Serial Persistence in Disaggregated Australian Real Estate Returns

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Executive Summary: Serial persistence of total annual returns for all properties in the Property Council of Australia database is shown to be statistically significant in all quartiles of disaggregated returns between 1985 and 1997. More precisely, performance in a particular quartile is generally followed by continued performance in the same quartile. However, when grouped by property type, persistence differences emerge. Office and Retail properties show statistically significant persistence in the extreme (combined first and fourth) quartiles and moderate (combined second and third) quartiles but Industrial properties show serial independence in both the extreme and moderate quartiles. When Office properties are grouped by CBD and non-CBD locations, serial persistence exists in all quartiles for CBD Office properties but not for non-CBD Office properties. The empirical evidence of serial persistence among real estate returns in the Property Council of Australia database challenges the conclusions of research based upon models that incorporate the assumption of serial independence.

Introduction

This study examines persistence in relative investment return performance for Australian commercial property during the thirteen-year interval January 1985 through December 1997. Cross-sectional total return data are compiled for year-end annual sampling frequencies, and are further divided into property type subgroups. Because office property performance data are available for Central Business District (CBD) and non-Central Business District (non-CBD) subsets, we further divide the office sample into two subsamples according to location.

This work extends to the Australian market the results of earlier research by two of the authors (Young & Graff [1996]), which found statistically significant serial persistence in annual returns from privately-held U.S. real estate in the NCREIF database. Some researchers have suggested that the unexpected persistence reported in those studies results from spuriously low observed volatility in appraisal-based, privately-held real estate returns due to appraisal smoothing. We reject applicability of suggestion to the present study on both theoretical and practical grounds.[1]

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[1] Although never verified directly, appraisal smoothing has been popular among real estate economists because of its purported ability to explain the relatively high Sharpe ratio observed for U.S. privately-held real estate in the mid-1980s by implying that sample real estate volatility is biased downward from true real estate volatility. However, two recent developments, undermine the logic of this rationale: (1) Lai & Wang [1998] show that, under modeling assumptions employed in appraisal smoothing studies, appraisal smoothing cannot reduce observed volatility; and (2) Graff & Webb [1997] show that appraisal smoothing would produce cross-sectional return distributions that are normal or platykurtic (i.e., zero or negative kurtosis), whereas it is known from previous empirical studies of both U.S. and Australian data (Young &

The methodology in this study is as follows: for each annual sample period, we group individual property returns into quartiles and record the quartile rank. *Successful persistence* is then defined as the same quartile rank in the subsequent annual period, and *unsuccessful persistence* as a different quartile rank in the subsequent annual period. Serial independence is used to describe asset returns for which return performance in each sample period relative to the commercial real estate investment universe is unrelated to relative return performance in the subsequent sample period. Since the returns are grouped into quartiles, the theoretical probability of repetitive quartile rankings is 25% if consecutive quartile rankings for each property are serially independent, the typical assumption made by researchers. Accordingly, statistically significant departures from 25% among sample persistence statistics are deemed evidence that asset returns are not serially independent.

Additional objectives of the study are to examine whether persistence behavior differs between returns of extreme-percentile rank and returns of moderate-percentile rank, and to examine whether persistence behavior is uniform within the respective subclasses of extreme and moderate returns.

We extend the methodology to longer runs by applying the same criteria for performance persistence in the period subsequent to a sequence of same-quartile rankings. By analogy with the above case, successful (unsuccessful) persistence is defined as the same (different) quartile rank in the sampling period immediately subsequent to an initial sequence of sampling periods in which the quartile rank does not vary. This enables us to examine whether the incidence of persistence depends solely on quartile rank for the immediately preceding sampling period, or whether the incidence of persistence is a function of quartile ranks over several preceding sampling periods.[2]

Tests in this study are nonparametric, although the test outcomes are not totally independent of specification of a class of statistical models for property returns. As will be discussed, the statistical test methodology is closely tied to the assumption that there is no simple linear factor model for property returns that could be applied to all properties irrespective of type, an assumption that is supported by empirical results in this study.

Australian Real Estate Performance Data

The Property Council of Australia's Investment Performance Index provides investment performance information on Australian commercial property. As of December 1997, the Index comprised 554 office, retail, and industrial properties, valued at $A34.7 billion. The market coverage by area is around 33% of Australian CBD office stock and in excess of 32% of the total retail stock.

The Index data are compiled from information supplied by more than seventy of Australia's largest superannuation funds (pension funds), life insurance companies, and listed property trusts (equivalent to the U.S. REITs).

Graff [1995] and Graff, Harrington & Young [1997]) that cross-sectional returns are leptokurtic (i.e., positive kurtosis).

2 Sample numbers decline significantly as initial run length increases, weakening the sensitivity of tests based on multiperiod initial runs. Consequently, these tests tend to yield indications of results rather than definitive conclusions.

The Investment Performance Index extends back to December 1984. Until June 1995, the Index was calculated on a semiannual basis. However, in response to the demand for a more frequent information service, the Property Council now produces a quarterly index.

The Index is directly comparable to the U.S. NCREIF Property Index with a slight difference in the denominator of the return formula.[3] Investment returns are calculated using realized income and market values as determined by a registered valuer. The majority of valuations are conducted on an annual basis, although around 25% of the index by market capitalization is revalued quarterly. Most Australian funds revalue property assets in either June or December. The data collection and verification procedures of the Property Council of Australia differ from those of NCREIF, and are discussed in Graff, Harrington & Young [1997].

Exhibit 1 presents descriptive cross-sectional statistics for the Property Council of Australia property database decomposed into annual and property-type aggregates. In contrast to NCREIF properties, the Property Council of Australia properties show generally higher mean annual returns and standard deviations. Also, the annual returns show notable skewness and considerable leptokurtosis, i.e., positive kurtosis.

Persistence Test

For each annual sample period in the interval 1985 through 1997, the total returns for each property are assigned quartile rankings. As previously discussed, within each quartile group we examine the incidence of serial runs of uniform quartile rank. Our test statistic is the sample incidence of successful persistence, i.e., the observed rate at which a repetitive quartile rank occurs in the period immediately subsequent to a run of identical quartile rankings over one, two, three, or four sample periods. The persistence counting procedure is described more fully in the Appendix.

Our null hypothesis is that the quartile ranks of the annual property returns are serially independent. This implies that the probability of a return quartile rank remaining the same from one year to the next is 25%. Thus, statistically significant departures from 25% are considered statistical justification for rejection of the null hypothesis, i.e., evidence of performance persistence.

We aggregate returns in the two extreme quartiles as our proxy for extreme returns, and returns in the two middle quartiles as our proxy for moderate returns. Within each subclass, the sample incidence of successful persistence is then defined to be the combined number of occurrences of successful quartile persistence in the two component quartiles divided by the combined number of samples in the two quartiles.[4]

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[3] The formula used to calculate the quarterly time-weighted total returns is: Total Return = (EMV - BMV + PS - CI + NI) / (BMV - 0.5 PS + 0.5 CI - 0.5 NI) where EMV is the quarter-end market value, BMV is the beginning market value for the quarter, PS is partial sales proceeds, CI is capital improvements made in the quarter, and NI is the net income for the quarter. Unlike the NCREIF formula, the Property Council Australia formula assumes that net income is received at the mid-point of the quarter rather than monthly.

[4] An alternative approach to performance persistence in extreme and moderate returns would be to define the test statistic directly in terms of the incidence of repetitive performance within the two subclasses. However, this approach is unacceptable because a property return that falls within one extreme quartile during any sample period (e.g., first quartile) and in the other extreme quartile during the following period (e.g., fourth quartile) would be included erroneously among the persistent extreme returns.

If returns within each component quartile are serially independent, then it follows that the expected value of sample persistence within the subclass is 25%. Thus, the test for performance persistence in the component quartiles extends to a test for performance persistence in the larger subclasses of extreme and moderate returns.

For each year we let statistical software determine the 25th, 50th (median), and 75th percentile breakpoints, and then define the quartile groupings as follows: returns greater than the 75th percentile breakpoint constitute the 1st Quartile, returns greater than or equal to the 50th percentile breakpoint and less than or equal to the 75th percentile breakpoint constitute the 2nd Quartile, returns greater than or equal to the 25th percentile breakpoint and less than the 50th percentile breakpoint constitute the 3rd Quartile, and returns less than the 25th percentile breakpoint constitute the 4th Quartile.

Because the number of property returns is usually not evenly divisible by four, sample returns in the four quartiles are not always precisely equal in number. It follows from the definition of the quartiles that the priority for enlarging quartile groups as the number of return samples increases is as follows: first, the 2nd Quartile; next, the 3rd Quartile; then, the 1st Quartile; and finally, the 4th Quartile. Thus, there is a marginal downward persistence bias in the case of the extreme quartiles and a marginal upward bias in the case of the moderate quartiles.

Confidence Interval Estimation

To determine whether quartile performance is serially dependent, we calculate confidence intervals for the binomial distribution under the assumption that the probability of repeating quartile performance is 25%.

The sample statistic is the percent of sample returns for which the quartile rank during each initial sampling period equals the quartile rank in the immediately subsequent sample period. The critical question is whether or not the sample statistic is statistically equivalent to 25%.

For a $q\%$ confidence interval and n samples, the upper end point of the confidence interval is m/n, where the cumulative probability of m or fewer successes is at least $(1+.01*q)/2$ and the cumulative probability of $m-1$ or fewer successes is less than $(1+.01*q)/2$. Similarly, the lower end point of the confidence interval is k/n, where the cumulative probability of k successes is at least $(1-.01*q)/2$ and the cumulative probability of $k-1$ or fewer successes is less than $(1-.01*q)/2$.

Since the binomial distribution is discrete, the sample statistic can only assume a finite number of potential values between 0 and 1. Thus, in contrast to smooth probability distributions, there is a positive probability that a sample value for the statistic can equal one of the end points of a $q\%$ confidence interval. In order to avoid confusion in such a case about whether or not the sample value is within the confidence interval, the left end point of the $q\%$ confidence interval is reported in the exhibits as $(m+1/2)/n$, and the right end point of the confidence interval is reported as $(k-1/2)/n$.[5] Since $(m+1/2)/n$ and $(k-1/2)/n$ cannot occur as sample values (each is midway between two possible sample values for the binomial distribution), each sample value reported in the exhibits is either unambiguously inside or outside each confidence interval.

[5] Since the range of the binomial distribution is the closed unit interval [0,1], in order to avoid confusion the end points of the confidence interval are not expanded by $1/(2*n)$ in the extreme cases $m=n$ or $k=0$.

The standard determination of confidence intervals for the binomial distribution is based on the assumption that samples from the distribution are independent. Since pairs of successive property return rankings for different properties in the same years are treated as distinct samples, it follows that there is an implicit assumption under the null hypothesis that each persistence test sample is independent of samples for other properties in the same year. This assumption would be questionable were a linear factor model to exist that could describe the variance of property returns in terms of a small number of parameters.[6]

This potential complication is diminished by recent evidence that linear factor models cannot describe a significant percentage of the variance of returns from privately-held institutional-grade real estate in either Australia or the U.S.[7]

Tests and Results

As shown in Exhibit 2, Panel A, performance persistence is statistically significant in the extremes of the cross-sectional distribution of the full set of Property Council of Australia property returns for the years 1985 to 1997. Statistically significant performance persistence is found in each of quartile following runs of 1 year; in the first, second, and fourth quartiles following runs of 2 years; in the first and fourth quartiles following runs of 3 years; and in the fourth quartile following runs of 4 years. Combining the first and fourth quartiles into an extreme-quartile group and combining the second and third quartiles into a moderate-quartile group, we find that there is statistically significant persistence in the extreme-quartile group following runs of 1 through 4 years, and that there is somewhat lesser statistically significant persistence in the moderate-quartile group following runs of 1 and 2 years.

When we disaggregate properties by type, two distinct patterns of return persistence become apparent. Panels B and D of Exhibit 2 show persistence similar to the property aggregates in Panel A for Office and Retail properties. In particular, Office and Retail property return persistence exists in both the extreme-quartile and the moderate-quartile groupings. Again, the degree of persistence is greater in the extreme quartiles than in the moderate quartiles. Panel B, Office properties, shows that persistence of total annual returns in the extreme first and fourth quartiles is statistically significant for runs of 1, 2, and 3 years. In addition, persistence in the moderate quartiles is statistically significant for runs of 1 and 2 years.

The results for Industrial properties shown in Panel C of Exhibit 2 stand in sharp contrast to the results of Office and Retail properties. There is no statistically significant persistence in the extreme quartiles of any run . In the case of the moderate quartiles, there is marginally significant persistence in the second quartile results following a run of 1 year, and for the third quartile results following a run of 2 years. However, we cannot reject the possibility that these are among the small number of random false positive test results to be expected whenever a large number of

6 It is well known that factor models exist that describe substantial portions of asset return variance in major stock and bond classes. Thus, the null hypothesis in the performance persistence test cannot be rejected for these asset classes solely on the basis of confidence intervals computed from the binomial distribution, although such confidence intervals do provide sufficient criteria for acceptance of the null hypothesis. This suggests that applicability of the statistical methodology in this study is limited in scope. However, it is reasonable to expect that the methodology can be applied to test performance persistence in narrowly defined asset subclasses such as privately-held real estate and publicly traded REITs (for the latter, see Graff & Young[1997]).

7 See Graff & Young [1996]; Young & Graff [1996]; Graff, Harrington & Young [1997]; and Graff & Webb [1997].

tests is conducted. In short, both the extreme and moderate quartile results in Panel C fail to show persistence statistically distinguishable from the theoretical expected value of 25%.

Panels E and F of Exhibit 2 show persistence results for Office property type divided into two subgroups based on their locations: CBD and non-CBD. Panel E, CBD Office properties, shows statistically significant performance persistence in all four quartiles following a run length of 1. When results of the extreme and moderate quartiles are combined, we find that persistence in the extreme quartiles exceeds that of the moderate quartiles in a manner similar to the All Property, Office, and Retail persistence results discussed above.

Panel F, non-CBD Office properties, show randomness in all quartiles following a run of 1 year, and contrasts sharply with serial dependence in the CBD Office results. Likewise, the combined extreme and moderate quartile results are statistically indistinguishable from the theoretical expected value of 25%.

In Exhibit 3, which covers two intervals—1985 to 1992 and 1992 to 1997—of CBD and non-CBD Office data, we find some evidence that, over time, non-CBD Office performance persistence might approach CBD Office performance persistence. While still not statistically significant over the 1992 to 1997 sampling interval, the non-CBD Office persistence shown in Panel B increases in both the extreme-quartile and moderate-quartile groups relative to the performance persistence exhibited over the 1985 to 1992 interval. In particular, the percent of successful persistence of non-CBD Office property in the extreme-quartile following runs of 1 year over the 1992 to 1997 interval is 30.2% versus 25.9% over the 1985 to 1992 interval. Similarly, the percent of successful persistence of non-CBD Office property in the moderate-quartile group following runs of 1 year over the 1992 to 1997 interval is 27.9% versus 25.1% over the 1985 to 1992 interval.

The results of the statistical tests in the combined extreme quartiles as well as the moderate quartiles provide irrefutable evidence of systematic serial dependence, a finding that invalidates the current formulations of portfolio theory and practice within the real estate asset class that rely upon assumptions of normal distributions and uniform risk across time.

Conclusions

By employing the Markowitz mean-variance model that assumes that the mean and standard deviation of one-period returns are sufficient statistics for evaluating investment portfolios, researchers generally have ignored higher moments of return distributions. In the real estate asset class, empirical studies by the authors and others have challenged the applicability of Modern Portfolio Theory (MPT) and its antecedent the Efficient Markets Hypothesis (EMH) in their current forms.[8] The present study extends this challenge by presenting empirical evidence about the third and fourth moments of annual commercial property returns that conflict with implications of the mean-variance model.

The empirical persistence results in this study demonstrate conclusively that total returns from properties within the Property Council of Australia database between 1985 and 1997 exhibit serial dependence within Office and Retail property returns and serial independence within Industrial property returns. These conclusions are at odds with the prevailing assumption about real estate risk, and appear to invalidate current beliefs about statistically-derived risk

8 Liu, Hartzell & Grissom [1992], Myer & Webb [1990, 1993], and Young & Graff [1995] note substantial departures from Gaussian normal return distributions in commercial real estate.

proxies and MPT-based portfolio construction applications.[9] In particular, if MPT or EMH are valid models for equity real estate, our findings of performance persistence in extreme returns and qualitative differences in performance persistence across property types or geographical regions should not be observed. More generally, it follows that the conclusions of research based upon models that incorporate the assumption of serial independence within real estate returns are of dubious reliability for real estate investors.

That persistence in extreme or moderate quartiles is qualitatively different depending upon property type argues strongly against the existence of linear multifactor market models in the case of Australian commercial real estate. Unless researchers can demonstrate the existence of a class of linear multifactor models based on financial and real economic imput variables that generate persistence in extreme quartiles of annual property returns for Office and Retail properties but imply serial independence in extreme and moderate quartiles of annual property returns for Industrial properties, we must conclude that linear multifactor models are inapplicable in the case of Australian commercial real estate.

There is no explanation in terms of efficient market theory for the qualitatively different persistence behavior observed in Exhibit 2 between CBD and non-CBD Office properties, although the explanations for serial persistence proposed in Graff & Webb [1997] in terms of agency costs can account for this difference. For example, the Graff & Webb study proposes that sporadic intense competition among institutional managers to place investment capital generates acquisition premia with respect to comparable market prices that are amortized away by appraisers over several years of subsequent valuations. The amortization translates into several years of downward bias in the appraisal-based return series that tends to generate fourth-quartile returns exhibiting apparent serial persistence.[10]

In the case of Australian Office property, the large numerical ratio of CBD to non-CBD properties together with the higher valuations associated with CBD property has resulted in a great deal of institutional manager interest in CBD property and relatively little institutional manager interest in non-CBD property. Thus, the Graff & Webb model can account for the difference in serial persistence between CBD and non-CBD Office property returns by invoking agency effects in the case of CBD property and observing that these effects are absent in the case of non-CBD property.

This explanation can also account for the observation presented in Exhibit 3. Although not yet statistically significant, the increase in serial persistence observed in non-CBD Office property returns between the 1985-1992 interval and the 1992-1997 interval is consistent with a gradual increase in institutional manager interest in non-CBD Office property that has developed in the 1990s. If institutional manager interest continues to increase, the Graff & Webb model suggests that serial persistence in non-CBD Office returns should rise to the levels observed in CBD Office property returns.

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9 Virtually all analyses of real estate risk and return proxy risk as the standard deviation of an i.i.d. (independent identically distributed) time series. However, if some real estate return series are serially dependent, then such a risk proxy is invalid.

10 A related model also explains serial persistence in first quartile performance in terms of agency costs, see Graff & Webb [1997].

In general, in efforts to identify the economic forces and mechanisms that produce the results observed in this study, we suggest that agency-related concepts will provide a fertile field for future research.

Appendix

Counting Runs and Persistence

The manner by which we count runs and determine persistence can be shown by way of example from the actual sample data. The following table is an excerpt from the data covering the years 1985 to 1997, the last full year of our sample.

Quartile Rank for Properties, 1985 to 1997

Property	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Prop01	4	3	3	4	1	3	3	1	1	4	3	2	1
Prop02	4	4	4	4	2	1	1	3					
Prop03			4	1	3	1	2	3	3	4			
Prop04		3	2	2	2	1	2	3	4	2	4	3	4
Prop05	1	1	2	2	4	2	2	3	4	3	4	4	4

Reading across, we find that Prop01 has three runs of first-quartile rank with a length of 1 in 1989, 1992, and 1993 (we cannot count the 1997 rank of 1 as a run because the “end point” must be reserved to examine whether or not persistence exists for the year immediately preceding the “end point,” i.e., for the year 1996). Also, Prop01 has one run of length 2 of the first-quartile rank: years 1992 and 1993. Prop01 has only one run of the second-quartile rank in 1996; five runs of length 1 of third-quartile rank: years 1986, 1987, 1990, 1991, and 1995; two runs of length 2 of third-quartile rank: years 1986 and 1987 and years 1990 and 1991; and three runs of length 1 of fourth quartile rank: years 1985, 1988, and 1994.

Staying with Prop01, we find that runs of length 2 give rise to persistence following a run of length 1, which we refer to as a “success.” In the Prop01 data, we find that a third-quartile run of length 1 in 1986 is followed by persistence within the third quartile in 1987. Similarly, a third-quartile run of length 1 in 1990 is followed by persistence within the third quartile in 1991. Also, a first-quartile rank of length 1 in 1992 is followed by persistence within the first quartile in 1993.

The Prop02 returns demonstrate imbedded runs. There are four fourth-quartile runs of length 1 for the years 1985, 1986, 1987, and 1988. The first three of these years show persistence in the fourth quartile because the following year also exhibits a fourth quartile rank. Also, there are three fourth-quartile runs of length 2 for the years 1985 and 1986, 1986 and 1987, and 1987 and 1988. Only the first two pairs of years show persistence in the following year. Next, there are two fourth-quartile runs of length 3 for the years 1985, 1986, and 1987; and 1986, 1987, and 1988. Only the first run of three years shows persistence in the following year, i.e., continuation in the fourth quartile in 1988. Finally, there is one fourth-quartile run of length 4, but no persistence in the year immediately following.

We follow this procedure of counting runs and successful persistence for each sample property. The results for the small set shown above would tally as follows:

	1st Quartile Performance			2nd Quartile Performance		
	Length of Run	No. of Samples	No. of Successes	Length of Run	No. of Samples	No. of Successes
Prop01	1	3	1	1	1	0
	2	1	0			
Prop02	1	2	1	1	1	0
	2	1	0			
Prop03	1	2	0	1	1	0
Prop04	1	1	0	1	5	2
				2	2	1
				3	1	0
Prop05	1	2	1	1	4	2
	2	1	0	2	2	0

	4th Quartile Performance			3rd Quartile Performance		
	Length of Run	No. of Samples	No. of Successes	Length of Run	No. of Samples	No. of Successes
Prop01	1	3	0	1	5	2
				2	2	0
Prop02	1	4	3			
	2	3	2			
	3	2	1			
Prop03	1	1	0	1	3	1
				2	1	0
Prop04	1	2	0	1	3	0
Prop05	1	4	2	1	2	0
	2	1	1			

References

Graff, R.A., A. Harrington and M.S. Young, The Shape of Australian Real Estate Return Distributions and Comparisons to the United States, *Journal of Real Estate Research*, 1997, 14:3, 291-308.

Graff, R.A. and J.R. Webb, Agency Costs and Inefficiency in Commercial Real Estate, *Journal of Real Estate Portfolio Management*, 1997, 3:1, 19-36.

Graff, R.A. and M.S. Young, Real Estate Return Correlations: Real-World Limitations on Relationships Inferred from NCREIF Data, *Journal of Real Estate Finance and Economics*, 1996, 13:2, 121-142.

Graff, R.A. and M.S. Young, Serial Persistence in Equity REIT Returns, *Journal of Real Estate Research*, 1997, 14:3, 183-214.

Lai, T-Y. and K. Wang, Appraisal Smoothing: The Other Side of the Story, *Real Estate Economics*, 1998, 26:3, 511-535.

Liu, C.H., D. J. Hartzell and T.V. Grissom, The Role of Co-Skewness in the Pricing of Real Estate, *Journal of Real Estate Finance and Economics*, 1992, 5:3, 299-319.

Myer, F.C.N. and J.R. Webb, Are Commercial Real Estate Returns Normally Distributed? working paper, Cleveland State University, 1990.

Myer, F.C.N. and J.R. Webb, Return Properties of Equity REITs, Common Stocks, and Commercial Real Estate: A Comparison, *Journal of Real Estate Research*, 1993, 8:1, 87-106.

Young, M.S. and R.A. Graff, Real Estate Is Not Normal: A Fresh Look at Real Estate Return Distributions, *Journal of Real Estate Finance and Economics*, 1995, 10:3, 225-259.

Young, M.S. and R.A. Graff, Systematic Behavior in Real Estate Investment Risk: Performance Persistence in NCREIF Returns, *Journal of Real Estate Research*, 1996, 12:3, 369-381.

Exhibit 1

Property Council of Australia Property Database
Cross-sectional Statistics

Type/Year	Number	Mean	Std Deviation	Skewness	Kurtosis
All Properties					
1985	220	16.05	15.42	0.80 *	8.69 *
1986	296	17.84	16.59	2.12 *	7.65 *
1987	321	27.29	33.59	9.24 *	124.66 *
1988	376	29.12	21.53	1.52 *	6.11 *
1989	453	18.20	14.31	0.96 *	6.53 *
1990	503	3.74	14.51	-0.18	2.88 *
1991	540	-8.79	16.20	-0.25 *	-0.12
1992	546	-3.97	19.10	0.09	1.00 *
1993	547	0.14	16.93	-0.47 *	0.58 *
1994	524	13.10	14.11	0.37 *	3.21 *
1995	561	10.03	12.55	0.35 *	8.62 *
1996	557	8.78	11.30	-0.15	3.35 *
1997	511	12.34	11.81	-0.12	3.53 *
Office Property					
1985	113	17.13	18.74	0.94 *	6.10 *
1986	168	18.24	18.52	2.31 *	7.37 *
1987	193	30.13	40.80	8.39 *	93.44 *
1988	232	31.48	21.82	1.20 *	3.12 *
1989	293	17.17	14.11	0.74 *	4.83 *
1990	327	1.94	15.35	-0.10	2.94 *
1991	351	-12.73	15.56	-0.20	-0.08
1992	357	-10.60	17.71	0.32 *	2.36 *
1993	351	-5.51	16.15	-0.36 *	1.02 *
1994	352	10.72	14.93	0.41 *	3.20 *
1995	327	7.93	13.52	-0.04	4.46 *
1996	315	6.99	12.06	0.11	3.28 *
1997	278	10.69	13.29	-0.38 *	1.44 *
Industrial Property					
1985	64	13.09	11.69	-1.55 *	9.75 *
1986	76	17.22	12.80	1.94 *	4.46 *
1987	72	23.46	16.75	1.06 *	2.80 *
1988	78	24.59	16.38	-0.16	2.21 *
1989	79	22.62	15.20	-0.46	3.82 *
1990	82	2.45	12.87	0.19	3.25 *
1991	89	-9.35	13.00	-0.34	0.12
1992	91	3.79	14.58	0.18	1.14 *
1993	98	5.15	13.44	-0.72 *	1.28 *
1994	99	18.12	13.84	0.53 *	2.19 *
1995	117	15.67	11.43	3.73 *	25.95 *
1996	122	12.51	10.05	-0.96 *	2.88 *
1997	123	17.57	9.61	2.17 *	12.14 *

Exhibit 1 (continued)

Property Council of Australia Property Database
Cross-sectional Statistics

Type/Year	Number	Mean	Std Deviation	Skewness	Kurtosis
Retail Property					
1985	43	17.61	8.88	1.44 *	2.79 *
1986	52	17.45	15.04	0.51	4.96 *
1987	56	22.39	17.90	1.58 *	4.11 *
1988	66	26.18	24.72	2.84 *	13.94 *
1989	81	17.63	13.45	3.90 *	24.20 *
1990	94	11.12	9.87	0.56 *	1.02 *
1991	100	5.51	12.73	-0.94 *	2.73 *
1992	98	12.94	13.96	0.29	2.33 *
1993	98	15.36	10.81	-0.56 *	1.38 *
1994	100	15.85	8.99	1.71 *	6.26 *
1995	117	10.24	8.45	-1.70 *	7.97 *
1996	120	9.68	9.29	0.13	7.77 *
1997	110	10.66	7.70	-0.09	2.16 *
Office Property, CBD					
1985	100	18.29	19.57	0.77 *	5.48 *
1986	135	19.63	19.36	2.27 *	6.94 *
1987	158	29.66	22.77	2.01 *	7.15 *
1988	187	32.20	22.94	1.12 *	2.83 *
1989	228	16.59	14.81	0.77 *	4.97 *
1990	254	2.58	15.96	-0.05	2.91 *
1991	274	-13.03	16.12	-0.21	-0.27
1992	274	-11.41	17.80	0.18	1.57 *
1993	264	-6.43	16.15	0.01	0.45
1994	246	10.11	15.89	0.55 *	3.13 *
1995	243	5.94	14.58	0.22	4.26 *
1996	228	5.39	12.59	0.41 *	3.87 *
1997	196	8.29	13.63	-0.35 *	1.26 *
Office Property, Non-CBD					
1985	13	8.21	4.58	-0.15	0.55
1986	33	12.56	13.40	1.93 *	4.89 *
1987	35	32.29	83.67	5.50 *	31.41 *
1988	45	28.47	16.21	1.46 *	2.68 *
1989	65	19.20	11.18	0.86 *	1.70 *
1990	73	-0.31	12.86	-0.72 *	2.09
1991	77	-11.63	13.39	-0.02	0.92
1992	83	-7.89	17.22	0.90 *	5.47 *
1993	87	-2.71	15.88	-1.59 *	4.42 *
1994	79	12.63	11.33	-0.32	1.67 *
1995	84	13.69	7.31	0.62 *	1.53 *
1996	87	11.17	9.40	-0.70 *	2.16 *
1997	82	16.45	10.45	0.26	1.82 *

* statistically significant with 95% confidence

Exhibit 2
Annual Return Persistence, 1985 to 1997

Panel A: All Properties

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st Quartile:					2nd Quartile:				
1	1,269	451	35.5 ****	(22.6,27.5)	1	1,302	367	28.2 **	(22.6,27.4)
2	382	146	38.2 ****	(20.5,29.5)	2	315	97	30.8 *	(20.2,30.0)
3	119	48	40.3 ***	(17.2,33.2)	3	81	27	33.3	(15.4,35.2)
4	40	15	37.5	(11.3,41.3)	4	22	7	31.8	(6.8,47.7)
4th Quartile:					3rd Quartile:				
1	1,223	480	39.2 ****	(22.5,27.5)	1	1,286	391	30.4 ***	(22.6,27.4)
2	373	170	45.6 ****	(20.5,29.6)	2	321	89	27.7	(20.1,30.1)
3	121	63	52.1 ****	(16.9,33.5)	3	69	19	27.5	(13.8,37.0)
4	39	23	59.0 ***	(11.5,39.7)	4	16	6	37.5	(3.1,53.1)
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1	2,492	931	37.4 ****	(23.3,26.7)	1	2,588	758	29.3 ***	(23.3,26.7)
2	755	316	41.9 ****	(21.9,28.1)	2	636	186	29.2 *	(21.6,28.5)
3	240	111	46.3 ****	(19.4,30.6)	3	150	46	30.7	(17.7,32.3)
4	79	38	48.1 ***	(14.6,34.8)	4	38	13	34.2	(11.8,40.8)

Panel B: Office Properties

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st Quartile:					2nd Quartile:				
1	781	274	35.1 ****	(22.0,28.1)	1	818	225	27.5	(22.1,28.1)
2	242	79	32.6 **	(19.6,30.8)	2	186	57	30.6	(18.5,31.5)
3	66	21	31.8	(14.4,37.1)	3	44	15	34.1	(12.5,39.8)
4	16	2	12.5	(3.1,53.1)	4	12	2	16.7	[0.0,54.2)
4th Quartile:					3rd Quartile:				
1	740	266	35.9 ****	(21.8,28.2)	1	804	239	29.7 **	(22.0,28.0)
2	202	84	41.6 ***	(19.1,31.4)	2	201	71	35.3 **	(18.7,31.1)
3	59	28	47.5 ***	(14.4,36.4)	3	57	18	31.6	(13.2,37.7)
4	20	7	35.0	(7.5,47.5)	4	16	5	31.3	(3.1,53.1)
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1	1,521	540	35.5 ****	(22.8,27.3)	1	1,622	464	28.6 **	(22.9,27.2)
2	444	163	36.7 ****	(20.8,29.2)	2	387	128	33.1 ***	(20.5,29.6)
3	125	49	39.2 ***	(17.2,33.2)	3	101	33	32.7	(16.3,34.2)
4	36	9	25.0	(9.7,40.3)	4	28	7	25.0	(8.9,44.6)

Exhibit 2 (continued)
Annual Return Persistence, 1985 to 1997

Panel C: Industrial Properties

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st Quartile:					2nd Quartile:				
1	244	55	22.5	(19.5,30.5)	1	247	76	30.8 *	(19.6,30.6)
2	46	12	26.1	(12.0,38.0)	2	58	19	32.8	(12.9,37.1)
3	9	3	33.3	[0.0,61.1)	3	15	5	33.3	(3.3,50.0)
4	2	1	50.0	[0.0,100.0]	4	5	2	40.0	[0.0,70.0)
4th Quartile:					3rd Quartile:				
1	230	62	27.0	(19.3,31.1)	1	257	55	21.4	(19.6,30.5)
2	47	15	31.9	(11.7,39.4)	2	43	4	9.3 *	(10.5,40.7)
3	12	4	33.3	[0.0,54.2)	3	3	0	0.0	[0.0,83.3)
4	3	2	66.7	[0.0,83.3)	4				
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1	474	117	24.7	(21.0,29.0)	1	504	131	26.0	(21.1,28.9)
2	93	27	29.0	(15.6,34.9)	2	101	23	22.8	(16.3,34.2)
3	21	7	33.3	(7.1,45.2)	3	18	5	27.8	(2.8,47.2)
4	5	3	60.0	[0.0,70.0)	4	5	2	40.0	[0.0,70.0)

Panel D: Retail Properties

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st Quartile:					2nd Quartile:				
1	243	69	28.4	(19.5,30.7)	1	241	70	29.0	(19.3,30.9)
2	59	13	22.0	(14.4,36.4)	2	58	18	31.0	(12.9,37.1)
3	9	3	33.3	[0.0,61.1)	3	14	6	42.9	(3.6,53.6)
4	2	1	50.0	[0.0,100.0]	4	6	2	33.3	[0.0,75.0)
4th Quartile:					3rd Quartile:				
1	234	90	38.5 ***	(19.4,31.0)	1	241	70	29.0	(19.3,30.9)
2	72	29	40.3 **	(14.6,35.4)	2	54	19	35.2	(13.9,38.0)
3	22	9	40.9	(6.8,47.7)	3	14	5	35.7	(3.6,53.6)
4	8	3	37.5	[0.0,68.8)	4	3	2	66.7	[0.0,83.3)
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1	477	159	33.3 ***	(21.1,29.0)	1	482	140	29.0 *	(21.1,28.9)
2	131	42	32.1	(17.2,32.2)	2	112	37	33.0	(16.5,33.5)
3	31	12	38.7	(8.1,43.5)	3	28	11	39.3	(8.9,44.6)
4	10	4	40.0	[0.0,55.0)	4	9	4	44.4	[0.0,61.1)

Exhibit 2 (continued)
Annual Return Persistence, 1985 to 1997

Panel E: Office Properties, CBD

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st Quartile:					2nd Quartile:				
1	602	225	37.4 ****	(21.5,28.7)	1	626	188	30.0 **	(21.6,28.5)
2	203	73	36.0 ***	(19.0,31.3)	2	162	49	30.2	(18.2,32.4)
3	63	22	34.9	(13.5,37.3)	3	40	15	37.5	(11.3,41.3)
4	17	4	23.5	(2.9,50.0)	4	12	4	33.3	[0.0,54.2)
4th Quartile:					3rd Quartile:				
1	580	206	35.5 ****	(21.5,28.7)	1	612	179	29.2 *	(21.5,28.5)
2	156	66	42.3 ***	(18.3,32.4)	2	148	52	35.1 **	(17.9,32.8)
3	50	24	48.0 ***	(13.0,39.0)	3	45	15	33.3	(12.2,38.9)
4	19	7	36.8	(2.6,50.0)	4	14	5	35.7	(3.6,53.6)
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1	1,182	431	36.5 ****	(22.5,27.5)	1	1,238	367	29.6 ***	(22.6,27.5)
2	359	139	38.7 ****	(20.5,29.7)	2	310	101	32.6 **	(20.2,30.2)
3	113	46	40.7 ***	(16.4,33.2)	3	85	30	35.3 *	(15.9,34.7)
4	36	11	30.6	(9.7,40.3)	4	26	9	34.6	(5.8,44.2)

Panel F: Office Properties, non-CBD

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st Quartile:					2nd Quartile:				
1	180	52	28.9	(18.6,31.9)	1	193	56	29.0	(18.9,31.3)
2	45	6	13.3	(12.2,38.9)	2	49	17	34.7	(13.3,37.8)
3	6	0	0.0	[0.0,75.0)	3	15	6	40.0	(3.3,50.0)
4					4	5	2	40.0	[0.0,70.0)
4th Quartile:					3rd Quartile:				
1	171	47	27.5	(18.4,31.9)	1	179	43	24.0	(18.7,31.6)
2	36	10	27.8	(9.7,40.3)	2	38	12	31.6	(11.8,40.8)
3	8	2	25.0	[0.0,68.8)	3	11	4	36.4	[0.0,59.1)
4	1	1	100.0	[0.0,100.0]	4	3	0	0.0	[0.0,100.0)
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1	351	99	28.2	(20.4,29.8)	1	372	99	26.6	(20.6,29.7)
2	81	16	19.8	(15.4,35.2)	2	87	29	33.3	(15.5,35.1)
3	14	2	14.3	(3.6,53.6)	3	26	10	38.5	(5.8,44.2)
4	1	1	100.0	[0.0,100.0]	4	8	2	25.0	[0.0,68.8)

*	Null hypothesis rejected at the 5% level of significance
* *	Null hypothesis rejected at the 1% level of significance
* * *	Null hypothesis rejected at the 0.1% level of significance
* * * *	Null hypothesis rejected at the 0.00001% level of significance

Exhibit 3
Annual Return Persistence for Office Properties
Covering Two Intervals: 1985 to 1992 and 1992 to 1997

Panel A: Office Properties, CBD

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1985 to 1992 Interval									
1	642	242	37.7 ****	(21.6,28.4)	1	655	191	29.2 **	(21.6,28.5)
1992 to 1997 Interval									
1	540	189	35.0 ***	(21.4,28.8)	1	583	176	30.2 *	(21.5,28.6)

Panel B: Office Properties, non-CBD

Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval	Length of Run	No. of Samples	No. of Successes	% of Successes	95% Conf. Interval
1st & 4th Combined Quartiles:					2nd & 3rd Combined Quartiles:				
1985 to 1992 Interval									
1	162	42	25.9	(18.2,32.4)	1	171	43	25.1	(18.4,31.9)
1992 to 1997 Interval									
1	189	57	30.2	(18.8,31.5)	1	201	56	27.9	(18.7,31.1)

* Null hypothesis rejected at the 5% level of significance
* * Null hypothesis rejected at the 1% level of significance
* * * Null hypothesis rejected at the 0.1% level of significance
* * * * Null hypothesis rejected at the 0.00001% level of significance