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Real estate as part of an investment portfolio in Australia

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Abstract

Real estate is an important investment asset class yet this asset class poses considerable problems for portfolio managers because of reliance on appraisals in valuing direct real estate investment and the equity like behaviour of listed Australian real estate investment trusts (ASX 300 A-REITs). Analysis is based on quarterly returns spanning the period from the 3rd quarter 1986 to the 3rd quarter 2009 using various combinations of the Australian All Ordinaries share price index and three classes of property investment. Comparison of Sharpe measures across a range of portfolios suggest that diversification benefits can be achieved through diversifying into real estate investment, particularly direct investment in residential real estate, given an initial exposure to the equity market.

1. Introduction

The importance of real estate investment, a major investment asset class for individual Australian investors, is likely to increase with growth in Australian superannuation contributions and further development of the Australian economy. While individuals may see real estate as a safe asset for longer-term investment, this attraction to real estate is not so evident with professionally run pension or superannuation funds (Blake *et al.* 1999; Hudson-Wilson *et al.* 2003).

Real estate consists of heterogeneous, often illiquid assets, though it has been argued that this asset class should form an important part of a well-diversified investment portfolio (Brounen & Eichholtz 2003; Hudson-Wilson *et al.* 2003; Lee & Stevenson 2005). Real estate can be purchased (direct investment) or investment can take place through land held by listed companies or more directly through listed or unlisted entities such as REITs (indirect investment). Direct investment can impose considerable liquidity and transaction costs. There are also problems with valuation of this asset class due to reliance on costly and often infrequent appraisal based valuation. Indirect investment in real estate investment trusts (listed REITs) and real estate mutual funds (REMF) offer more liquid investment vehicles (Feldman 2003) though research concerning these vehicles is inconclusive, with both support for (Brounen & Eichholtz 2003) and criticism of (Byrne & Lee 1995; Clayton & MacKinnon 2001; Georgiev *et al.* 2003) these approaches to real estate investment in the literature.

Appraisal methods used in the valuation of direct real estate investments generate valuations that are smoothed over time. Smoothing can have a considerable impact on the time series behaviour of real estate prices, with one study reporting US direct real estate return volatility (3.4% p.a.), about half the volatility calculated for REITs (7%-8%) (Giliberto 1993, 2003). Further, valuations tend to occur infrequently and so it is likely that stale valuations will be included in the calculation of real estate indices. Corrections for smoothing include, more careful index calculation (Geltner & Goetzmann 2000), simple statistical adjustment (MacGregor & Nanthakumaran 1992; Newell & MacFarlane 1996; Cho *et al.* 2003; Georgiev *et al.* 2003) and increasing the return estimation period to minimise the impact of smoothing (Byrne & Lee 1995). Index recalculation

requires access to pricing information for each of the individual properties that make up the index and so this alternative is not possible given the nature of the data used in this study. As a result simple statistical adjustment is used to gain a more precise indication of the benefit of direct investment in Australian real estate. Further, indices used to capture the performance of indirect investment in listed REITs are observed to suffer from microstructure effects (Brounen & Eichholtz 2003) and so hedged quarterly returns are calculated for this asset class using the A-REITs subindex of the ASX300 share price index.

Mutual funds do invest in real estate both locally and globally (Higgins 2007), accounting for around 10% of UK and 5% of US portfolio investments (Blake *et al.* 1999). Published Australian real estate research has generally focused on describing the market (Higgins 2007), modelling the determinants of real house prices (Bodman & Crosby 2003; Abelson *et al.* 2005), surveying Australian fund manager attitudes to real estate investment funds (Keng 2004) and assessing the performance of Australian listed REITs (Higgins & Ng 2009). There is little published analysis dealing with the diversification benefits arising from investment in Australian real.

The main contribution of this paper is in the comparison of the impact of direct and indirect real estate returns on portfolios in an Australian setting. There are two main analyses to be completed. The first is analysis of the relations that exist between listed A-REITs and direct real estate investment returns, where A-REIT returns are corrected for their equity market component (Georgiev *et al.* 2003) and direct investment indices are corrected for smoothing that could arise from appraisal based valuation and use of stale valuations in real estate index calculations (Brounen & Eichholtz 2003; Georgiev *et al.* 2003). The second provides an analysis of the impact of real estate investment on portfolio performance where the portfolio consists of a well-diversified share portfolio and real estate investments.

2. Data description

The data used in this study consist of quarterly returns calculated for the Australian share market and three real estate investment classifications (listed A-REIT, commercial real estate and residential real estate) over the period from December 1985 through to September 2009. The Australia Securities Exchange All Ordinaries Share Price Accumulation Index is used to capture returns to share investment and is adjusted for both capitalisation changes and dividends.

Returns to direct commercial real estate are calculated using the IPD/PCA Property Investors Digest Series (Composite) Index an index. There is no total return index available for direct investment in residential real estate over the period of this study and so this return series is calculated using a house price index and a rental return index obtained from the Australian Bureau of Statistics. Rental returns on private real estate are reduced by 12% to account for outgoings associated with managing residential real estate.

Given the use of appraisal values and the illiquid nature of direct investment in real estate, a common adjustment for smoothing in the quoted indices is based on the assumption that the smoothed data follows an autoregressive process, say an AR(3) process.

$$r_t^{DP} = \alpha + \beta_1 r_{t-1}^{DP} + \beta_2 r_{t-2}^{DP} + \beta_3 r_{t-3}^{DP} + \varepsilon_t$$

Where r_t^{DP} = quoted return on direct real estate investment at time *t*
ε_t = residual term at time *t*
α, β_i = estimated coefficients

The smoothed return observed at time t is modelled as a weighted average of prior period smoothed returns and current period underlying return where the weights sum to one.

$$r_t^{DP} = (1 - \beta_1 - \beta_2 - \beta_3) r_t^U + \beta_1 r_{t-1}^{DP} + \beta_2 r_{t-2}^{DP} + \beta_3 r_{t-3}^{DP}$$

Where r_t^U = underlying or adjusted return on direct real estate index at time *t*

This can be rearranged to provide an estimate of the underlying or adjusted return for direct investment in real estate.

$$r_t^U = \frac{1}{\varphi} r_t^{DP} - \frac{\beta_1}{\varphi} r_{t-1}^{DP} - \frac{\beta_2}{\varphi} r_{t-2}^{DP} - \frac{\beta_3}{\varphi} r_{t-3}^{DP}$$

where $\varphi = (1 - \beta_1 - \beta_2 - \beta_3)$

Autoregressive models are fitted to the direct investment indices used in this analysis and the results are reported in Table 1. An AR(8) model is initially fitted to the data. The model is then re-estimated excluding the statistically insignificant coefficients, with likelihood ratio test support for this restricted model (test statistics of 1.27 and 5.09 respectively). This approach to model choice results in an AR(3) model for the direct commercial real estate data and an AR model with lags at 1 and 3 for the residential real estate data. To assess the sensitivity of lag choice, in both cases, the model was further restricted to an AR(1) model. The likelihood ratio statistics indicate that this restriction is statistically significant, with a likelihood ratio of 31.82 for the commercial real estate index and 4.34 for the residential real estate model. As a result AR(1) models are not used in this analysis. The impact of the model choice is evident in Figure 1 where the original series, the AR(1) adjusted series and the final AR model adjusted series are graphed, starting with the same base value of 100. The greatest variation between the AR(1) model and the final model used in analysis is evident during the global financial crisis where the AR(1) based models are quite extreme in their reaction to this period, particularly for the commercial property indices.

[Insert Table 1 and Figure 1 about here]

The Australian Securities Exchange S&P 300 A-REIT index provides a measure of returns to listed Australian real estate investment trusts. It has been argued in the literature that listed real estate trust data exhibits excessive volatility driven by general share market movements. A commonly used adjustment for this effect is to remove the broad share market movements using a hedged portfolio. The hedge ratio is obtained in the usual way from a regression of the real estate trust index returns on a share market index.

$$r_t^{A-REIT} = \phi + \varphi r_t^{SPI} + \eta_t$$

Where r_t^{A-REIT} = return on A-REIT index at time *t*
r_t^{SPI} = return on All Ordinaries Share Price Index at time *t*

η_t = residual term at time t
ϕ, φ= estimated coefficients

The hedged A-REIT portfolio return is defined as:

$$r_t^H = r_t^{A-REIT} - \varphi r_t^{SPI}$$

Descriptive statistics are reported in Panel A of Table 2. Adjustment for smoothing in direct real estate returns is undertaken because of the use of appraisals in real estate valuation and the inclusion of stale prices in construction of direct real estate indices. Adjusted results are reported for both an AR(1) model which is commonly used in the literature and for the final models chosen for analysis in this paper, AR(3) for commercial property and AR(1&3) for residential property. The adjusted data is considerably more volatile. The standard deviation in quarterly returns for direct investment in commercial real estate increases from 0.0230 per quarter for RCom to 0.0598 per quarter for RCom, AR(3) and the standard deviation in quarterly returns for direct investment in residential real estate increases from 0.0222 per quarter for RRes to 0.0381 per quarter for RRes, AR(1&3). In both cases the standard deviation for the adjusted series is essentially double that of the unadjusted series, consistent with the results reported by Georgiev *et al.* (2003) for the US NCREIF data. The mean returns for the smoothed and unsmoothed direct real estate investment indices range from 0.0152 to 0.0327 per quarter.

[Insert Table 2 about here]

The volatility of the hedged ASX300 A-REIT index returns (0.0671 per quarter for Rareit(h)) is somewhat lower that of the unhedged index (0.0913 per quarter for Rareit) consistent with the hedging adjustment used to remove general equity market volatility. The reduction in standard deviation of around 30% is somewhat greater that noted by Georgiev *et al.* (2003) for the NAREIT hedged returns. The volatility for adjusted commercial property and for hedged A-REITs

is approximately 6% per quarter while the volatility for the adjusted residential property is around 4% per quarter.

The All Ordinaries share price index returns volatility per quarter is 0.0941 per quarter, which is fairly close to the volatility of the unadjusted A-REITs return series (0.0913 per quarter). The 90-day bank accepted bill yields have average return of 0.0198 per quarter with volatility of 0.0101 per quarter. These yields are used in calculation of risk free rate adjusted rates of return for the Sharpe ratios that are calculated for the various portfolios reported in the analysis that follows.

Serial correlation coefficients are reported in Panel B of Table 2 for each of the variables. Bank accepted bill yield serial correlation coefficients are large and generally statistically significant suggesting that these yields follow either unit root or near unit root processes though given the magnitude of the yields and the fact that they are used to adjust the considerably more volatile asset class returns we do not attempt to adjust for this characteristic of the data. Serial correlation is evident in the original direct real estate investment returns consistent with the existence of smoothing effects from appraisal based valuation and use of stale prices in property value index construction. Adjusted property returns show no evidence of serial correlation. Further, there is no evidence of serial correlation in the share market based index returns.

Pearson correlation coefficients are reported in Panel C of Table 2. As might be expected there is evidence of statistically significant correlation between the direct investment asset class returns and between the commercial direct investment and A-REITs though the A-REITs are not significantly correlated with residential property returns. The unadjusted and adjusted A-REIT returns are correlated. Further, the adjusted direct commercial real estate index returns are positively correlated with A-REITs returns and share market returns. The correlation coefficients between quarterly returns for adjusted residential real estate returns and share market returns are generally small (less than 0.40) suggesting the possibility of diversification gains from investment across these asset classes.

3. Analysis

The performance of direct investment in commercial and residential real estate as well as listed A-REIT asset classes is compared in Table 3. The comparisons are provided using both raw returns and risk free rate adjusted returns where R_P is the real estate portfolio return, R_P^A is the adjusted real estate portfolio return, $R_P - R_f$ is the real estate portfolio return less the 90-day bank accepted bill yield and $R_P^A - R_f$ is the adjusted real estate portfolio return less the 90-day bank accepted bill yield. The average return, standard deviation in return, Sharpe ratio or information ratio and the rank attached to these ratios are reported in Panel A using all available data, from the 3rd quarter 1986 to the 3rd quarter 2009. To gain some insight into the stability of the Sharpe or information ratio analysis, sub-period analysis is also provided in Panel B for sub-periods, the 3rd quarter 1986 to the 1st quarter 1998 and the 2nd quarter 1998 to the 3rd quarter 2009.

[Insert Table 3 about here]

The Sharpe ratio reported in Table 3 is defined as:

$$\text{Sharpe ratio} = \overline{R - R_f} \big/ \sigma$$

and the information ratio is defined as:

$$\text{Information ratio} = \overline{R} \big/ \sigma$$

Portfolios used in Table 3 include 100% investment in each of the three real estate asset classes, 50% investment in pairs of the real estate asset classes and one-third investment in each of the three real estate asset classes. Based on Sharpe ratio, a 100% direct investment in residential real estate ranks first or second amongst the alternatives, while a 100% investment in A-REITs is generally the worst performing of the real estate asset classes with a rank of 7 in most cases. Equal investment in residential real estate and A-REITs also performs poorly, with a Sharpe ratio rank of 6 in most cases (see Panel A). These results appear robust to choice of period used in analysis with

little variation between the total study period, 1986 quarter 3 to 2009 quarter 3, and sub periods, 1986 quarter 3 to 1998 quarter 1 and 1998 quarter 2 to 2009 quarter 3.

The reported results are sensitive to adjustment made for smoothing in the commercial real estate series and the residential real estate series, particularly for direct investment in commercial real estate where the adjusted returns result in stronger relative performance for the commercial real estate asset class. Yet, the hedging adjustment for the A-REITs has little impact on Sharpe ratio based rankings reported in panels A or B of Table 3.

In Table 4 the All Ordinaries share price index is used as a proxy for a well-diversified portfolio of shares. Portfolio proportions used in analysis consist of 95% shares with 5% real estate and 90% shares with 10% real estate reflecting the average levels of real estate investment reported for the US and the UK mutual funds respectively. Given the results reported in Tables 2 and 3 it seems appropriate to focus on the results from analysis of the adjusted real estate returns in Table 4 though the results for the unadjusted data are similar.

[Insert Table 4 about here]

The best performing portfolios in terms of Sharpe ratio and information ratio consist of shares and direct investment in residential real estate with this combination generally ranking first amongst the alternative combinations of shares and real estate portfolios. This result is also quite stable across the sub-periods as can be seen from Panel B of Table 4. Further, some combination of shares and direct real estate investment is always preferred to holding a well-diversified share portfolio alone. Portfolios of shares and A-REITs generally rank worst (8), though ranking is less consistent with combinations of shares, A-REITs and direct investment in property changing with sub-period and choice of metric. Finally, the choice of whether 5% or 10% is allocated to real estate has little impact on the Sharpe ratio or information ratio based ranking of the portfolios.

4. Conclusion

This paper uses Sharpe ratios and information ratios in an analysis of the comparative performance of portfolios of direct residential real estate investment, direct commercial real estate investment and investment in A-REITs as well as analysis of the impact of combining property with a well-diversified share portfolio. Sharpe ratio and information ratio comparisons show that combinations of shares and direct real estate investments are generally preferred to shares alone. Combinations of shares and direct real estate investments are also preferred to combinations of shares and A-REITs even after adjustment for equity effects. It would appear that real estate investment does offer valuable diversification potential though the choice of asset class is important.

References

Abelson, P., Joyeux, R., Milunovich, G., Chung, D., 2005. Explaining house prices in Australia: 1970 to 2003. Economic Record 81, S96-S103

Blake, D., Lehmann, B.N., Timmermann, A., 1999. Asset Allocation Dynamics and Pension Fund Performance. Journal of Business 72, 429-461

Bodman, P., Crosby, M., 2003. How far ro fall? Bubbles in major city house prices in Australia. In: University of Queensland, School of Economics, working paper, pp. 1-16

Brounen, D., Eichholtz, P., 2003. Property, common stock, and property shares. Journal of Portfolio Management 30, 129-137

Byrne, P., Lee, S., 1995. Is there a place for property in the multi-asset portfolio? Journal of Property Finance 6, 60-83

Chan, F., Lim, C., McAleer, M., 2005. Modelling multivariate international tourism demand and volatility. Tourism Management 26, 459-471

Chandrashekaran, V., 1999. Time-series properties and diversification benefites fo REIT returns. Journal of Real Estate Research 17

Chiang, K.C.H., Lee, M.-L., Wisen, C.H., 2004. Another Look at the Asymmetric REIT-Beta Puzzle. Journal of Real Estate Research 26, 25-42

Cho, H., Kawaguchi, Y., Shilling, J., 2003. Insmoothing commercial proprty returns: A revision to the Fisher-Geltner-Webb's unsmoothing methodology. Journal of Real Estate Finance and Economics 27, 393-405

Clayton, J., MacKinnon, G., 2001. The time-varying nature of the link between REIT, real estate and financial asset returns. Journal of Real Estate Portfolio Management 7, 43-54

Geltner, D., Goetzmann, W., 2000. Two decades of commercial property returns: A repeated-measures regression-based version of the NCREIF index. Journal of Real Estate Finance and Economics 21, 5-21

Georgiev, G., Gupta, B., Kunkel, T., 2003. Benefits of real estate investment. Journal of Portfolio Management 30

Giliberto, S.M., 1993. Measuring real estate returns: The hedged REIT index. Journal of Portfolio Management 19, 94-99

Giliberto, S.M., 2003. Assessing real estate volatility. Journal of Portfolio Management 30, 122-128

Higgins, D., 2007. Placing commercial property in the Australian capital market. RICS research paper series 7, 9-32

Higgins, D., Ng, B., 2009. Australian securitised property funds: An examination of their risk-adjusted performance. Journal of Property Investment and Finance 27, 404-412

Hillier, D., Draper, P., Faff, R., 2006. Do precious metals shine? An investment perspective. Financial Analysts Journal 62, 98-106

Hudson-Wilson, S., Fabozzi, F.J., Gordon, J.N., 2003. Why real estate. Journal of Portfolio Management 30, 12-25

Lee, S., Stevenson, S., 2005. The case for REITs in the mixed-asset portfolio in the short and long run. Journal of Real Estate Portfolio Management 11, 55-80

MacGregor, B.D., Nanthakumaran, N., 1992. The allocation to property in the multi-asset portfolio: The evidence and theory reconsidered. Journal of Property Research 9, 5-32

Newell, G., MacFarlane, J., 1996. Risk estimation and appraisal-smoothing in UK property returns. Journal of Property Research 13, 1-12

Table 1, Auto regression models for direct investment returns

Auto regression models with 8 lags are initially fitted to the data. Statistically insignificant lags are dropped from the model and the restricted model is re-estimated. A likelihood ratio test is used to test whether the restricted model is statistically significantly different from the more general model. A further restricted model is estimated with just one lag and a likelihood test is conducted to test this restriction. RCom is the continuously compounding return on the direct commercial real estate index based on IPD/PCA Property Investors Digest Series (Composite) Index. RRes is the continuously compounded return on direct residential real estate calculated using the house

price index and rental return index obtained from the Australian Bureau of Statistics with 12% imputed management cost. * (+) statistically significant at the 5% (10%) level of significance. (N = 96)

Variable names	*RCom*	*RCom*	*RCom*	*RRes*	*RRes*	*RRes*
Constant	0.0237*	0.0241*	0.0215*	0.0325*	0.0323*	0.0324*
	(3.62)	(3.50)	(1.69)	(6.83)	(7.56)	(5.86)
AR model lag coefficients						
Lag 1	0.9533*	0.9993*	0.9430*	0.7931*	0.7769*	0.6966*
	(4.43)	(6.15)	(33.95)	(6.76)	(8.81)	(11.82)
Lag 2	0.5005*	0.4417*		0.0445		
	(2.07)	(2.44)		(0.22)		
Lag 3	-0.5178*	-0.5480*		-0.3566*	-0.1732*	
	(-2.24)	(-7.55)		(-2.02)	(-2.09)	
Lag 4	-0.1053			0.2348		
	(-0.43)			(1.55)		
Lag 5	0.0870			-0.0079		
	(0.37)			(-0.04)		
Lag 6	-0.0302			-0.0775		
	(-0.14)			(-0.54)		
Lag 7	0.0472			-0.0932		
	(0.20)			(-0.57)		
Lag 8	-0.0576			0.0756		
	(-0.31)			(0.51)		
Wald test (full model)	1812.27*	1814.11*	1152.38*	101.71*	115.26*	139.81*
LR test of restrictions		1.27	31.82*		5.09	4.34*
No. of restrictions		5	2		6	1

Table 2, Descriptive statistics

RCom is the continuously compounding return on the direct commercial real estate index based on IPD/PCA Property Investors Digest Series (Composite) Index. RCom, AR(1) is the smoothing adjusted RCom series using an AR(1) model. RCom, AR(3) is the smoothing adjusted RCom series using an AR(3) model. RRes is the continuously compounded return on direct residential real estate calculated using the house price index and rental return index obtained from the Australian Bureau of Statistics with 12% imputed management cost. RRes, AR(1) is the smoothing adjusted RRes series using an AR(1) model. RRes(1&3) is the smoothing adjusted RRes series using an AR model with lags one and three. Rareit is the continuously compounding return on the Australian Securities Exchange S&P 300 A-REIT index, Rareit(h) is the continuously compounded return on the Rareit index hedged for equity market risk using the all ordinaries share price index, Rallord is the continuously compounding return on the Australia Securities Exchange All Ordinaries Share Price Accumulation Index, BAB90 refers to the 90 day bank accepted bill rate quoted at the beginning of the quarter expressed as a continuously compounding rate of return. Mean, median, standard deviation, maximum and minimum for the continuously compounding return series for each of the variables are reported in Panel A. Serial correlation coefficients for lags 1, 2, 3, 4, 8, and 10 are provided in Panel B. Correlation coefficients between the various series are reported in Panel C. (N = 93)

Panel A, Descriptive Statistics

	Average	*Median*	*Standard Deviation*	*Maximum*	*Minimum*
RCom	0.0228	0.0252	0.0230	0.0762	-0.0323
RCom, AR(1)	0.0152	0.0189	0.1328	0.3807	-0.3779
RCom, AR(3)	0.0231	0.0252	0.0598	0.2298	-0.1723
RRes	0.0317	0.0284	0.0222	0.1116	-0.0177
RRes, AR(1)	0.0330	0.0341	0.0509	0.2025	-0.0999
RRes, AR(1&3)	0.0327	0.0320	0.0381	0.1696	-0.0564
Rareit	0.0206	0.0381	0.0913	0.2684	-0.4040
Rareit(h)	0.0040	0.0152	0.0671	0.1394	-0.2647
Rallord	0.0251	0.0387	0.0941	0.2470	-0.5219
BAB90	0.0198	0.0152	0.0101	0.0471	0.0104

Panel B, Serial correlation coefficients

	ρ1	*ρ2*	*ρ3*	*ρ4*	*ρ8*	*ρ10*
RCom	0.94*	0.88*	0.77*	0.64*	0.06	-0.22
RCom, AR(1)	0.11	0.48*	0.05	0.13	-0.05	-0.32
RCom, AR(3)	-0.03	0.03	0.03	-0.07	0.16	-0.13
RRes	0.72*	0.46*	0.20	0.12	-0.11	-0.07
RRes, AR(1)	0.12	0.11	-0.23	0.02	0.09	0.16
RRes, AR(1&3)	0.05	0.06	-0.14	0.13	0.14	0.17
Rareit	0.23	-0.04	0.15	0.13	-0.01	-0.19
Rareit(h)	0.12	-0.08	0.18	0.17	0.04	-0.19
Rallord	-0.07	-0.01	0.00	-0.15	0.12	-0.02
BAB90	0.97*	0.94*	0.90*	0.84*	0.66*	0.62*

* (+) statistically significant at the 5% (10%) level of significance.

Panel C, Correlation Coefficients

	RCom	*RCom AR(1)*	*RCom AR(3)*	*RRes*	*RRes AR(1)*	*RRes AR (1&3)*	*Rareit*	*Rareit (h)*	*Rall ord*
RCom, AR(1)	0.34*								
RCom, AR(3)	0.29*	0.85*							
RRes	0.42*	0.10	0.10						
RRes, AR(1)	0.21*	0.16	0.11	0.71*					
RRes, AR(1&3)	0.23*	0.11	0.08	0.69*	0.98*				
Rareit	0.13	0.42*	0.41*	0.11	0.04	0.01			
Rareit(h)	0.11	0.26*	0.25*	0.16	0.07	0.05	0.73*		
Rallord	0.07	0.34*	0.33*	-0.01	-0.02	-0.05	0.68*	0.00	
BAB90	0.00	-0.19*	-0.07	0.04	0.06	0.10	-0.01	0.03	-0.06

* (+) statistically significant at the 5% (10%) level of significance.

Table 3, Real estate portfolio performance

CP refers to both the smoothed (R_P) and adjusted (R_P^A) continuously compounding return on the direct commercial real estate index based on IPD/PCA Property Investors Digest Series (Composite) Index. RP refers to both the smoothed (R_P) and adjusted (R_P^A) continuously compounded return on direct residential real estate calculated using the house price index and rental return index obtained from the Australian Bureau of Statistics with 12% imputed management cost. LP refers to both the unhedged (R_P) and hedged (R_P^A) continuously compounding return on the Australian Securities Exchange S&P 300 A-REIT index. The hedged return is hedged for equity market risk using the all ordinaries share price index. The 90-day bank accepted bill rate quoted at the beginning of the quarter expressed as a continuously compounding rate of return is used as a measure of the risk free rate of return (R_f). Mean, standard deviation, Sharpe ratio or information ratio and ratio rank are reported in Panel A for various real estate portfolios using continuously compounding quarterly returns series. $R_P - R_f$ is the real estate portfolio return less the 90-day bank accepted bill yield, $R_P^A - R_f$ is adjusted real estate portfolio return less the 90-day bank accepted bill yield, R_P is real estate portfolio return and R_P^A is adjusted real estate portfolio return. The results for the Sharpe ratio and the information ratio are reported in Panel B using all available data, 1986q3 to 2009q3, as well as for sub periods, 1986q3 to 1998q1 and 1998q2 to 2009q3.

Panel A, Comparative real estate portfolio performance (1986q3 to 2009q3)

	CP	*RP*	*LR*	*CP/RP*	*CP/LR*	*RP/LR*	*CP/RP/LR*
Asset weight							
Com. prop.	1.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.3333
Res. Prop.	0.0000	1.0000	0.0000	0.5000	0.5000	0.0000	0.3333
a-reit	0.0000	0.0000	1.0000	0.0000	0.5000	0.5000	0.3333
$R_P - R_f$							
Return	0.0030	0.0119	0.0009	0.0075	0.0064	0.0020	0.0053
Std. dev.	0.0251	0.0240	0.0920	0.0214	0.0493	0.0497	0.0361
Sharpe ratio	0.1212	0.4963	0.0094	0.3500	0.1296	0.0393	0.1460
SR rank	5	1	7	2	4	6	3
$R_P^A - R_f$							
Return	0.0033	0.0130	-0.0157	0.0082	-0.0014	-0.0062	0.0002
Std. dev.	0.0613	0.0384	0.0676	0.0381	0.0399	0.0514	0.0379
Sharpe ratio	0.0544	0.3388	-0.2329	0.2145	-0.0343	-0.1206	0.0053
SR rank	3	1	7	2	5	6	4
R_P							
Return	0.0228	0.0317	0.0206	0.0272	0.0261	0.0217	0.0250
Std. dev.	0.0230	0.0222	0.0913	0.0190	0.0482	0.0485	0.0346
Info. ratio	0.9912	1.4290	0.2257	1.4292	0.5426	0.4474	0.7228
IR rank	3	2	7	1	5	6	4
R_P^A							
Return	0.0231	0.0327	0.0040	0.0279	0.0184	0.0136	0.0200
Std. dev.	0.0598	0.0381	0.0671	0.0367	0.0394	0.0502	0.0367
Info. ratio	0.3864	0.8600	0.0599	0.7613	0.4660	0.2700	0.5430
IR rank	5	1	7	2	4	6	3

Panel B, Stability of Sharpe or Information ratios ranks for the full period 1986q3 to 2009q3 and sub periods, 1986q3 to 1998q1 and 1998q2 to 2009q3

	CP	*RP*	*LR*	*CP/RP*	*CP/LR*	*RP/LR*	*CP/RP/LR*
Asset weight							
Com. prop.	1.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.3333
Res. Prop.	0.0000	1.0000	0.0000	0.5000	0.5000	0.0000	0.3333
A-REIT	0.0000	0.0000	1.0000	0.0000	0.5000	0.5000	0.3333
Sharpe ratio with unadjusted returns							
1985q4-2009q3	5	1	7	2	4	6	3
1985q4-1997q3	7	1	3	5	2	6	4
1997q4-2009q3	3	2	7	1	5	6	4
Sharpe ratio with adjusted returns							
1985q4-2009q3	3	1	7	2	5	6	4
1985q4-1997q3	3	1	7	2	4	6	5
1997q4-2009q3	3	1	7	2	5	6	4
Information ratio with unadjusted returns							
1985q4-2009q3	3	2	7	1	5	6	4
1985q4-1997q3	5	1	7	2	4	6	3
1997q4-2009q3	3	2	7	1	5	6	4
Information ratio with adjusted returns							
1985q4-2009q3	5	1	7	2	4	6	3
1985q4-1997q3	6	2	7	4	1	5	3
1997q4-2009q3	3	1	7	2	5	6	4

Table 4, Impact of real estate investment on equity portfolio

SP refers to the continuously compounding return on the Australia Securities Exchange All Ordinaries Share Price Accumulation Index. CP refers to both the smoothed (R_P) and unsmoothed (R_P^A) continuously compounding return on the direct commercial real estate index based on IPD/PCA Property Investors Digest Series (Composite) Index. RP refers to both the smoothed (R_P) and unsmoothed (R_P^A) continuously compounded return on direct residential real estate calculated using the house price index and rental return index obtained from the Australian Bureau of Statistics with 12% imputed management cost. LP refers to both the unhedged (R_P) and hedged (R_P^A) continuously compounding return on the Australian Securities Exchange S&P 300 A-REIT index. The hedged return is hedged for equity market risk using the all ordinaries share price index. The 90-day bank accepted bill rate quoted at the beginning of the quarter expressed as a continuously compounding rate of return is used as a measure of the risk free rate of return (R_f). Mean, standard deviation, Sharpe ratio or information ratio and ratio rank are reported in Panel A for various real estate portfolios using continuously compounding quarterly returns series. $R_P^A - R_f$ is adjusted real estate portfolio return less the 90-day bank accepted bill yield. R_P^A is adjusted real estate portfolio return. The results for the Sharpe ratio and the information ratio are reported in Panel B using all available data, 1986q3 to 2009q3, as well as for sub periods, 1986q3 to 1998q1 and 1998q to 2009q3.

Panel A, Comparative share and real estate portfolio performance (1986q3 to 2009q3)

	SP	*CP*	*RP*	*LR*	*CP/RP*	*CP/LR*	*RP/LR*	*CP/RP/LR*
Asset weight								
Commercial		1.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.3333
Residential		0.0000	1.0000	0.0000	0.5000	0.5000	0.0000	0.3333
A-REIT		0.0000	0.0000	1.0000	0.0000	0.5000	0.5000	0.3333
$R_P^A - R_f$	95% shares	5% real estate						
Return	0.0054	0.0053	0.0057	0.0043	0.0055	0.0050	0.0048	0.0051
Std. dev.	0.0952	0.0916	0.0905	0.0906	0.0910	0.0905	0.0911	0.0909
Sharpe ratio	0.0563	0.0575	0.0635	0.0476	0.0605	0.0556	0.0526	0.0562
SR rank	4	3	1	8	2	6	7	5
R_P^A	95% shares	5% real estate						
Return	0.0251	0.0250	0.0255	0.0241	0.0253	0.0248	0.0245	0.0249
Std. dev.	0.0941	0.0905	0.0894	0.0895	0.0899	0.0894	0.0899	0.0897
Info. ratio	0.2668	0.2765	0.2854	0.2689	0.2810	0.2772	0.2728	0.2770
IR rank	8	5	1	7	2	3	6	4
$R_P^A - R_f$	90% shares	10%real estate						
Return	0.0054	0.0052	0.0061	0.0033	0.0056	0.0047	0.0042	0.0048
Std. dev.	0.0952	0.0881	0.0857	0.0861	0.0868	0.0858	0.0870	0.0865
Sharpe ratio	0.0563	0.0586	0.0715	0.0378	0.0650	0.0547	0.0484	0.0560
SR rank	4	3	1	8	2	6	7	5
R_P^A	90% shares	10%real estate						
Return	0.0251	0.0249	0.0259	0.0230	0.0254	0.0244	0.0240	0.0246
Std. dev.	0.0941	0.0869	0.0846	0.0850	0.0857	0.0847	0.0858	0.0854
Info. ratio	0.2668	0.2867	0.3058	0.2708	0.2964	0.2886	0.2791	0.2881
IR rank	8	5	1	7	2	3	6	4

Panel B, Stability of Sharpe or Information ratios ranks for the full period 1986q3 to 2009q3 and sub periods, 1986q3 to 1998q1 and 1998q2 to 2009q3

	SP	*CP*	*RP*	*LR*	*CP/RP*	*CP/LR*	*RP/LR*	*CP/RP/LR*
Asset weight								
Commercial		1.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.3333
Residential		0.0000	1.0000	0.0000	0.5000	0.5000	0.0000	0.3333
A-REIT		0.0000	0.0000	1.0000	0.0000	0.5000	0.5000	0.3333
	95%							
Sharpe ratio with adjusted returns	shares	5% real estate						
1985q4-2009q3	4	3	1	8	2	6	7	5
1985q4-1997q3	3	6	1	8	2	4	7	5
1997q4-2009q3	5	3	1	8	2	6	7	4
	95%							
Information ratio with adjusted returns	shares	5% real estate						
1985q4-2009q3	8	5	1	7	2	3	6	4
1985q4-1997q3	8	5	1	7	2	3	6	4
1997q4-2009q3	7	3	1	8	2	5	6	4
	90%							
Sharpe ratio with adjusted returns	shares	10% real estate						
1985q4-2009q3	4	3	1	8	2	6	7	5
1985q4-1997q3	3	6	1	8	2	4	7	5
1997q4-2009q3	5	3	1	8	2	6	7	4
	90%							
Information ratio with adjusted returns	shares	10% real estate						
1985q4-2009q3	8	5	1	7	2	3	6	4
1985q4-1997q3	8	6	1	7	2	3	5	4
1997q4-2009q3	7	3	1	8	2	5	6	4

Figure 1, Comparison of initial and adjusted direct real estate investment indices