$</th>
<th>$F_{0.05}$ (approx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spec.Apts</td>
<td>Allords</td>
<td>74</td>
<td>1.775</td>
<td>1.4</td>
</tr>
<tr>
<td>Spec.Apts</td>
<td>Gen.Ppty</td>
<td>74</td>
<td>6.053</td>
<td>1.4</td>
</tr>
<tr>
<td>Allords</td>
<td>Gen.Apts</td>
<td>58</td>
<td>1.884</td>
<td>1.43</td>
</tr>
<tr>
<td>Gen.Apts</td>
<td>Gen.Ppty</td>
<td>58</td>
<td>1.869</td>
<td>1.43</td>
</tr>
<tr>
<td>Allords</td>
<td>Housing</td>
<td>94</td>
<td>2.548</td>
<td>1.39</td>
</tr>
<tr>
<td>Allords</td>
<td>Property</td>
<td>94</td>
<td>4.605</td>
<td>1.39</td>
</tr>
<tr>
<td>Housing</td>
<td>Property</td>
<td>94</td>
<td>1.807</td>
<td>1.39</td>
</tr>
</tbody>
</table>

CAUSALITY

Prior to applying co-integration tests it is appropriate to verify the direction of causality implied by the representation of the APM presented above and to ascertain any lead-lag relationships that may exist. In this procedure we follow Granger (1969)
and the intuitive argument may be presented as follows. If $X$ Granger-causes $Y$ but $Y$ does not Granger-cause $X$, then past values of $X$ should be able to help predict future values of $Y$, but past values of $Y$ should not be helpful in forecasting $X$ [cf. Ramanathan (1992)]. To apply the test consider the following model in which $X$ and $Y$ are expressed as deviations from their respective means:

$$Y_t = \Sigma^p \alpha_j Y_{(t-j)} + \Sigma^q \beta_j X_{(t-j)} + u_t$$

(9)

where: $u_t$ is white noise

- $p$ is the order of the lag for $Y$
- $q$ is the order of the lag for $X$

A conventional Wald F-test is utilised to test the null hypothesis (restrictions) that the $\beta_j$ are zero. In (9) we use the Akaike (1969) final prediction error - FPE as our selection criterion for the number of lagged terms to be included. Since the indexed series for each of the 'portfolios' and the markets were I(1) we applied the Granger Causality tests to the differenced series. The results are shown in table III.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Wald F-statistic</th>
<th>Prob-Value</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI causes MA</td>
<td>2.07</td>
<td>0.154</td>
<td>reject</td>
</tr>
<tr>
<td>MA causes AI</td>
<td>0.21</td>
<td>0.649</td>
<td>reject</td>
</tr>
<tr>
<td>PI causes MA</td>
<td>0.74</td>
<td>0.393</td>
<td>reject</td>
</tr>
<tr>
<td>MA causes PI</td>
<td>0.05</td>
<td>0.943</td>
<td>reject</td>
</tr>
<tr>
<td>AI causes UI</td>
<td>0.96</td>
<td>0.333</td>
<td>reject</td>
</tr>
<tr>
<td>UI causes AI</td>
<td>0.23</td>
<td>0.630</td>
<td>reject</td>
</tr>
<tr>
<td>PI causes UI</td>
<td>8.56</td>
<td>0.005</td>
<td>accept</td>
</tr>
<tr>
<td>UI causes PI</td>
<td>0.25</td>
<td>0.614</td>
<td>reject</td>
</tr>
<tr>
<td>AI causes HI</td>
<td>3.23</td>
<td>0.076</td>
<td>accept</td>
</tr>
<tr>
<td>HI causes AI</td>
<td>0.01</td>
<td>0.919</td>
<td>reject</td>
</tr>
<tr>
<td>PI causes HI</td>
<td>6.19</td>
<td>0.015</td>
<td>accept</td>
</tr>
<tr>
<td>H I causes PI</td>
<td>7.78</td>
<td>0.006</td>
<td>accept</td>
</tr>
</tbody>
</table>

Where:
AI refers to the securities market, MA refers to the specific location apartment 'portfolio', PI refers to the general property market, UI refers to the general location apartment 'portfolio', HI refers to the general location housing 'portfolio'.
The Granger causality test on whether changes in the securities market 'causes' changes in the specific apartment market was, we believed, inconclusive in the sense that, at the ten percent level of significance we can reject the claim but at about the fifteen percent we can accept it (although the table indicates rejection). The causality test for the general apartment market did not support either direction of causality with the securities market. However, the test indicated that the general property market led the general apartment market by one quarter, that is, the general apartment market was slower to 'move' than the overall property market (based on the property transfer proxy). Finally the analysis indicated that, for the general housing market, there were feedback effects between the housing market and the securities market and there were feedback effects in both directions between the housing market and the general property market.

The Granger causality tests did not present clear evidence on either market integration or segmentation. The tests indicated no causality between the securities market and either specific apartments or general apartments 'portfolios', but did indicate causality between the securities market and housing 'portfolios'.

TESTS OF CO-INTEGRATION

Co-integrating regressions were run with the logarithms of the price series for specific location apartments, general location apartments and housing as the LHS variables for each regression while the All Ordinaries Index and a General Property Index formed the RHS variables in each case. Table IV shows the results of our tests using the multi-index framework of the APM. The test results are weakly supportive of co-integration between the physical real estate and securities markets. We reach this conclusion simply because four of the six test statistics suggest co-integration. All the CRDW statistics were significantly greater than zero, thus indicating that the series were co-integrated while one out of the three ADF t-tests running the Phillips-Perron model were significantly smaller than the critical value (thus indicating co-integration in this case). The conflicting evidence on co-integration in these latter two cases could be due to the weak power of the tests\(^5\). An alternative explanation is that the players at the upper end of the apartment market are more likely to operate in
both the equity and property markets, seeking the best avenue for investment funds. On the other hand, the general housing and apartment markets are more likely to be dominated by owner occupiers rather than investors/market players.

<table>
<thead>
<tr>
<th>TABLE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phillips-Perron Tests on Residuals of Co-integrating Regressions (Securities and General Property)</strong></td>
</tr>
<tr>
<td><strong>LHS VARIABLE</strong></td>
</tr>
<tr>
<td>Spec.Apts.</td>
</tr>
<tr>
<td>Gen.Apts.</td>
</tr>
<tr>
<td>Housing</td>
</tr>
</tbody>
</table>

* 5% Significance Level from Engle and Granger (1987) Table II. 10% Sign.Level given by -3.84

**MARKET RESPONSE AND JENSEN'S INDEX**

The above tests used different ‘portfolios' of residential property. The evidence neither clearly accepts nor clearly rejects co-integration. Since the evidence was not unanimous in either direction we chose to proceed with our second test of market integration and estimate the coefficients for the returns series via ordinary least squares. The $\beta_i$ indicate the responsiveness of the returns for the given ‘portfolio' to changes in the securities market and the general property market. The $\alpha_i$ represent Jensen’s Abnormal Performance Index. If the APM (or, indeed, the CAPM) is appropriate then, in equilibrium, we would expect all the $\alpha_i$ to be zero and the $\beta_i$ to be non-zero. Table V shows estimated coefficients for our APM representation.
Table V

INVESTMENT RETURNS- APM FRAMEWORK

RHS Variables - Stock Market & General Property Market

<table>
<thead>
<tr>
<th>LHS Var.</th>
<th>$\alpha_1$</th>
<th>t-val.</th>
<th>$\beta_{m}$</th>
<th>t-val.</th>
<th>$\beta_{r}$</th>
<th>t-val.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\left(R_s-R_f\right)$</td>
<td>-.032</td>
<td>-.83</td>
<td>-.131</td>
<td>-0.55</td>
<td>.694</td>
<td>1.53</td>
</tr>
<tr>
<td>$\left(R_c-R_f\right)$</td>
<td>-.057</td>
<td>-3.59</td>
<td>-.076</td>
<td>-0.84</td>
<td>.293</td>
<td>1.67</td>
</tr>
<tr>
<td>$\left(R_i-R_f\right)$</td>
<td>-.037</td>
<td>-3.21</td>
<td>.046</td>
<td>0.74</td>
<td>.522</td>
<td>4.50</td>
</tr>
</tbody>
</table>

Table V indicates that the $\alpha_1$ were significant for the housing and general apartment markets, but the $\alpha_1$ was not significant for the specific apartment market. As a reflection of Jensen's Abnormal Performance Index this suggests that the housing and general apartment markets were performing in an inferior fashion in relation to the securities and general property markets (and the sign of the $\alpha_1$ for the specific apartment market indicates a tendency in this direction). However, since the securities and general property markets are being considered together in the APM representation, it is not possible to isolate the comparison between the LHS and RHS variables in terms of Jensen's Abnormal Performance Index.

The $\beta_1$ for the general property market were significant across the board at the 0.10 level. This, of course, is to be expected since it is reasonable to suppose that 'typical' assets in the various segments of the property market will be responsive to any changes in the general property market. The $\beta_1$ for the securities market were not significantly different from zero across the board, which was surprising in view of at least some of the earlier co-integration results. The conclusion that can be drawn from the tests of significance on the $\beta_1$ for the securities market is that the markets were not integrated.
CONCLUSIONS AND LIMITATIONS

This paper has presented the results of a preliminary exploration into the issue of whether real estate and equity markets are integrated. Data limitations necessitated a consideration of physical real estate markets (rather than real estate security markets). The research ignored the special characteristics of physical real estate (spatial fixity, non-homogeneity etc.) and instead assumed the existence of arbitrageurs who are able to price physical (and locational) differences in real estate and to estimate expected returns. The analysis further assumed that such arbitrageurs then explore the risk/return attributes of assets across different asset classes and markets for profit opportunities and buy and sell accordingly. If, in fact, they exist it is expected that the activity of such arbitrageurs would reduce or eliminate market segmentation and ensure the construction of 'efficient' portfolios of assets. Assuming the APM as an appropriate paradigm the methodological approach adopted involved the testing for co-integration between the price series of financial variables and real asset variables as well as tests of significance on the $\alpha_t$ and $\beta_t$ for the returns equations. Such testing explored the existence of an equilibrium relationship amongst these variables.

On balance the results suggest market segmentation except, perhaps, in the case of specific location apartments. The conflicting evidence on co-integration for the general housing and general apartment markets and other markets may be the result of several factors: (a) relevant variables may have been omitted from the co-integrating regression for instance, inflation, the term structure of interest rates etc. etc. suggested by the work of Chen,Roll and Ross (1986) or, (b) there may be structural breaks in the series or, (c) the co-integrating regression tests themselves may lack power. The results favouring integration between the specific location apartments market and the securities and general property markets may be indicative of the greater likelihood that participants in this upper end of the residential property market will view property in an investor sense rather than an owner/occupier sense.

The conflicting evidence found here on market integration between the real estate and securities markets agrees with similar inconclusiveness found in other studies.
There is clearly a need for further investigation. The underlying assumption in this and other investigations has been that the relationships are linear. Current work is testing the appropriateness of several non-linear models, developed in other research, for use with the present data sets. If shown to be suitable such models may provide a definitive means of measuring the degree of market integration between real estate and equity markets.
REFERENCES


ENDNOTES

1. We use the terms Arbitrage Pricing Model (APM) and Arbitrage Pricing Theory (APT) interchangeably.

2. Integration in this latter sense refers to the number of times that the series must be differenced to achieve stationarity. Cf. Perman (1991, p. 12).

3. All price series are in nominal terms. The cointegration tests were also undertaken for real rather than nominal data with little difference to the results.

4. The authors would like to express their appreciation to Mr. Andrew Cameron of MIRVAC LTD. for supplying this data for analysis.

5. Our appreciation goes to Mr. David Wellfare - REI(NSW) Research Department for the provision of this data and the data on three bedroom housing. We are also indebted to the EAC (Mr. Ross Graham, Ms. Raelene Weirwick and Ms. Julie McWhirter for continuing data provision on Sydney real estate prices).

6. The Phillips-Perron method is to use a non-parametric correction for serial correlation. The approach is to first calculate the unit root tests using Augmented Dickey-Fuller regressions with the number of lags set to zero. The statistics are then transformed to remove the effects of serial correlation on the asymptotic distributions of the test statistic (cf. SHAZAM User's Reference Manual, p. 160).

7. Taking natural logs of the variables (original index series) and including constant and trend. In this data set the series were I(1) irrespective of whether natural logs were taken or not.

8. The position was not made any clearer by analysing single index models. We ran PP-tests on the residuals of co-integrating regressions for a series of single index models with the security and property markets treated separately as RHS variables. Only five of the twelve test statistics supported co-integration. Again only in the case of Specific Location Apartments were all test statistics in agreement.

9. "After running the co-integrating regression the Durbin Watson statistic is tested to see if the residuals appear stationary. If they are nonstationary, the Durbin Watson will approach zero and thus the test rejects non-co-integration (finds co-integration) if the DW is too big." (Engle and Granger, 1987, p. 266).