The Time Series Performance Of UK Real Estate Indices

A report funded by the Real Estate Research Institute as part of an enquiry into property performance measures in the United States for the US Pensions Real Estate Association.

Stephen Lee, Colin Lizieri and Charles Ward
The Department of Land Management and Development
The University of Reading
August 2000

Thanks are due to David Geltner for comments on an earlier draft. The PREA report, by David Geltner and David Ling may be downloaded from the Real Estate Research Institute's website www.reri.org

1. Introduction

In this report, the performance of real estate in the UK will be considered. Data on the performance of property held by institutional investors will be compared to the public real estate market (in the form of property company shares) and to other investment assets. In addition, the behaviour of the "industry benchmark" real estate performance measure – the Investment Property Databank indices – will be compared to the indices published by other providers. These other indices generally rely on smaller samples of property. The private market indices are, typically, based on actual properties, with capital appreciation estimated by appraisals (valuations) rather than by use of actual transactions.

The report begins with a brief introduction to the property market indices available in the UK. We then consider, in turn, monthly, quarterly and annual performance. The monthly and quarterly analysis is over the period 1987-1999: monthly information becoming publicly available from January 1987. A longer time period is available for the annual analysis – 1971-1999. However, data in the early years of this time series are considered somewhat unreliable. Basic time series statistics are described and the inter-relationships between variables discussed. Finally, sector differences are also highlighted, using monthly and quarterly data.

2. UK Property Market Indices

One of the endemic problems in assessing the performance of an investment asset is the search for a suitable benchmark to represent the returns that could reasonably have been expected from equivalent investment decisions. In the stock market, it is common to use a broad-based index compiled from a large sample of stocks trading in the same market but in real estate, it is much more difficult because there is no clear definition of the constituents of the market, there is a complete lack of bid-offer quotations from market makers or dealers as well as information on market transactions. Thus investors trying to create an index for real estate have had to create various quasi-indices based on the kind of information to which they have access. In the UK, there have been numerous attempts at producing representative real estate indices but the successful examples, which continue to be widely circulated, have come from two main sources; individual firms of agents/brokers which are close to the transaction data on the properties that

are offered for sale and an independent organisation set up by a group of agents and institutional investors[1].

The longest-established form of the first type of index is that of Jones Lang LaSalle[2]. The index has been constructed for the period from mid-year 1967 on an annual basis and on a quarterly basis from 1977. It is constructed by valuing individual properties and then estimating the capital, income and total returns from the portfolio (subjectively weighted based on assumed market proportions). Returns are reported for the main institutional property sectors (Industrial, Retail and Offices).

Because the index is based on an actual portfolio, the constituents change as a result of investment and management decisions. Since the portfolio increases in value each time a property is bought, the convention is adopted that the property bought will not be included in the index until the following quarter and its incoming value will be set equal to the valuation of the property as at the first quarter date following acquisition. This convention implies that the value of the portfolio at the beginning of one quarter will not necessarily accord with the value of the portfolio at the end of the previous quarter even after the purchase costs of new properties are taken into account. The chief virtue of the JLL indices is that they cover a longer period than other indices but the small size and value of the constituent properties of the portfolios the and the proprietorial origin have always mitigated against their widespread adoption as industry standards. At the end of December, the quarterly appraised portfolio consisted of 179 properties with an estimated capital value of £560m ($840m).

An alternative agent-produced index comes from Richard Ellis and was launched in 1978 as an annual index and from December 1986 on a monthly basis (monthly data exists from 1979). Like the JLL indices, the Richard Ellis indices reports returns for individual sectors (shops, offices and industrials) and are based on actual properties which are valued at the requisite interval. Morrell et. al.(1994) estimated that, in value terms, the Richard Ellis index was (as at December 1992) about 50% larger than the JLW/JLL portfolio but less than 30% of the value of the IPD monthly index (see below). At the end of 1999, the index was based on 331 properties with a capital value of £2.5bn ($3.75bn) implying that it is four times as large as the JLL index by value but only 30% of the value of the IPD monthly index.

Like all proprietorial indices, the Richard Ellis suffers from management decisions and consequential bias. For example, a tendency for Richard Ellis or JLL investors to hold on to properties that were performing badly whilst selling properties that were doing well would tend to bias downwards the performance of the real estate market as reported by their indices. Correspondingly, a policy of rebalancing portfolios to hold a constant proportion of properties of different types (or sector) would tend to bias downwards the reported performance of the real estate market as reflected in the indices if the actual real estate market trended (either upwards or downwards) over time. A further objection to the indices provided by individual firms is that they

[1] There is also a third source of real estate indices. Actuarial consultants such as WM, Watson-Wyatt and CAPS construct indices based on data from institutional investment clients. These are mainly confined to annual indices although there is a CAPS quarterly index.

[2] The index was constructed by Jones, Lang Wootton from the properties they managed on behalf of clients.

are subject to 'house-style' appraisal bias. An individual firm may take a view on the current state of the market which could conceivable color the valuations provided by its staff.

The second type of index is from IPD – a firm that was set up with the sponsorship of surveying firms/agents (who continue to hold a minority stake in the company). IPD collects data directly from institutional investors, including property companies and open-ended investment funds, and produce independent indices for monthly and annual performance. When it was established in 1985, IPD aimed to reflect the whole institutional market in the UK. As additional information has been acquired from new institutional subscribers, its asset base has increased and it has revised the recorded (published) performance of its indices for as far back as the new subscribers have been able to supply information. This policy, which has had the consequence that the reported performance for any historical period, reflected by the indices, has changed significantly between the contemporaneous report and later revised reports, has not had the universal approval of its main clients. From the researchers' point of view, however, it has ensured that the latest edition of the indices have reported the performance has at least minimised "new client bias" that might otherwise have distorted the historical record of market performance. Only in 1999 was it decided to publish future indices on a 'frozen' basis in which historical performance of the indices would not be revised simply because of the availability of new client information[3].

The IPD monthly indices were originally derived from open-ended investment trusts which specialised in real estate. UK regulation permits the setting-up of "unauthorised property unit trusts" that were appropriate investment vehicles for predominately institutional investor clients (these are similar in structure, but pre-date, CREFs, which were modelled on PUTs). The property unit trusts are required to supply independent monthly valuations of their portfolios and these valuations, together with valuations supplied by insurance based real estate funds and some pooled pension funds, have proved successful sources of short-interval information from which IPD has constructed monthly indices.

Unfortunately, the constituents of the monthly indices have, like the proprietorial agents' indices, reflected historical biases and policies of a relatively small group of investors. Consequently, the representation of different sectors of the real estate market in the monthly indices has differed from the weighting in the larger and more comprehensive annual IPD indices. This has proved to be a significant issue in restricting the usefulness of the monthly indices since over any annual period, the performance of the monthly and annual indices can be seen to be inconsistent. Furthermore, the trusts, by virtue of their size, face market entry barriers in certain sub-markets (such as AAA City of London offices or major regional shopping malls). The average value of properties in the monthly database, at £3.3m ($5m) is half that of properties in the aggregate IPD database (£6.5m, $9.75m)[4]. This disparity contributes to the tracking error. Nevertheless, the value of assets included in the IPD monthly indices are estimated to account for something in the region of 10% of the institutional real estate market. At the end of 1999, the IPD monthly

[3] Revised indices which reflect historical performance including new client assets will continue to be made available to clients even though the headline indices will only be revised to reflect additional contemporaneous information.

[4] It is interesting to note that the average value of properties on the Richard Ellis Monthly Index is reported to be £7.5m ($11.2m). In December 1994, when there were 274 properties, the average value of properties was £4.38m. Applying the Richard Ellis capital value index to this gives an estimated capital value per property of £4.78m. This implies that the individual value of properties added over the five year period has been considerably higher and, thus, that there has been a change in composition over the period.

database consisted of just over 2,500 properties from 50 portfolios with a total capital value of around £8.5bn ($2.75bn).

The annual indices of the IPD have a much stronger claim to reflect the performance of the institutional real estate investment market. It has been estimated by IPD that the coverage of the IPD annual indices represented (as at the end of 1999) more than 75% of the institutional real estate investment market and amounted in value to approximately £87bn ($130bn) and over 13,000 properties from 230 portfolios.

Because of the size of the constituent portfolio, IPD can produce more sub-indices than the proprietorial agents' indices. Hence, IPD publishes performance indicators for different geographic regions, building values and key sub-sectors. For example, IPD in its Property Investors Digest supplies performance measures of Retail (standard units, parades and arcades), Shopping centres, Retail Warehouses, Department Stores, Offices and Office Parks, Industrial-Warehouse centres, Industrial Parks and other Industrial properties. In a policy designed to reduce firm-valuation bias and confidentiality agreements with its subscribers, IPD will only produce indices that represent valuations from at least four different firms and this clearly provides greater authority for its claim to represent a market view of the current state of the institutional real estate market than the smaller proprietorial indices.

3. Analysis of Monthly Performance Statistics.

3.1 Introduction

In this section, we examine the performance of various equity and real estate measures on a monthly basis. The full period for analysis is 1987-1999. The main private market indicator of real estate performance, the Investment Property Databank monthly index was established at the start of 1986, determining the start point. We analyse the following series:

1. IPD Monthly Index – Returns (IPDMINR)
2. IPD Monthly Index – Prices (Capital Values) (IPDMINP)
3. IPD Annual Index, Interpolated Monthly Returns (IPDAGeltR)
4. Richard Ellis Monthly Index, Returns (REMINR)
5. Richard Ellis Monthly Index, Prices (REMINP)
6. Financial Times-Stock Exchange Real Estate Sector Returns (FTRENR)
7. Financial Times-Stock Exchange Real Estate Sector, Prices (FTRENP)
8. Financial Times –Stock Exchange All Share Index, Returns (FTALLNR)
9. Financial Times –Stock Exchanges All Share Index, Prices (FTALLNP)

We thus have return and price (capital value) series for private real estate (based on appraised values), public, securitised real estate and an overall stock market indicator. All series are analysed as the log difference in index values, equivalent to the monthly percentage change in value. The IPDAGeltR series has been created by taking the annual log difference and distributing it evenly throughout the year – equivalent to assuming a constant compound growth rate over the year. This will enable comparisons with the published monthly series, highlighting any lagged or seasonal effects. The nine series have also been deflated using the UK Retail Price

Index (equivalent to the US CPI) to produce real price and return series removing common inflationary influences.

3.2 Trends and Time Series Descriptives

Figures 3.1, 3.2 and 3.3 show, respectively, the nominal returns of the appraisal-based private real estate indices, the nominal returns of the all share index and the real estate sector index and, finally, capital value indices for both private and securitised indices. Comparing Figures 3.1 and 3.2, the greater volatility of the stock market indices is clear to see, even discounting the sharp downward spike that is "Black Monday", the global stock market falls of October 1987. In figure 3.1, the Richard Ellis Monthly index appears to exhibit greater volatility than the IPD Monthly index (an impression confirmed by the descriptive statistics discussed below) but generally tracks the larger sample market benchmark.

The capital value indices shown in Figure 3.3 show that the FTSE All Share index has grown at a faster rate than all the real estate indices, securitised or unsecuritised. The extent of the gap is somewhat exaggerated by the compounding effect. Figure 3.4 shows the same indices on a logarithmic scale. Up to 1990, the price indices seem to track each other broadly. Thereafter, the real estate and overall stock market series diverge. Property companies appear to perform worse than private real estate in the depths of the market slump in the early 1990s (one should recall that he IPD and Richard Ellis indices are appraisal based and may, thus, understate the fall in capital values) but, thereafter, all three property indices seem to move together in the longer term despite short-run periods of divergence.

Figure 3.1

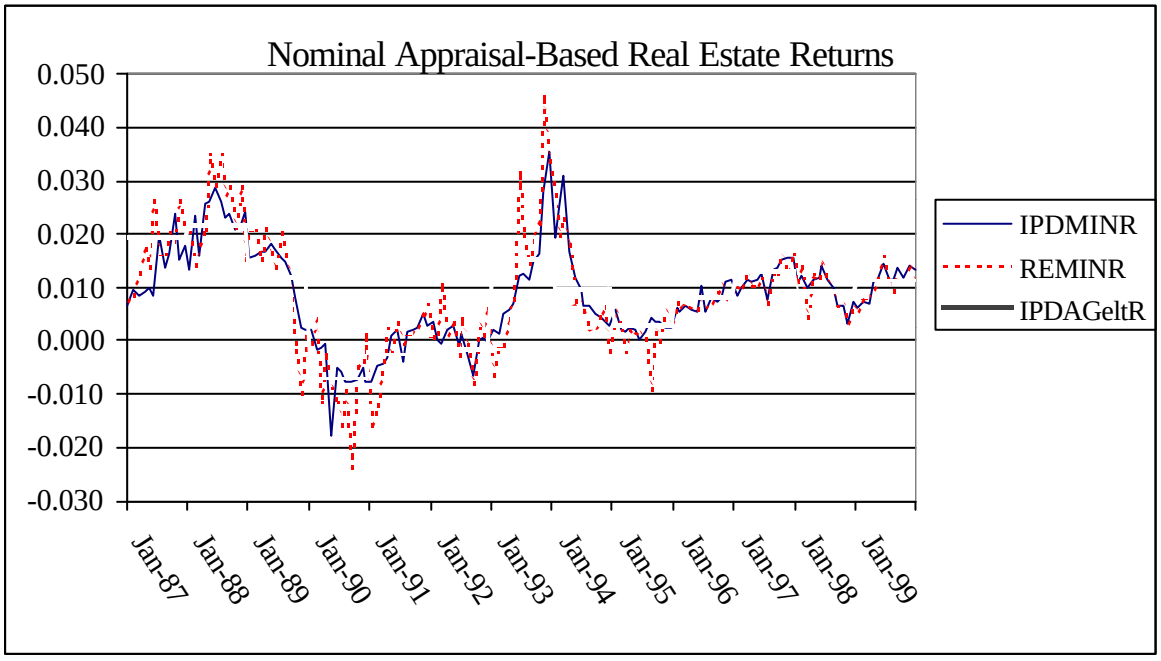


Figure 3.2

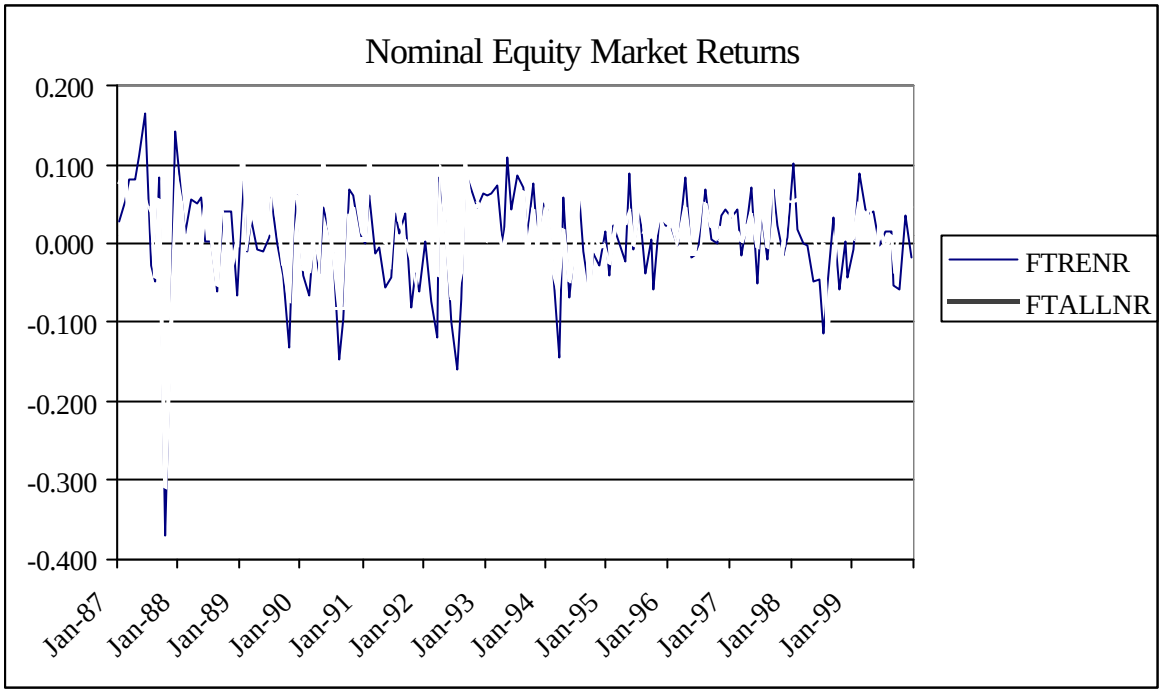


Figure 3.3

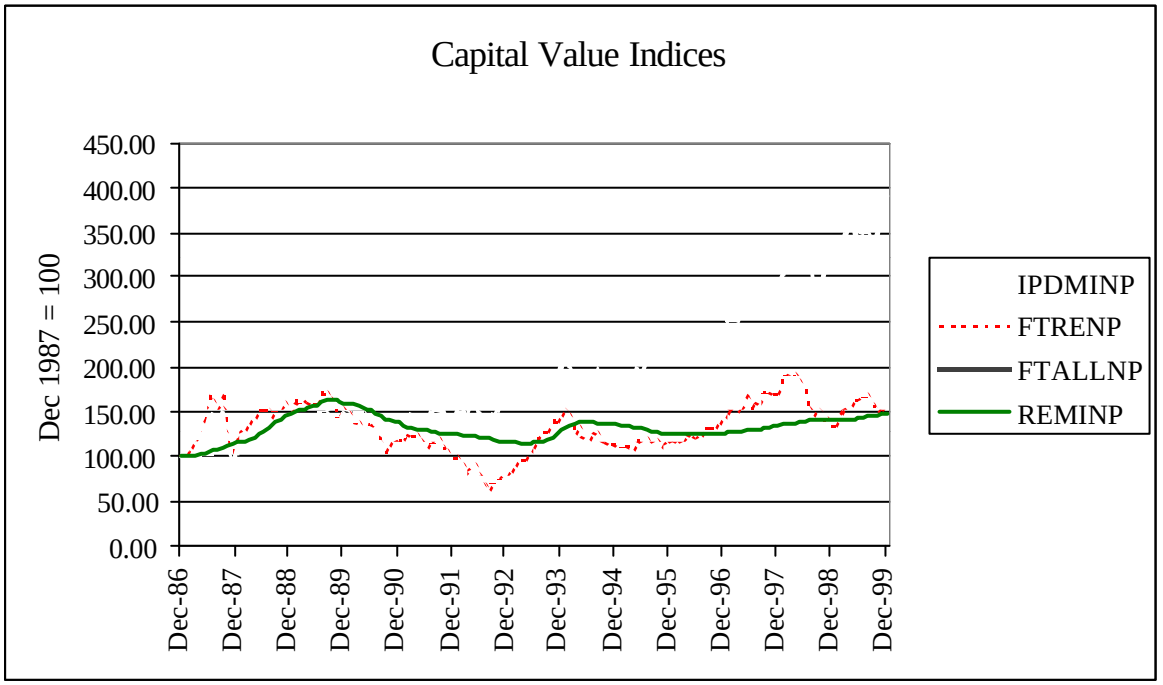
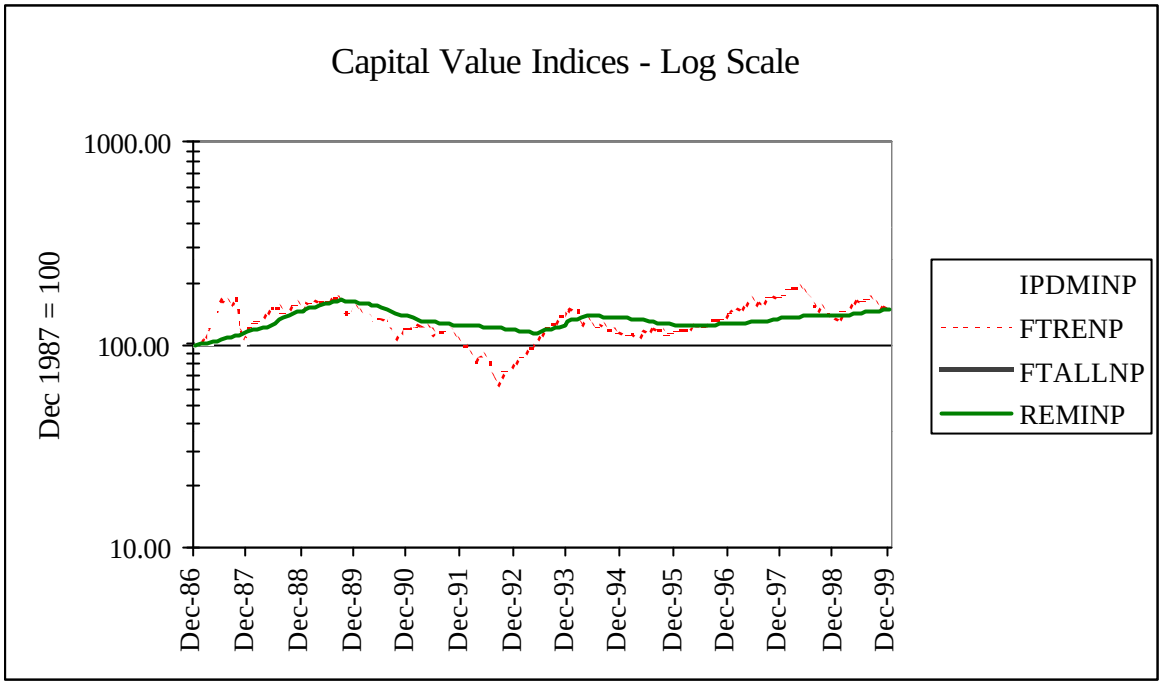
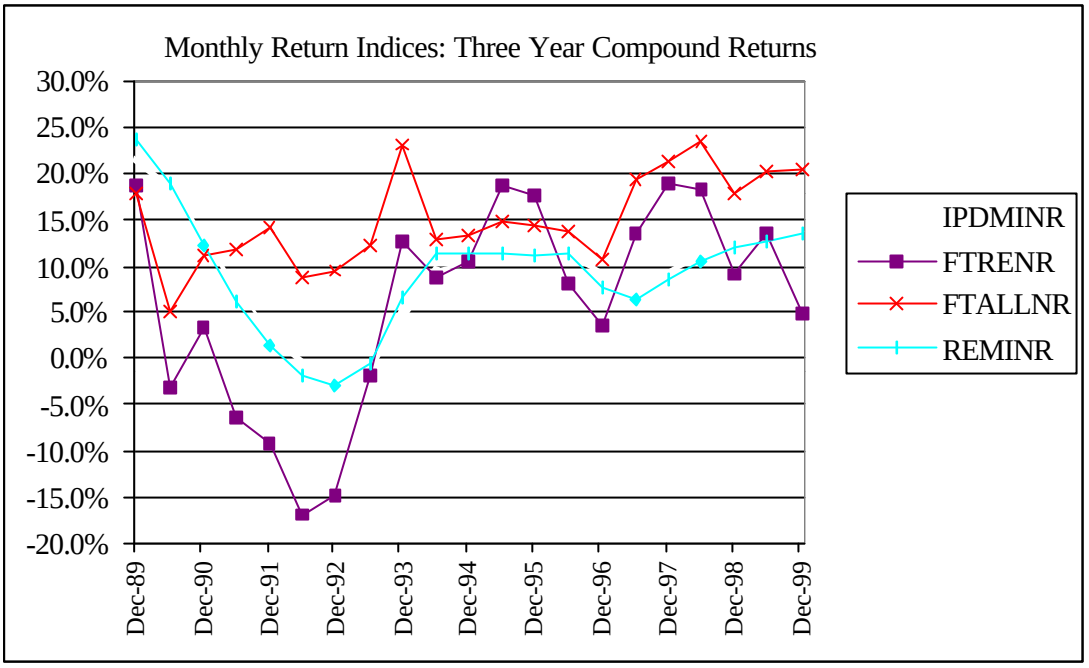


Figure 3.4



The nominal mean return for the IPD Monthly Index over the full analysis period was 0.84% per month – equivalent to 10.6% per annum. The Richard Ellis Monthly Index and Interpolated IPD Annual Series exhibit a very similar level of return. The overall stock market produced, as might be expected, a higher average return, of around 15.6% on an annualised basis. The FT Real Estate series produced a *lower* return than both the stock market and the private market at just 7.3% p.a. This lower return is, in part due to the poor performance of property companies in the real estate recession of the early 1990s, and partly to the switch away from value stocks to growth, high tech and dot.com equities in the late 1990s (see Figure 3.5). Inflation over the full analysis period ran at around 4% per annum. A greater share of the equity indices' returns can be attributed to price / capital value growth, private property values growing at around 3% per annum.

Figure 3.5



Given that the real estate indices are based on appraised values, one would expect them to exhibit lower volatility than the transaction-based stock indices. This is confirmed in the data. The FTSE All Share index has a standard deviation some six times higher than that of the IPD Monthly Index – on an annualised basis, around 17.2% compared to 3.0%. Removing appraisal smoothing using standard methods would increase the volatility of real estate returns but not to stock levels. The securitised real estate index is still more volatile than the All Share Index. The Richard Ellis Monthly Index is more volatile than the IPD Monthly index (with an annualised standard deviation of around 3.7%), presumably reflecting the smaller sample size and, hence, greater specific risk. Further descriptive statistics are set out in Figure 3.6 and 3.7. It is worth noting that the distributions of the securitised indices are strongly negatively skewed (reflecting sharp downward corrections) while the real estate indices, with the exception of the interpolated series, show weak positive skewness. Falls in returns are damped by the contractual nature of leases (limiting falls in income), while it may be that appraisers are more reluctant to lower values than to increase them!

Figure 3.6 Descriptive Statistics, Nominal Returns, 1987-1999

	RPI	*IPDMINR*	*FTRENR*	*FTALLNR*	*REMINR*	*IPDMINP*	*FTRENP*	*FTALLNP*	*REMINP*	*IPDAGeltR*
Mean	0.0033	0.0084	0.0059	0.0121	0.0086	0.0024	0.0027	0.0087	0.0025	0.0085
Median	0.0035	0.0081	0.0105	0.0154	0.0077	0.0014	0.0045	0.0109	0.0012	0.0094
Standard Dev'n	0.0047	0.0088	0.0646	0.0498	0.0108	0.0092	0.0646	0.0499	0.0111	0.0082
Sample Variance	0.0000	0.0001	0.0042	0.0025	0.0001	0.0001	0.0042	0.0025	0.0001	0.0001
Kurtosis	6.6367	0.3991	6.6354	10.2352	0.8749	0.1986	6.4534	9.8400	0.5581	-0.7220
Skewness	1.4081	0.2698	-1.4635	-1.8335	0.2459	0.4030	-1.4607	-1.7919	0.3349	-0.3543
Range	0.0394	0.0534	0.5348	0.4386	0.0693	0.0522	0.5280	0.4390	0.0682	0.0290
Minimum	-0.0094	-0.0178	-0.3693	-0.3080	-0.0238	-0.0226	-0.3710	-0.3092	-0.0293	-0.0073
Maximum	0.0300	0.0356	0.1656	0.1306	0.0455	0.0296	0.1570	0.1298	0.0389	0.0217
Count	156	156	156	156	156	156	156	156	156	156

Figure 3.7 Descriptive Statistics, Real Returns, 1987-1999

	RIPDMIR	*RFTRER*	*RFTALLR*	*RREMIR*	*RIPDAGelt*	*RIPDMIP*	*RFTREP*	*RFTALLP*	*RREMIP*
Mean	0.0051	0.0026	0.0087	0.0053	0.0051	-0.0010	-0.0007	0.0054	-0.0008
Median	0.0057	0.0070	0.0122	0.0056	0.0070	-0.0005	0.0033	0.0084	-0.0004
Standard Dev'n	0.0100	0.0651	0.0505	0.0120	0.0088	0.0103	0.0652	0.0507	0.0122
Sample V'nce	0.0001	0.0042	0.0026	0.0001	0.0001	0.0001	0.0043	0.0026	0.0001
Kurtosis	1.2625	6.5014	9.8182	1.5241	-0.1363	0.8579	6.3202	9.4066	1.1545
Skewness	-0.3436	-1.4318	-1.8406	-0.1115	-0.7744	-0.1730	-1.4281	-1.7958	-0.0064
Range	0.0642	0.5397	0.4372	0.0800	0.0309	0.0618	0.5329	0.4376	0.0789
Minimum	-0.0307	-0.3741	-0.3129	-0.0331	-0.0147	-0.0355	-0.3759	-0.3142	-0.0386
Maximum	0.0334	0.1656	0.1243	0.0470	0.0162	0.0264	0.1570	0.1234	0.0403
Count	156	156	156	156	156	156	156	156	156

Statistical evidence for appraisal smoothing effects may be found by examining the serial correlation in returns. *A priori*, one would expect to see little autocorrelation in the public, stock market series, but considerable autocorrelation in the valuation-based private real estate indices. These expectations are confirmed. The figures below shows autocorrelation figures for 13 lags for the real value/price returns for the FTSE All Share, FTSE Real Estate, IPD Monthly and Richard Ellis Monthly indices. As can readily be seen, the stock series reveal very little serial correlation (conforming to weak form market efficiency) while the two appraisal based indices show very strong, statistically significant and persistent autocorrelation, the coefficients remaining above 0.5 for six months in both cases. Full details of autocorrelations and partial autocorrelations are tabulated in Appendix A3.

Conventional tests of seasonality were applied to the appraisal-based property returns in nominal and real forms. Census X11 procedures failed to detect evidence of seasonality, whilst difference from moving average procedures produce insignificant scaling factors. If valuations are bunched in particular months but positive and negative changes tend to cancel each other out over the analysis period, seasonality might be missed. To test for this, we generated new series with the absolute change (that is a rise or a fall of 2% are treated equally). Once again, standard tests failed to find any evidence of seasonality in the data. This finding goes against anecdotal evidence that, for monthly properties, "full" valuations are bunched in mid-year and end of year, associated with financial reporting with desk-top valuations taking place in the intervening

months. However, the correlogram of the IPD real price series shows a sharp jump in the partial autocorrelation coefficient (PAC) at a lag of 12 months which would be consistent with seasonality or bunching of "true" or full appraisals (the coefficient reflecting annual first order serial correlation). As expected, the PAC coefficient reverses at 13 lags. However, there is less evidence of such an effect in the Richard Ellis real capital growth series. Although the PAC rises at lag 12, it is not statistically significant.

Additional evidence can be found by regressing the real IPD capital growth series on values lagged one month and twelve months. Figure 3.8 shows the results of such a regression. The lag 12 coefficient *is* statistically significant at the 0.05 level, although the amount of additional explanation over a simple AR(1) representation is not great.

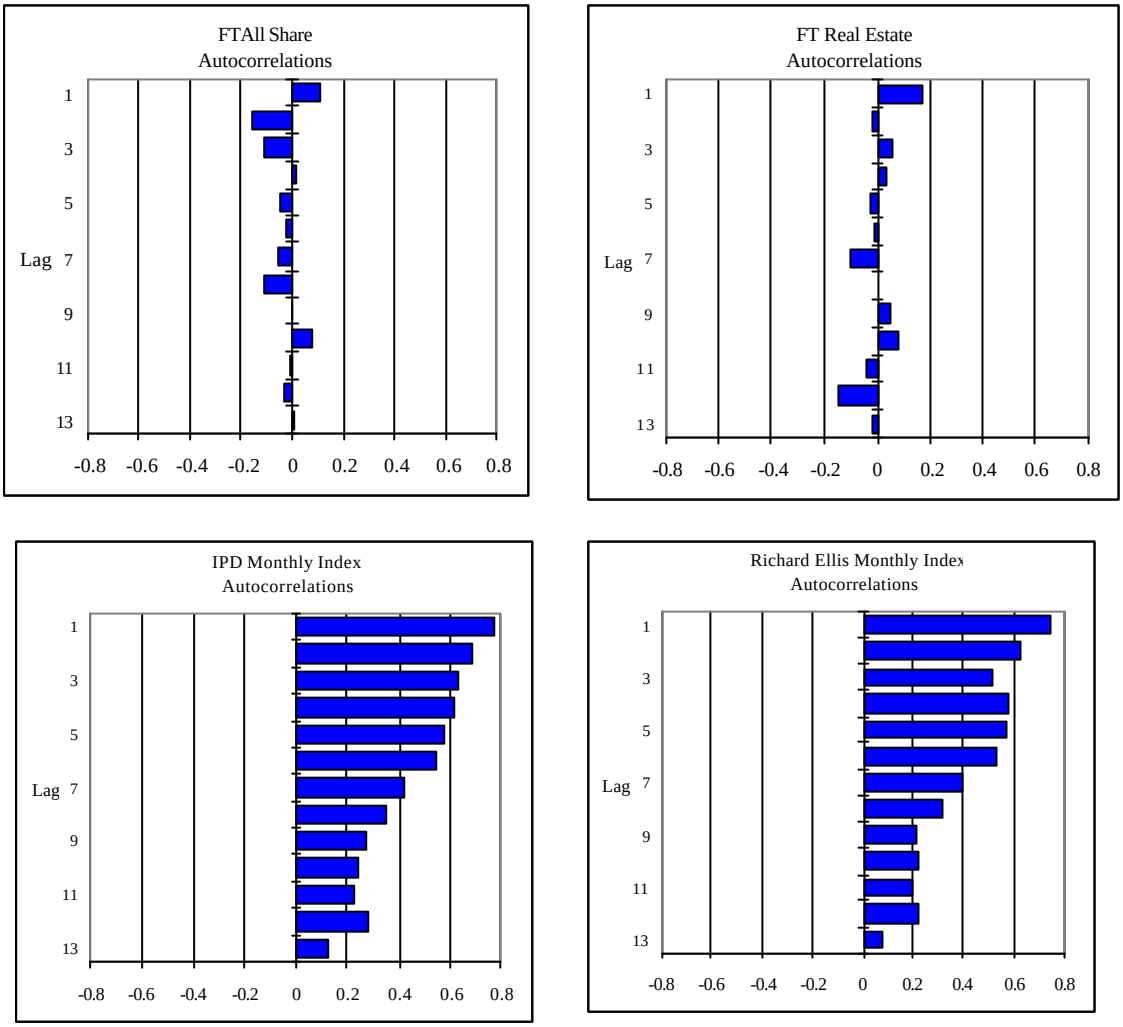
Figure 3.8 Real IPD Prices AR(1), AR(12) model.

Dependent Variable: RIPDMIP
Method: Least Squares
Sample(adjusted): 1988:01 1999:12
Included observations: 144 after adjusting endpoints
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002091	0.003796	-0.550868	0.5826
AR(1)	0.747309	0.052641	14.19641	0.0000
AR(12)	0.111970	0.052192	2.145348	0.0336

R-squared	0.623030	Mean dependent var	-0.001479
Adjusted R-squared	0.617683	S.D. dependent var	0.010325
S.E. of regression	0.006384	Akaike info criterion	-7.249303
Sum squared resid	0.005747	Schwarz criterion	-7.187431
Log likelihood	524.9498	F-statistic	116.5177
Durbin-Watson stat	2.135600	Prob(F-statistic)	0.000000

Figure 3.9: Autocorrelations, Securitised and Unsecuritised Real Price/Value Series



3.3 Interrelationships between variables

This section explores the linkages between the various indices. Initially, we examine contemporaneous correlations between the return series, concentrating on the real returns to remove the common impact of inflationary increases. Later, we examine any leads and lags in the relationships between variables. Prior research has suggested that the securitised, public, real estate market leads the private market: we will investigate this hypothesis and see whether any of the private market indices lead the others. In particular, if the series interpolated from the IPD annual returns can be shown to lead the IPD monthly index, his may suggest that a proportion of the properties in the monthly index samples are not being "effectively" appraised each month, creating a lagging effect.

Figure 3.10 shows contemporaneous correlations for the real, deflated series for the whole of the analysis period. The private market indices all exhibit strong positive correlation. Both the IPD

Monthly and Richard Ellis Monthly Returns and Capital Value indices have strongly positive 0.91 correlations. This implies that over 80% of variation in returns is common to both series. However, the interpolated series based in the IPD annual index has a slightly lower, if still highly significant, correlation with the two monthly indices, around 0.75 with IPDMI and 0.71 with REMI.

The FTSE Real Estate series (in total return and price formats) shows only low correlation with the direct market index, confirming prior research. The highest correlations are with the interpolated IPD annual series (0.226 with price, 0.216 with return). The FTSE Real Estate return series correlations with the IPD monthly index are indistinguishable from zero. By contrast, the FTSE Real Estate total return and price series both have 0.77 correlations with their FTSE All Share equivalent series. Thus, on a month to month basis, securitised real estate appears to behave more like the stock market than the underlying (appraisal measured) real estate market, as found in other published research.

Figure 3.10 Contemporaneous Correlations – Real Returns 1987-1999

	RFTALLP	RFTALLR	RFTREP	RFTRER	RIPDAGELT	RIPDMIP	RIPDMIR	RREMIP	RREMIR
RFTALLP	1.000								
RFTALLR	0.999	1.000							
RFTREP	0.771	0.772	1.000						
RFTRER	0.768	0.769	0.998	1.000					
RIPDAGELT	0.081	0.071	0.228	0.219	1.000				
RIPDMIP	0.056	0.045	0.105	0.097	0.753	1.000			
RIPDMIR	0.029	0.017	0.075	0.067	0.751	0.983	1.000		
RREMIP	0.087	0.076	0.170	0.164	0.708	0.906	0.906	1.000	
RREMIR	0.092	0.081	0.176	0.172	0.708	0.899	0.907	0.996	1.000

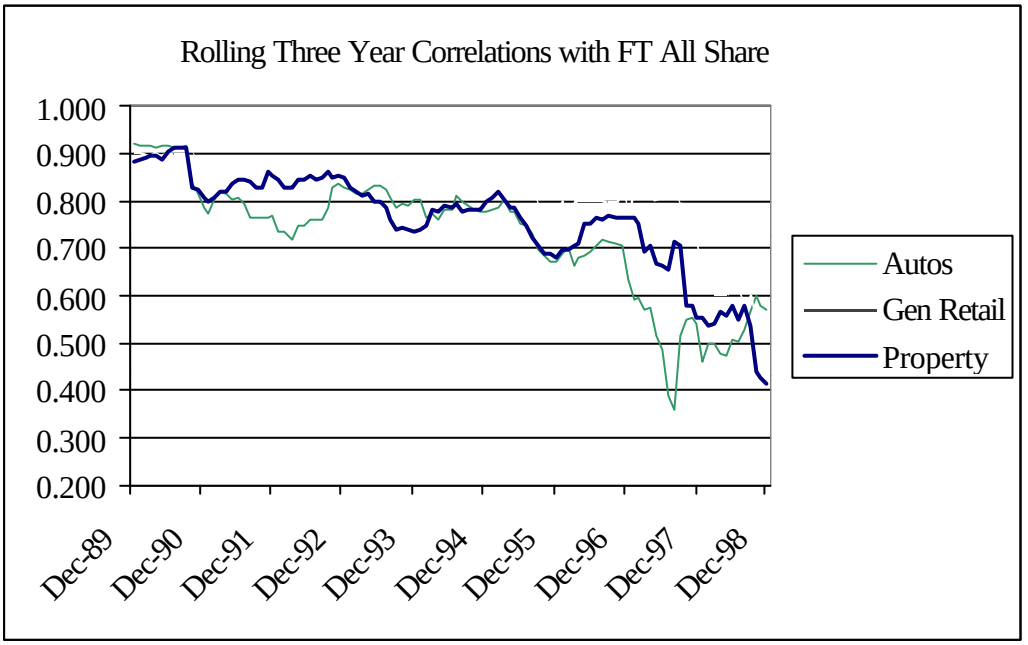
To test for stability in these correlations, figure 3.11 sets out correlations for the period 1993-1999 – that is after the boom-bust cycle of the late 1980s and early 1990s. The correlations between the appraisal-based real estate indices remain high, close to or above 0.90. The interpolated IPD annual index exhibits lower correlation with the private market series (ranging from 0.42 to 0.48) perhaps suggesting greater volatility in the monthly statistics. Correlations between the appraisal-based indices and securitised real estate are close to zero. The most striking change is the fall in the correlation between property company shares and the overall stock market, which drops from nearly 0.8 to just over 0.5 suggesting a decoupling of the securitised property and general stock markets. In the period 1989-1992, the correlation between securitised real estate indices and the whole stock market was around 0.86.

Figure 3.11 Contemporaneous Correlations – Real Returns 1993-1999

	RFTALLP	RFTALLR	RFTREP	RFTRER	RIPDAGELT	RIPDMIP	RIPDMIR	RREMIP	RREMIR
RFTALLP	1.000								
RFTALLR	0.999	1.000							
RFTREP	0.524	0.526	1.000						
RFTRER	0.520	0.522	0.998	1.000					
RIPDAGELT	0.064	0.057	0.273	0.269	1.000				
RIPDMIP	0.046	0.031	-0.054	-0.060	0.420	1.000			
RIPDMIR	0.017	0.002	-0.065	-0.071	0.441	0.987	1.000		
RREMIP	0.079	0.062	0.051	0.050	0.467	0.887	0.904	1.000	
RREMIR	0.087	0.070	0.072	0.072	0.476	0.876	0.897	0.998	1.000

This decoupling of property stocks with the overall equity market (also observed in US markets with REITs) has been attributed to the shift away from value stocks to growth and high tech offerings. Figure 3.12 plots rolling three year correlations of the FTSE real estate sector (total returns) with the FTSE All Share index from 1987 to 1999. Also plotted are the rolling correlations for the automobile and general retailing sectors illustrating that this is not simply a real estate phenomenon. This decoupling has not resulted in higher correlations with the underlying private market, at least as reported by the appraisal based indices.

Figure 3.12 Equity Returns and the Stock Market



Further evidence of this decoupling can be seen in the decline of explanatory power from regressing returns from the FTSE Real Estate sector on the FTSE All Share returns in a single index framework. Figure 13.13 sets out estimated intercepts and betas for a series of five year window regressions. The adjusted R^2 falls from 73% 1987-1991 to just 15% (1995-1999). Over the same span, the beta shifts from a figure statistically indistinguishable from one to close to 0.5.

Figure 3.13 Five Year Regressions, Real Estate on Stock Market

Period	Intercept	Estimated Beta	Adjusted R^2
Full Sample	-0.01 (-1.75)	0.99 (14.69)	0.581
1987-1991	-0.01 (-1.37)	1.04 (12.81)	0.734
1988-1992	-0.02 (-3.06)	1.02 (10.47)	0.648
1989-1993	-0.01 (-2.11)	1.06 (10.01)	0.627
1990-1994	-0.01 (-1.72)	1.09 (9.67)	0.611
1991-1995	-0.01 (-1.98)	1.12 (8.53)	0.549
1992-1996	-0.01 (-1.03)	1.24 (9.43)	0.598
1993-1997	+0.00 (0.79)	0.94 (6.85)	0.410
1994-1998	-0.01 (-1.13)	0.73 (5.17)	0.304
1995-1999	-0.00)-0.12)	0.53 (3.42)	0.153

Note, figures in parentheses are t-statistics

Prior research has shown that the securitised real estate tends to lead appraisal-based private market indicators. There is some evidence for such an effect in the data. In nominal terms, the contemporaneous correlation between the FTSE Real Estate price series and the IPD Capital Value series over the whole analysis period is just 0.04. As the FTSE Real Estate price index returns are lagged, so the correlation increases, peaking at 0.27 after seven months. Correlations exceed 0.25 from a lag of three months to a lag of seven months before declining back to below 0.2. In real terms, correlations rise from 0.10 contemporaneous to 0.33 with the securitised series lagged six months.

Unsurprisingly, then, Granger causality tests suggest that the securitised series leads the direct, appraisal based series. This has been taken as evidence of support for price discovery between the public and private markets. Some caution should, however, be expressed. To some extent the results may be an artefact of the high levels of autocorrelation in the appraisal-based data, despite the construction of the Granger test. For example, regressing the real returns of the IPD Monthly capital value series on lagged values of the FTSE Real Estate price series produces estimated coefficients for lags from one month to nine months that are all statistically significantly different from zero at the 0.05 level except lags four and five (significant at 10%). However, introducing a lagged value of the IPD series on the right hand side suggests that only the sixth lag of the securitised series is significant: and that, too, could be removed according to AIC or Schwartz criteria. Hence, although there is information contained in the equity market series that arrives, with a lag, in the private market, its degree of explanatory power may be low.

Figure 3.14 Granger Causality Tests Securitised and Private Real Estate

Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
RIPDMIP does not Granger Cause RFTREP	143	0.72882	0.73167
RFTREP does not Granger Cause RIPDMIP		1.83762	0.04509

Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
IPDMINP does not Granger Cause FTRENP	143	0.68067	0.77857
FTRENP does not Granger Cause IPDMINP		2.49615	0.00482

There seems little to suggest that the IPD Monthly index leads the Richard Ellis index, or *vice versa*. Nominal IPD capital value growth may lead REMI; in real terms, the Richard Ellis series may lead: but the evidence is flimsy and it would be safer to assume two-way causality. However, Granger causality tests do strongly suggest that the monthly interpolated IPD annual index leads the IPD monthly index, in both nominal and real representations. One possible interpretation of this is that changes in values reported in desk-based monthly appraisals understate actual changes, which only appear when there is a full appraisal. Since the interpolation process assumes a constant growth rate, this would produce the lead-lag relationship. However, there is no definitive evidence to support such an interpretation and other explanations are possible. For example, the result observed may simply result from the fact that price "shocks" later in the year are moved forward in the interpolated series by the averaging process[5]. The cross-correlogram of the two series shows the correlation declining smoothly when the interpolated series is lagged, but sustaining at high levels when the IPD Monthly Index is lagged, peaking with a three month lag. By construction, the interpolated series has very high degree of serial correlation: this might produce the cross-correlogram results, but cannot explain the relationship revealed by the Granger causality tests.

Figure 3.14 Granger Causality Test, IPD Annual Interpolated vs. Monthly Series

Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
IPDMINR does not Granger Cause IPDAGELTR	143	1.20330	0.28568
IPDAGELTR does not Granger Cause IPDMINR		6.89176	1.1E-09

Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
RIPDMIR does not Granger Cause RIPDAGELT	143	1.10666	0.36045
RIPDAGELT does not Granger Cause RIPDMIR		3.43537	0.00017

[5] On the other hand, early year shocks would be moved backwards by the interpolation, which would cancel out such an effect.

3.4 Summary

- Overall returns for public-traded real estate (property company shares) in the period 1987-1999 are *lower* than those measured by private-market appraisal indices and those of the aggregate stock market;

- Appraisal-based real estate indices exhibit lower apparent volatility than indices based on market-traded equities;

- There is evidence of strong positive serial correlation in the appraisal based indices, with autocorrelation coefficients remaining above 0.5 for lags of up to six months. As expected, the equity market indices exhibit little autocorrelation;

- The IPD and Richard Ellis appraisal-based indices have strong positive contemporaneous correlations. The FTSE Real Estate public-traded real estate index has a low correlation with the appraisal based indices and a high correlation with the overall stock market.

- The correlation between property company share performance and the aggregate stock market falls from nearly 0.9 in the first half of the time series to just over 0.4 in the second half. This provides some evidence of the decoupling of property company performance from that of other equities. It does not result in a higher correlation between appraisal based and market traded indices.

- There is no conclusive evidence of any bunching of appraisals in particular months, nor of any seasonal effects in the appraisal based data, although there are indications of a relationship between today's value and that twelve month's previous;.

- The monthly index lags an interpolated series based on the IPD annual index. This provides tentative evidence supporting the idea that full appraisals are carried out less frequently than monthly;

- The FTSE Real Estate index appears to lead the appraisal based indices indicating the possibility of price discovery between public and private markets. Although the relationship is statistically significant, the degree of variability explained by the prior information may be small.

4. Analysis of Quarterly Performance

4.1 Introduction

In this section, we examine capital appreciation and total return series on a quarterly basis. The analysis period is, once again 1987 to 1999. An additional series has been utilised – the Jones Land LaSalle (formerly Jones Lang Wootton) quarterly price index. Prior expectations are that this small sample appraisal based index will broadly track the other private market indices but will exhibit more volatility, due to additional, undiversified, specific risk. The JLL series is analysed with the IPD and Richard Ellis monthly series (converted to a quarterly series by taking

the March, June, September and December index values), and compared to the FTSE Real Estate sector equity market performance and to the FTSE All Share index. Since much of the analysis would simply replicate that for the monthly analysis, this section will be shorter and focuses on any different results that emerge (further results are shown in Appendix A4). Some random noise from the monthly series may be eliminated, enabling relationships between variables to emerge more clearly. The results found, however, largely confirm those reported above.

The series available for analysis are:

1.	FTALLNP	FTSE All Share, Nominal Price Changes
2.	FTALLNR	FTSE All Share, Nominal Total Returns
3.	FTRealNP	FTSE Real Estate Sector, Nominal Price Changes
4.	FTRENR	FTSE Real Estate Sector, Nominal Total Returns
5.	IPDGeltNR	Interpolated Nominal Returns Series Based on IPD Annual Index
6.	IPDMINP	IPD Monthly (quarterly representation), Nominal Capital Appreciation
7.	IPDMINR	IPD Monthly (quarterly representation), Nominal Total Returns
8.	JLLNP	Jones Lang LaSalle, Nominal Price Changes
9.	REMINP	Richard Ellis Monthly Index (quarterly), Nominal Cap.Appreciation
10.	REMINR	Richard Ellis Monthly (quarterly), Nominal Total Returns
11.	RFTALLR	FTSE All Share, Real Price Changes
12.	RFTAP	FTSE All Share, Real Total Returns
13.	RFTSERealP	FTSE Real Estate Sector Real Price Changes
14.	RFTRER	FTSE Real Estate Sector, Real Total Returns
15.	RIPDGltR	Interpolated Real Returns Series Based on IPD Annual Index
16.	RIPDMIP	IPD Monthly (quarterly representation), Real Capital Appreciation
17.	RIPDMIR	IPD Monthly (quarterly representation), Real Total Returns
18.	RJLLP	Jones Lang LaSalle, Real Price Changes
19.	RPI	Retail Price Index as Proxy for Inflation
20.	RREMIP	Richard Ellis Monthly (quarterly), Real Cap.Appreciation
21.	RREMIR	Richard Ellis Monthly (quarterly), Nominal Total Returns

4.2 Basic Time Series Analysis

Figure 4.1 shows the movement of the capital appreciation indices over the full analysis period. As with the monthly indices, the FTSE All Share index has outperformed all the real estate indices (the compounding effect exaggerating the out-performance in the later years – although even with a logarithmic representation it is clear that equities have generated more growth than real estate). The Jones Lang LaSalle index tracks the IPD and Richard Ellis indices. This can be seen more clearly in Figure 4.2 which isolates the three appraisal based indices.

Figure 4.1 Quarterly Price Indices 1987-1999

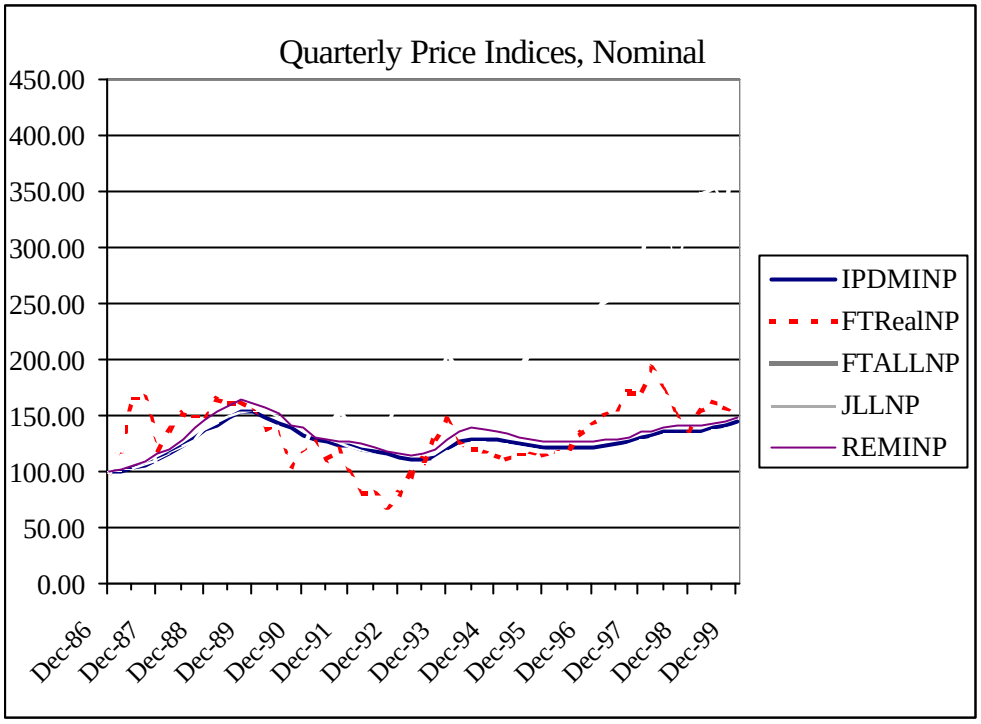
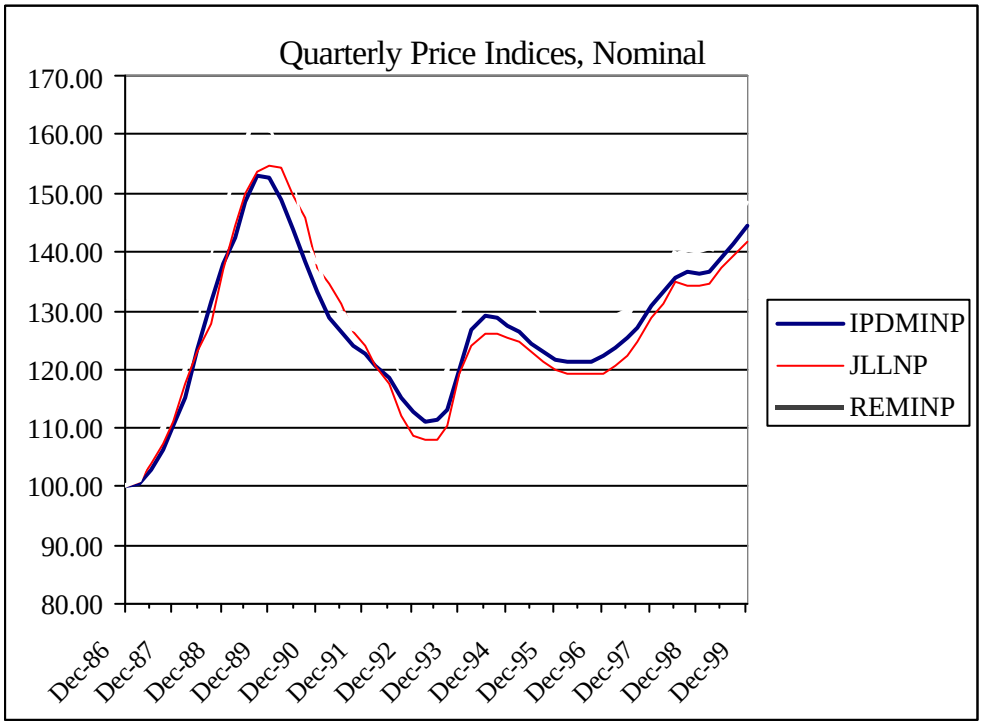


Figure 4.2 Quarterly Appraisal Based Real Estate Indices 1987-1999



Examining descriptive time statistics, perhaps the most striking feature is the poor performance of the public real estate sector, both in relation to the rest of the stock market and in relation to

risk-adjusted measures of private market performance. Figure 4.3 shows the mean and standard deviation for the five capital appreciation series over the full analysis period. Property companies offer barely more capital growth than the appraisal-based indices but exhibit greater volatility than the fast-growing general stock market. When income returns are added, the appraisal based series appear to dominate the listed real estate sector, with superior total returns and lower volatility (albeit a reported volatility subject to appraisal smoothing and bias). This poor performance by property companies largely relates to negative growth in the early 1990s rather than the flight from value stocks in the late 1990s. The quarterly series calculated from the IPD Monthly Index exhibits slightly lower volatility than the JLL and Richard Ellis indices, presumably reflecting the larger sample size. Further descriptive statistics are provided in Appendix A4.

Figure 4.3 Capital Appreciation, Annualised from Quarterly Indices

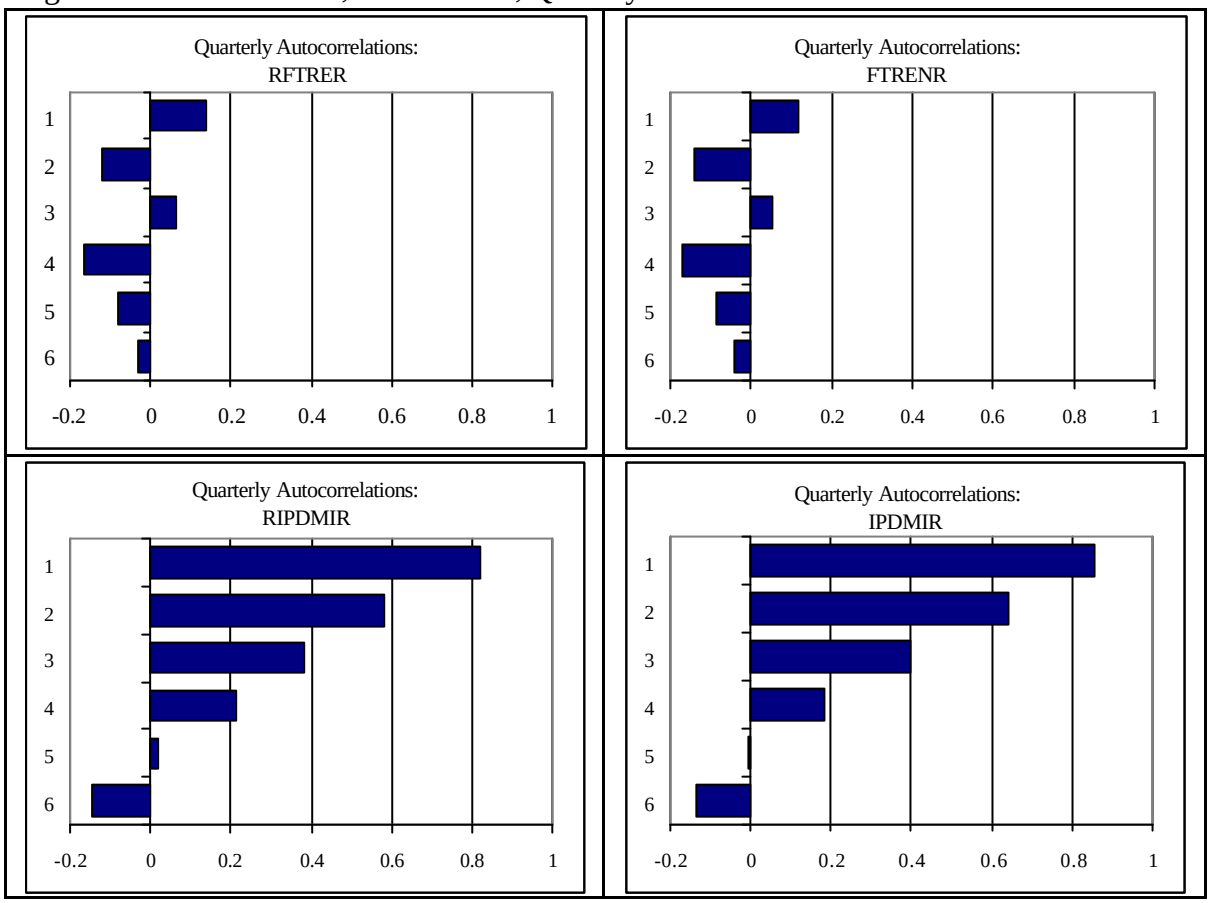
	IPDMI	*REMI*	*JLL*	*FTSE-Real Estate*	*FTSE –All Share*
Mean	2.9%	3.1%	2.7%	3.3%	11.0%
Standard Deviation	5.4%	6.4%	5.9%	25.9%	18.8%

The JLL series exhibits similar autocorrelation patterns to the IPD and Richard Ellis Series. Figure 4.4 sets out autocorrelations for the first four quarters for capital appreciation. Although first order correlation is slightly lower for the JLL series, it appears to be more persistent. Neither the FTSE Real Estate sector nor the FTSE All Share index exhibit significant autocorrelation in quarterly returns. Figure 4.5 compares autocorrelation for six lags for public and private series.

Figure 4.4 Autocorrelation in Capital Growth, Quarterly Appraisal-Based Real Estate Series

Lag	1 Quarter	2 Quarters	3 Quarters	4 Quarters
IPD Monthly	0.870	0.657	0.423	0.232
Richard Ellis	0.783	0.625	0.374	0.185
JLL	0.796	0.646	0.452	0.261

Figure 4.5 Autocorrelations, Total Returns, Quarterly Public & Private Market Series



A variety of techniques was used to test for seasonality on the data. There is no statistical evidence of seasonal patterns in the quarterly data for any of the series, whether exchange traded or appraisal based using conventional procedures.

4.3 Interrelationships Between Variables

Appendix A4 contains detailed tables of contemporaneous correlation coefficients. Examining the real, deflated, series, the FTSE Real Estate sector has a correlation of around 0.75 with the broad market All Share series over the full analysis period. However, the correlation falls to around 0.50 in the latter half of the series, 1993-1999, having been 0.85 in the 1987-1992 period. This holds true whether capital appreciation or total returns are considered. Figure 4.6 shows how the Real Estate sector's beta falls over the analysis period as the explanatory power of the single index model declines.

Figure 4.6 Single Index Regression: FTSE Real Estate Sector on FTSE All Share Returns

4.6a: Full Analysis Period

Dependent Variable: FTRENR
Method: Least Squares
Sample: 1987:1 1999:4
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.019065	0.012323	-1.547101	0.1281
FTALLNR	1.016121	0.129018	7.875836	0.0000

R-squared	0.553686	Mean dependent var	0.017769
Adjusted R-squared	0.544760	S.D. dependent var	0.121852
S.E. of regression	0.082215	Akaike info criterion	-2.121255
Sum squared resid	0.337965	Schwarz criterion	-2.046207
Log likelihood	57.15264	F-statistic	62.02879
Durbin-Watson stat	1.623651	Prob(F-statistic)	0.000000

4.6b Early Period, 1987-1992

Dependent Variable: FTRENR
Method: Least Squares
Sample: 1987:1 1992:4
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.035667	0.017616	-2.024693	0.0552
FTALLNR	1.158444	0.154641	7.491191	0.0000

R-squared	0.718375	Mean dependent var	0.001500
Adjusted R-squared	0.705573	S.D. dependent var	0.152607
S.E. of regression	0.082806	Akaike info criterion	-2.064969
Sum squared resid	0.150852	Schwarz criterion	-1.966798
Log likelihood	26.77963	F-statistic	56.11794
Durbin-Watson stat	1.814154	Prob(F-statistic)	0.000000

4.6c Later Period: 1993-1999

Dependent Variable: FTRENR
Method: Least Squares
Sample: 1993:1 1999:4
Included observations: 28

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005708	0.017338	0.329188	0.7447
FTALLNR	0.653084	0.227267	2.873642	0.0080

R-squared	0.241049	Mean dependent var	0.031714
Adjusted R-squared	0.211859	S.D. dependent var	0.088148
S.E. of regression	0.078256	Akaike info criterion	-2.188919
Sum squared resid	0.159223	Schwarz criterion	-2.093762
Log likelihood	32.64487	F-statistic	8.257816
Durbin-Watson stat	1.132093	Prob(F-statistic)	0.007980

The three appraisal based indices exhibit strong contemporaneous correlation, for both total returns and capital appreciation. This strong common performance is sustained over different time periods, is generally above 0.9 and never falls below 0.87. The appraisal based indices show low contemporaneous correlation with the FTSE Real Estate Sector (0.15-0.26 over the full analysis period, falling to zero in the latter half of the time series). The quarterly series created by interpolation from the IPD annual index has a higher correlation to the FTSE Real has a stronger correlation to the public-traded real estate sector (0.45) and lower correlations with the other appraisal-based indices (0.48-0.58). Given that the interpolated series had correlations of between 0.78-0.82 with the other appraisal series in the 1987-1992 period, this suggests that the pattern of movement between quarters has become more volatile in the latter half of the analysis period.

One rationale for the creation of the interpolated series was to provide a (crude) test to see whether the reported monthly and quarterly series are influenced by "stale" appraisals. There is tentative evidence for such an effect. The interpolated series does Granger cause all three of the appraisal based series, although, in part, this may be an artefact of the method of data construction. Tests suggest that there is no leading relationship in the early part of the analysis period. Given the evidence of lower correlations in the second half of the time series (implying greater quarterly volatility in appraisals), it may be that there are more "shocks" in the 1993-1999 period. When a shock occurs in Q3 or Q4, its effect will appear in Q1 and Q2 of the interpolated series, due to the averaging process. This may give rise to an apparent leading relationship. Equally, however, the impact of a shock in Q1 and Q2 will be spread over all four quarters. There seems no reason to anticipate an increase in "stale" appraisals over the analysis period.

Figure 4.7 Granger Causality Tests, Interpolated Series against Appraisal Returns

Pairwise Granger Causality Tests
Sample: 1987:1 1999:4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Probability
IPDGELTNR does not Granger Cause JLLNP	47	15.1066	5.3E-08
JLLNP does not Granger Cause IPDGELTNR		1.88015	0.12217

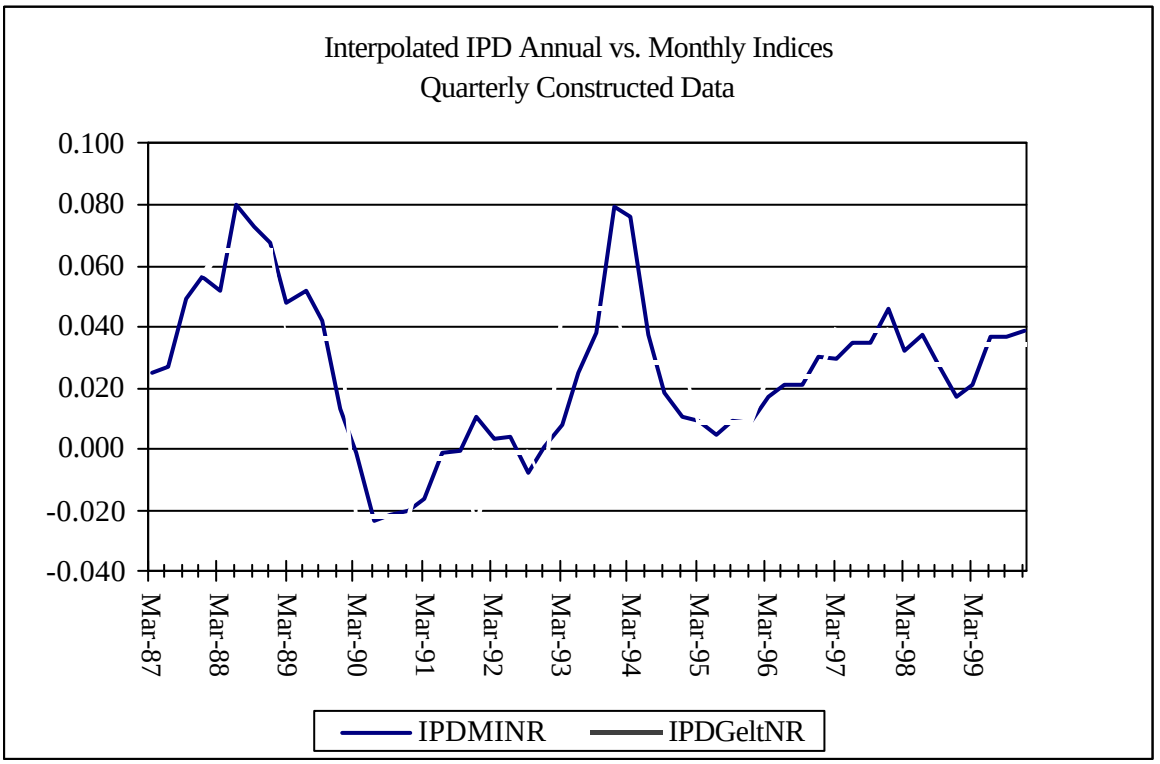
Pairwise Granger Causality Tests
Sample: 1987:1 1999:4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Probability
IPDGELTNR does not Granger Cause IPDMINR	47	15.7363	3.3E-08
IPDMINR does not Granger Cause IPDGELTNR		0.67765	0.64315

Pairwise Granger Causality Tests
Sample: 1987:1 1999:4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Probability
REMINR does not Granger Cause IPDGELTNR	47	1.76968	0.14400
IPDGELTNR does not Granger Cause REMINR		7.48889	6.6E-05

Figure 4.8 IPD Interpolated Series vs. IPD Monthly Returns



Granger causality tests do provide some evidence of a leading, price discovery, relationship between the securitised and private real estate markets. Tests on capital appreciation, reported in Appendix A4, show the FTSE Real Estate sector Granger causing all three of the appraisal-based indices. As noted in relation to the monthly index, this statistically strong result may over-emphasise the information content of the earlier arrival of information in the public market. Examination of the cross-correlogram shows significant correlations between the appraisal based capital returns and the FTSE Real Estate returns lagged one, two, three and four quarters, with a sharp decline thereafter. The lag with the highest correlation varies by appraisal series. Examination of regression equations with lagged values of both the appraisal indices and the FTSE Real Estate Series showed that lagged values of the public market returns did have a statistically significant impact, but did not contribute in large part to the return in any one quarter. An example is shown in Figure 4.9, below.

Figure 4.9, JLL Capital Appreciation, Autoregression & Lagged Values of FTSE Real Estate

Dependent Variable: JLLNP
Method: Least Squares
Sample(adjusted): 1987:4 1999:4
Included observations: 49 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001286	0.002182	0.589116	0.5587
JLLNP(-1)	0.647261	0.079353	8.156735	0.0000
FTREALNP(-1)	0.078342	0.019852	3.946297	0.0003
FTREALNP(-3)	0.067594	0.018896	3.577257	0.0008

R-squared	0.759854	Mean dependent var	0.005673
Adjusted R-squared	0.743844	S.D. dependent var	0.029554
S.E. of regression	0.014958	Akaike info criterion	-5.489064
Sum squared resid	0.010068	Schwarz criterion	-5.334629
Log likelihood	138.4821	F-statistic	47.46195
Durbin-Watson stat	2.085098	Prob(F-statistic)	0.000000

4.4 Summary

- The results for quarterly frequency data largely mirror those of the monthly analysis;
- The three appraisal-based real estate indices closely track each other and exhibit very similar risk/return profiles;
- The equity market property index exhibits greater volatility than the aggregate stock market benchmark but returns some three times lower, barely greater than the appraisal-based returns;
- All three appraisal based indices have similar levels of strong positive serial correlation, exceeding 0.7 for first order autocorrelation and still high after four lags. There is, however, no evidence of significant seasonality;

- The appraisal-based indices are strongly inter-correlated but have low to zero contemporaneous correlation with the public-traded FTSE Real Estate index. The FTSE Real Estate index has a high, but declining, contemporaneous correlation with the overall stock market;

- There is evidence that the market-traded FTSE Real Estate Index leads the appraisal-based indices. The degree of additional information over a simple autocorrelation model is, however, not large;

- The constructed real estate series based on interpolation of the IPD annual series does lead the appraisal-based indices. This may be an artefact of the construction method: alternatively, it may be evidence of a bunching of valuations in particular quarters and the use of "stale" valuations in prior periods.

- There is evidence that the market-traded FTSE Real Estate Index leads the appraisal-based indices. The degree of additional information over a simple autocorrelation model is, however, not large;

- The constructed real estate series based on interpolation of the IPD annual series does lead the appraisal-based indices. However, this may be as much an artefact of the construction method as clear evidence of a bunching of valuations in particular quarters and the use of "stale" valuations in prior periods.

5. Annual Data

5.1 Introduction

Annual data exists for a longer time period than the quarterly and monthly series. IPD publish an annual returns series that goes back to 1970 and the JLL series is available to 1967. There have also been some recent attempts to reconstruct long run property histories, assembling early data from archival records. Some caution must be exercised with the early data in the public series. JLL annual data had a stop date of June: this has been converted to an end December series by simple averaging. This will generate some moving average effects and, hence, tests for leads and lags will be unreliable. Given the low frequency of the data and the small number of observations, statistics must, inevitably, be largely descriptive.

The series analysed are:

1. FTASN: FTSE All Share, Nominal
2. FTASR: FTSE All Share, Real
3. GILTSN: Nominal Medium-Dated Gilts (Government Bonds) Returns
4. GILTSR: Real Medium-Dated Gilts Returns
5. JLLN: Jones Lang La Salle Returns Nominal
6. JLLR: Jones Lang La Salle Returns Real
7. PROPN: IPD Long-Run, Nominal
8. PROPR: IPD Long-Run, Real

9. RPI: Retail Price Index
10. TBILLN: 3 Month T-Bill Nominal
11. TBILLR: 3 Month T-Bill Real

5.2 Time Series Statistics

Figures 5.1 and 5.2 show graphically the indexed performance of the different assets, in nominal terms, over the thirty year period. It is evident that the all share index has outperformed the other assets over the period, once it recovered from the 1974 market crash. Descriptive statistics are given in Figure 5.3. As observed in other studies, the two real estate indices appear to offer a higher return than government bonds for less risk. This apparent lower risk is generally attributed to valuation smoothing, although this should be less evident in annual data than in data at higher frequency. That said, the IPD series has a first order serial correlation of 0.24. The JLL index appears to exhibit lower volatility than the IPD series. However, this results from the construction of the year-end series and the moving average process that results. This is reflected in the higher first order correlation of 0.53. The autocorrelation statistics are sensitive to the time period selected, as are the descriptive statistics (see Figure 5.4).

Figure 5.1 Annual Performance, Nominal Indices (log scale)

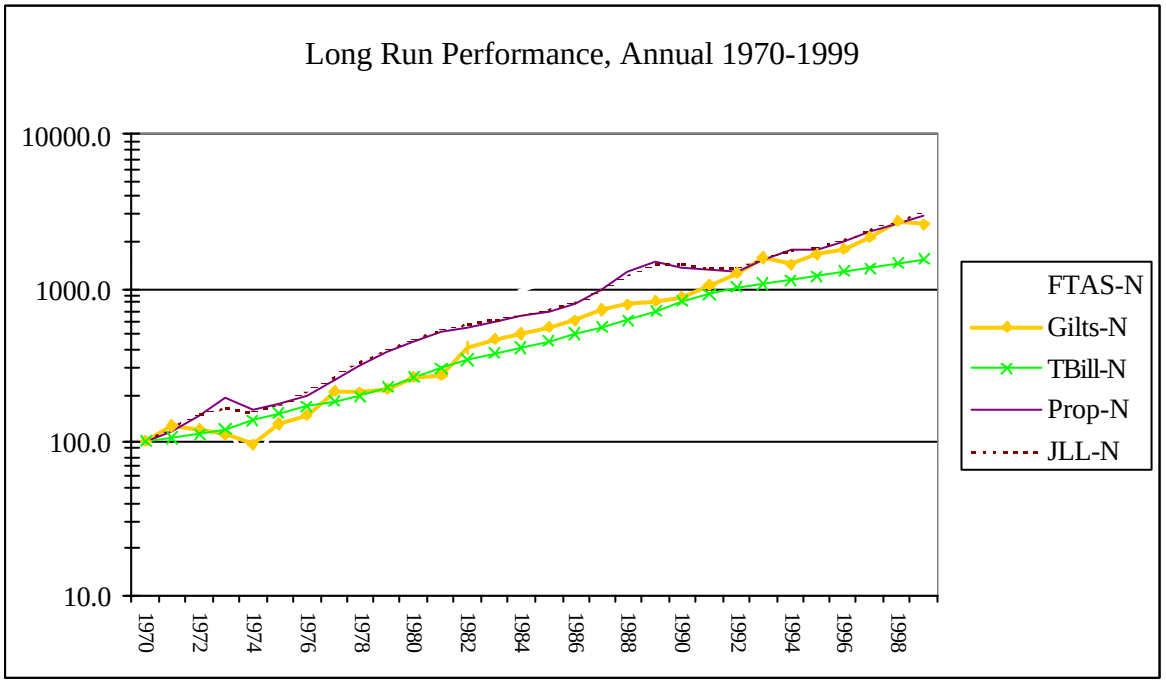


Figure 5.2 Annual Performance, Nominal Indices

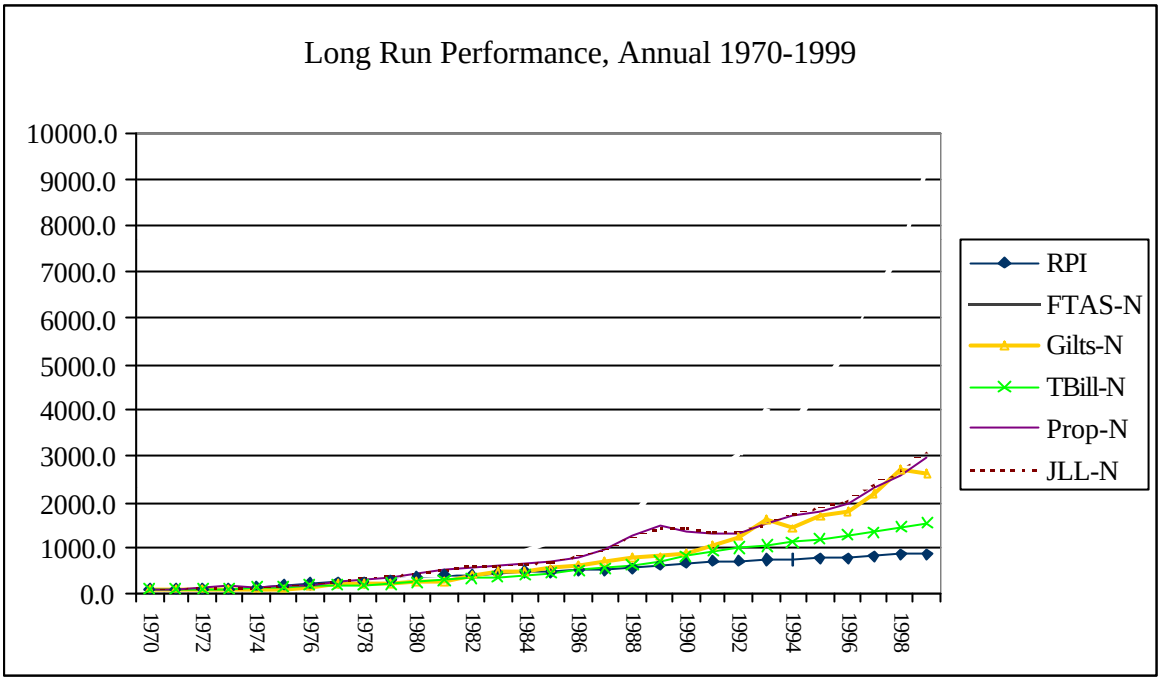


Figure 5.3 Descriptive Statistics, 1970-1999

	Mean	Median	Standard Deviation	Skewness	Kurtosis	Minimum	Maximum
RPI	7.5%	5.5%	5.2%	1.167	0.885	1.8%	22.2%
FTASN	15.6%	18.4%	26.0%	-0.632	5.609	-69.5%	91.3%
GiltsN	11.3%	10.4%	13.8%	0.104	0.018	-16.5%	41.4%
TBillN	9.5%	9.2%	2.9%	0.289	-0.615	5.3%	15.9%
PropN	11.7%	11.3%	10.3%	-0.923	1.228	-17.7%	26.0%
JLLN	11.8%	13.1%	7.9%	-0.419	-0.339	-4.3%	23.9%
FTASR	8.1%	14.5%	26.4%	-1.589	6.066	-87.0%	69.1%
GiltsR	3.8%	4.9%	14.9%	-0.279	0.485	-34.0%	36.1%
TBillR	2.0%	3.5%	4.5%	-1.306	1.806	-12.0%	6.7%
PropR	4.2%	6.3%	11.8%	-1.470	3.365	-35.1%	19.4%
JLLR	4.4%	4.6%	11.1%	-1.261	2.839	-31.6%	20.9%

Figure 5.4 Mean (Standard Deviation) for Different Time Periods

Time Period	IPD Series	JLL Series	Gilts Series	All Share Series	Treasury Bill Series	Inflation (RPI)
1971-1999	11.7 (10.3)	11.8 (7.9)	11.2 (13.8)	15.6 (26.0)	9.5 (2.9)	7.5%
1980-1999	10.2 (8.4)	10.3 (6.8)	12.4 (11.2)	17.4 (10.7)	9.6 (3.2)	5.1%
1985-1999	10.0 (9.5)	10.2 (7.6)	11.0 (9.7)	15.2 (11.0)	8.9 (3.0)	4.1%
1990-1999	6.9 (9.0)	7.8 (7.3)	11.4 (11.9)	13.6 (11.9)	7.8 (3.0)	3.4%
1995-1999	10.6 (4.6)	11.1 (4.2)	12.2 (10.4)	18.2 (4.0)	6.4 (0.8)	2.7%

5.3 Relationship Between Variables

Correlation analysis has frequently been used in portfolio studies to justify the place of property in the mixed asset portfolio. The results for the full time series show, as in previous studies, that Bonds and Equities have a relatively high correlation (here 0.7) while Real Estate has a far lower correlation with the stock market and a near zero correlation with government fixed interest securities. These results hold over different time periods, with the property-equity correlations falling once the pre-1975 period is excluded. However, in the 1990s, the correlation between the stock market and the real estate market appears to increase: in the 1990-1999 period, the FTSE All Share and IPD Series returns have a positive correlation of 0.41.

Figure 5.4 Contemporaneous Correlations, 1971-1999
5.4(a) Nominal Returns

	RPI	*FTASN*	*GiltsN*	*TBillN*	*PropN*	*JLLN*
RPI	1.00					
FTASN	0.02	1.00				
GiltsN	-0.03	0.70	1.00			
TBillN	0.52	-0.07	0.06	1.00		
PropN	-0.04	0.31	0.08	-0.29	1.00	
JLLN	0.08	0.30	0.08	-0.23	0.87	1.00

5.4(b) Real Returns

	FTASR	*GiltsR*	*TBillR*	*PropR*	*JLLR*
FTASR	1.00				
GiltsR	0.70	1.00			
TBillR	0.10	0.36	1.00		
PropR	0.36	0.25	0.25	1.00	
JLLR	0.17	0.11	0.28	0.82	1.00

Given the low number of observations, tests for price discovery and lead-lag relationships would be unreliable. With a one or two lag structure, against received wisdom, the IPD returns series appears to Granger cause the FTSE All Share index. This relationship disappears with an increase in the number of lags, suggesting that the result may simply be the outcome of outlier, extreme, events.

5.4 Summary

- Annual data permits analysis over a longer time period but, with less observations, there are limitations on the amount of statistical tests that can be conducted;

- Over the whole period 1971-1999, equity markets have outperformed other asset classes in terms of returns, but with higher volatility. Much of that volatility, however, relates to the early 1970s.

- For many time spans, appraisal-based property indices show higher average returns for less or comparable risk than government bonds. This does not hold over the last ten years, where the impact of the property recession of the early 1990s results in much lower returns.

- As noted in prior studies, equities have a high positive contemporaneous correlation with bonds, while property indices exhibit low (apparent) correlations with both bonds and equities, suggesting that some diversification potential exists. Such results, however, rely on the validity and accuracy of the appraisals that form the basis of performance.

6. Sectoral Analysis

6.1 Introduction

In this section, the time series characteristics of the main real estate sectors are considered. Monthly data are examined using the IPD Monthly and Richard Ellis monthly series; at a quarterly frequency, the two monthly series are compared to the Jones Lang LaSalle index. For each main series, we examine office, retail and industrial real estate. The monthly Richard Ellis index additionally distinguishes retail warehouse property. This sub-class, as we will show, has behaved in a manner quite distinctive from the rest of the retail sector. We focus on changes in capital values, although total return series are available for the two monthly indices. The analysis period runs from 1987 to 1999. Further statistical analyses are contained in Appendix A6.

At the end of December 1999, 48% of the capital value of the IPD monthly index consisted of retail property; offices made up 31% and 19% was industrial property (by number of properties, the proportions are 53%, 25% and 20% respectively, indicating that the retail property includes a sizeable number of individual high street shops, compared to larger shopping malls). These portfolio shares are different to those found on the aggregate annual IPD databank, where 50% of the capital value is contributed by the retail sector, 33% being office and just 13% by industrial real estate. These sectoral differences explain at least in part, the tracking error between monthly and annual series. The office share of the index has been falling, part due to portfolio rebalancing and part due to differential rates of capital growth between the sectors.

6.2 *Monthly Series*

The series analysed on a monthly basis are:

IPDRetP	IPD Monthly, Retail, Capital Growth
IPDOffP	IPD Monthly, Office, Capital Growth
IPDIndP	IPD Monthly, Industrial, Capital Growth
RERetP	Richard Ellis Monthly, Retail, Capital Growth
REOffP	Richard Ellis Monthly, Office, Capital Growth
REIndP	Richard Ellis Monthly, Industrial, Capital Growth
RERWP	Richard Ellis Monthly, Retail Warehouse, Capital Growth

Figure 6.1 shows the monthly price changes for the three series. All three series exhibit strongly cyclical behaviour with the property crash of the early 1990s very evident. In that period, the office sector performed worse than industrial and retail. These losses have not been regained, leading to lower office market capital growth over the whole period than that found in retail and industrial sectors. The higher capitalization rates (and hence income returns) of industrial

property have, over this period, produced higher total returns. The Richard Ellis data tell much the same story. However, the smaller number of properties in the Richard Ellis database contributes to a greater degree of return volatility (perhaps explained by aggregation effects and cross-serial correlation). This can be seen in Figure 6.2, which compares IPD Monthly and Richard Ellis monthly series for office markets. This greater volatility is confirmed by the higher standard deviation values for the Richard Ellis series, a result that holds for all three main asset classes (see Figure 6.3).

Figure 6.1 Monthly Price Changes, IPD Monthly

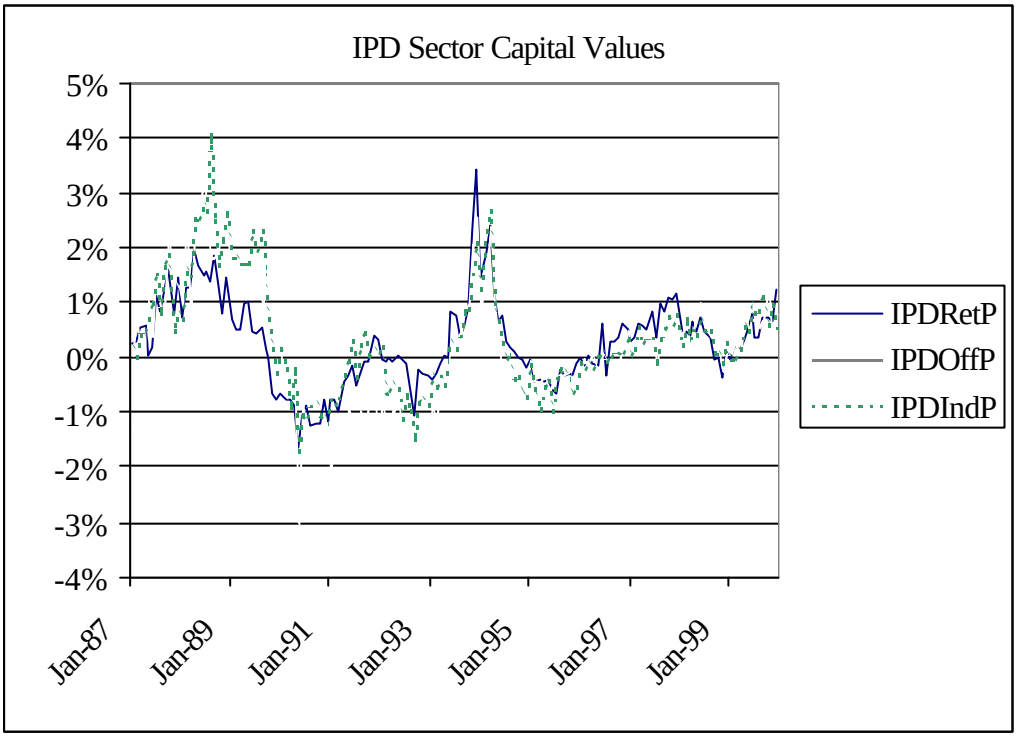


Figure 6.2 IPD and Richard Ellis Office Series Compared

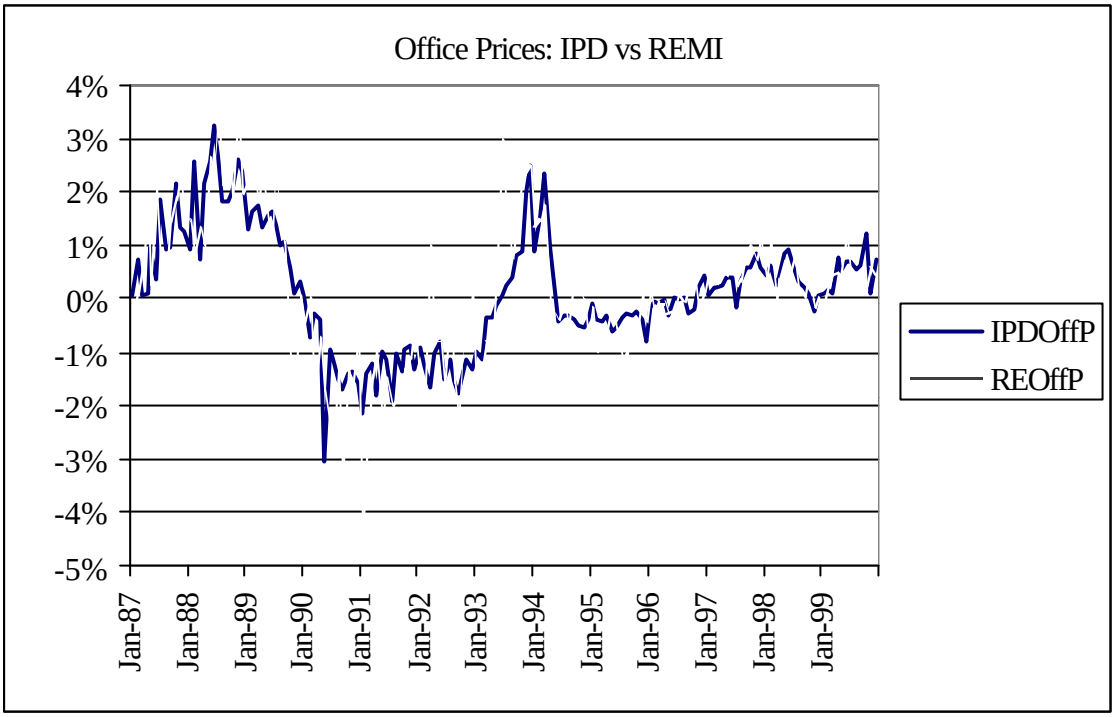


Figure 6.3 Time Series Statistics, Monthly Capital Value Change (log difference)

	IPDRetP	*IPDOffP*	*IPDIndP*	*RERetP*	*REOffP*	*REIndP*	*RERWP*
Mean	0.003	0.001	0.003	0.002	0.001	0.005	0.005
Median	0.003	0.001	0.001	0.002	0.002	0.002	0.004
Standard Deviation	0.008	0.011	0.010	0.010	0.014	0.013	0.015
Sample Variance	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kurtosis	1.193	0.043	0.697	5.611	0.355	1.705	32.086
Skewness	0.536	0.230	0.845	1.243	-0.118	0.609	3.770
Range	0.051	0.063	0.058	0.087	0.079	0.088	0.162
Minimum	-0.016	-0.030	-0.017	-0.028	-0.044	-0.041	-0.029
Maximum	0.034	0.033	0.041	0.059	0.035	0.047	0.133
CV	281%	839%	304%	475%	1032%	242%	277%
Mean Annualised	3.42%	1.62%	4.08%	2.68%	1.60%	6.82%	6.77%
St Dev Annualised	2.74%	3.93%	3.53%	3.65%	4.77%	4.64%	5.28%

We remarked above that retail warehouses have performed somewhat differently to more general retail real estate. This is evident from Figure 6.3. Retail warehouses seem to have generated nearly double the capital growth of the general retail series. It was reported that the sub-sector was able to sustain rental (and, hence, capital) values through strong tenant demand throughout the property recession – confirmed by evidence that landlords were able to sustain long leases throughout the early 1990s, in contrast to other sectors. The strong positive skewness and kurtosis can be, in large part, attributed to the dramatic leap in capital values in one month, June 1988, when values rose 14%. Whether this is, in some sense, an erroneous observation, results from a composition change in the index data or represents a change in the "house view" of the sub-sector

is not clear. Certainly, the jump in value is not corrected in subsequent months. With a small sample size, the retail warehouse sub-sector probably consists of just a handful of properties.

As would be expected from the aggregate analysis, all sector series show evidence of considerable serial correlation – with the exception of the Richard Ellis retail warehouse series. In the last case, the first order coefficient is 0.34, falling to under 0.25 after five lags. Removing the June 1988 value, the first order coefficient rises to 0.56 and stays above 0.35 for six lags. Nonetheless, this is still a low level of serial correlation than the other sectors, for both data providers. Each sector series exhibits lower autocorrelation than the "parent" series.

For all sectors, the IPD index exhibits slightly greater serial correlation than the Richard Ellis index, presumably reflecting the greater aggregation effects of the larger sample. Thus, the first order autocorrelation coefficient for offices is 0.86 for the IPD series and 0.78 for the Richard Ellis series. This difference is preserved as the number of lags increases. The sixth order coefficient is 0.67 for IPD and 0.59 for Richard Ellis (see Figure 6.4). The IPD industrial series has the highest first order correlation at 0.89. However, the IPD office sector seems more persistent. With six lags, the autocorrelation coefficient for industrial real estate has fallen to 0.56; the comparable office sector coefficient is 0.67 (first order = 0.86). The Richard Ellis office series has a higher first order coefficient than the RE industrial series: it, too, exhibits stronger persistence than the other sectors. It may be that the office sector is more influenced by macro factors and less by micro-locational drivers than the other sectors. There was no evidence of seasonality in the data using conventional tests, although the statistically significant PAC spike at lag 12 in the aggregate real capital value series is evident in the IPD office and retail sectors (but not in the industrial series).

Figure 6.4 Autocorrelation Coefficients, IPD and RE Office Price Series

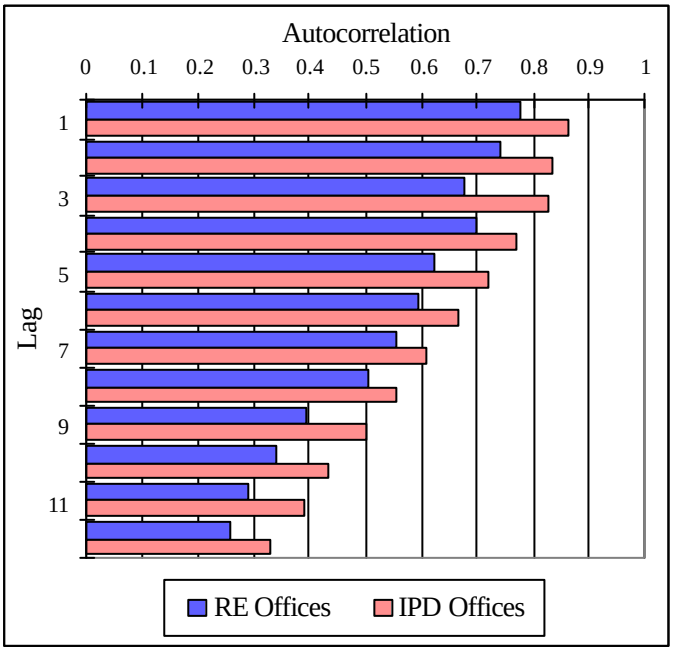


Figure 6.5 shows contemporaneous correlation coefficients for the price series. These are, typically, high, with the exception of the RE retail warehouse series. Excluding June 1988 increases the correlation with the two retail sectors by about +0.10 but makes little difference to the other sector correlations. The IPD sectors are more closely inter-correlated than the Richard Ellis sectors. For all three sectors, the highest correlation between pairs of IPD and Richard Ellis series is between equivalent categories (IPD office to RE office, for example).

Figure 6.5 Contemporaneous Correlation, Monthly Price Changes

	IPDRetP	*IPDOffP*	*IPDIndP*	*RERetP*	*REOffP*	*REIndP*	*RERWP*
IPDRetP	1.000						
IPDOffP	0.826	1.000					
IPDIndP	0.823	0.889	1.000				
RERetP	0.784	0.667	0.665	1.000			
REOffP	0.773	0.831	0.779	0.696	1.000		
REIndP	0.724	0.714	0.835	0.694	0.705	1.000	
RERWP	0.576	0.434	0.429	0.491	0.394	0.492	1.000

The series were examined for leading and lagging relationships, using Granger causality tests. Within the IPD series, the office sector appears to Granger cause the industrial sector ($p = 0.013$). Using a consistent lag length of 13, no leading or lagging relationships were found between IPD office and retail or between retail and industrial. IPD offices do not Granger cause RE offices; however IPD Retail Granger causes both RE Retail ($p = 0.001$) and RE Retail Warehouses ($p < 0.001$) and IPD Industrial Granger causes RE Industrial ($p < 0.001$). Given that IPD offices lead IPD industrial, as expected they also lead RE industrial ($p = 0.01$). These results are reported in Appendix A6.

Within the RE series, offices Granger cause industrial ($p = 0.04$), retail ($p = 0.002$) and retail warehouse ($p = 0.004$); industrials Granger cause both retail ($p = 0.03$) and retail warehouse ($p = 0.002$). There is no obvious explanation for such a result: it illustrates the problems of a small sample and a single, in-house, appraisal basis for the series.

6.3 Quarterly Series

Analyses for the quarterly series allows inclusion of the Jones Lang LaSalle office, retail and industrial series in comparison to the two monthly series. In each sector, the three series track each other clearly, although the two small sample series exhibit greater volatility than the larger IPD series as Figures 6.6 and 6.7 demonstrate. The standard deviations seem low when compared to the IPD annual index's standard deviation of 10% for capital growth over the same 1987-1999 period.

Figure 6.6 Quarterly Price Changes By Sector

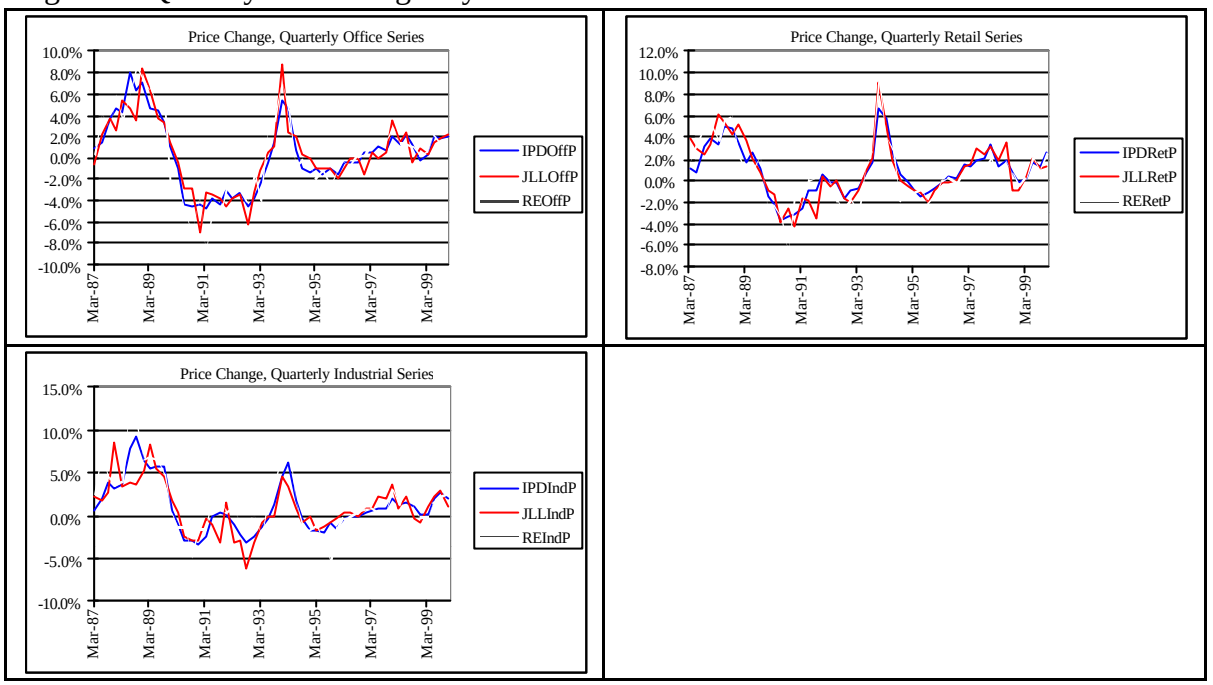


Figure 6.7 Descriptive Statistics, Quarterly Price Changes

	IPDRetP	*IPDOffP*	*IPDIndP*	*JLLRetP*	*JLLOffP*	*JLLIndP*	*RERetP*	*REOffP*	*REIndP*	*RERWP*
Mean	0.008	0.004	0.010	0.009	0.004	0.009	0.007	0.004	0.016	0.016
Median	0.008	0.005	0.005	0.006	0.005	0.008	0.006	0.003	0.008	0.018
Standard Deviation	0.023	0.032	0.029	0.027	0.033	0.029	0.027	0.038	0.037	0.034
Sample Variance	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Kurtosis	0.127	-0.483	0.336	0.467	0.465	0.530	1.464	-0.207	1.103	4.294
Skewness	0.330	0.259	0.839	0.546	0.262	0.326	0.473	-0.027	0.905	0.893
Range	0.103	0.127	0.126	0.135	0.158	0.145	0.160	0.174	0.182	0.209
Minimum	-0.036	-0.047	-0.034	-0.043	-0.070	-0.060	-0.066	-0.089	-0.053	-0.060
Maximum	0.067	0.080	0.092	0.092	0.089	0.084	0.094	0.085	0.129	0.149

The contemporaneous correlation coefficients of the quarterly series are, as expected, higher than those of the monthly series. The average correlation coefficient between series is 0.77 – excluding the RE Retail Warehouse series, this increases to 0.82. The three office series are the most similar (average correlation of 0.90), with industrial the least (average correlation of 0.79). All three JLL and RE sector indices are "more like" their IPD equivalents than each other. A full correlation matrix is shown in Appendix A6. Examining the latter half of the time series (1993:Q1 to 1999:Q4), average correlations increase to 0.85. The three retail series have an average correlation of 0.92.

Price changes for the IPD office series exhibit somewhat greater first order autocorrelation than the other two sectors (0.89 compared to 0.85 for industrials and 0.81 for retail): this autocorrelation is more persistent than for the other sectors, 0.74 at two lags and 0.54 at three lags. There is no fourth quarter partial autocorrelation spike. The JLL and RE sector series show less autocorrelation, first order AC values varying between 0.54 (RE retail warehouses) and 0.80

(RE offices). As with the IPD data, the two office series exhibit higher and more persistent levels of levels of autocorrelation than the industrial or retail series. Full results are shown in Appendix A6.

Tests for leads and lags in the series suggest that, in general, the office sector leads the other sectors. The Richard Ellis nominal price change series Granger causes IPD offices and retail, JLL offices, retail and industrial and RE retail warehouses, all at $p < 0.05$. The IPD office sector Granger causes the JLL industrial, RE industrial, retail and retail warehouse series, again all at $p < 0.05$. The JLL office index Granger causes RE retail, industrial and retail warehouse series and the IPD industrial series, all statistically significant at the 0.05 level. The RE industrial, retail, and retail warehouses seem to lag the other series (of the 21 possible bivariate Granger tests, the three RE series, in thirteen, the RE series are Granger caused by another series at $p<0.05$, in a further case there is weaker evidence of a lag, in one case there is two-way causality; one of the tests indicate a leading relationship).

6.3 Summary

- Sectoral analysis suggests that the retail sector is less volatile than offices or industrial property, and that the larger sample IPD series is less volatile than the small sample RE and JLL series;

- The office sector exhibits greater and more persistent serial correlation than the other sectors, a result that holds for all three providers;

- The RE and JLL sector series are more closely correlated to their IPD equivalents than to each other or other "in-house" sectors.

- Office capital value changes appear to lead those in other sectors, while the RE series appear to lag both IPD and JLL series.

Bibliography

Ball M, C Lizieri & B MacGregor (1998) *The Economics of Commercial Property Markets* London: Routledge

Brown G & G Matysiak (1995) Using Commercial Property Indices for Measuring Portfolio Performance *Journal of Property Finance* 6: 27-38

Barkham R & D Geltner (1994) Unsmoothing British Valuation-Based Returns Without Assuming an Efficient Market, *Journal of Property Research* 11: 81-95

Barkham R & D Geltner (1995) Price Discovery in American and British Property Markets *Real Estate Economics* 23 21-44

Byrne P & S Lee (2000) Risk Reduction in the UK Property Market *Journal of Property Research* 17: 23-46

Lizieri C and S Satchell (1997) Interactions Between Property and Equity Markets: An Investigation of the Linkages in the United Kingdom 1972-1992 *Journal of Real Estate Finance and Economics* 15, 11-26

Lizieri C & C Ward (2000, forthcoming) Commercial Real Estate Return Distributions: A Review Of Literature And Empirical Evidence , in Knight J and Satchell S (eds.) *Asset Return Distributions* London: Butterworth-Heinemann – version available as Working Papers in Land Management and Development 01/00, the University of Reading pp. 37

Matysiak G & P Wang (1995) Commercial Property Market Prices and Valuations: Analysing the Correspondence *Journal of Property Research* 12: 181-202

Morrell G (1991) Property Performance Analysis and Performance Indices: A Review *Journal of Property Research* 8: 29-57

Morrell G (1993) Value Weighting and the Variability of Real Estate Returns: Implications for Portfolio Construction and Performance Evaluation *Journal of Property Research* 10, 167-183

Morrell G, S Brown, R Unsworth & C Ward (1994) *Property Indices Research Report: The Commission's Findings and Recommendations* London: Society of Property Researchers Technical Paper No. 1

Morrell G (1995) Property Indices: A Coming of Age? *Journal of Property Valuation & Investment* 13: 8-21

Ward C and W Wu (1994) The Valuation Smoothing Effects on Property Returns: Does the Market Have a Memory? *Proceedings, The Cutting Edge Property Research Conference* 45-68, London, RICS

APPENDIX A3 Additional Statistics, Monthly Analysis

Autocorrelation – Nominal Data

FTSE All Share Nominal Prices

	AC	PAC	Q-Stat	Prob
1	0.096	0.096	1.4558	0.228
2	-0.155	-0.166	5.3192	0.070
3	-0.111	-0.081	7.3104	0.063
4	0.016	0.011	7.3520	0.118
5	-0.054	-0.090	7.8277	0.166
6	-0.062	-0.055	8.4515	0.207
7	-0.060	-0.072	9.0454	0.249
8	-0.110	-0.140	11.070	0.198
9	0.005	-0.005	11.075	0.271
10	0.085	0.028	12.296	0.266
11	-0.015	-0.066	12.332	0.339
12	-0.055	-0.045	12.848	0.380
13	0.011	-0.009	12.867	0.458

FTSE All Share Nominal Returns

	AC	PAC	Q-Stat	Prob
1	0.095	0.095	1.4485	0.229
2	-0.156	-0.167	5.3476	0.069
3	-0.108	-0.078	7.2271	0.065
4	0.015	0.009	7.2654	0.123
5	-0.057	-0.092	7.7882	0.168
6	-0.069	-0.062	8.5706	0.199
7	-0.061	-0.073	9.1834	0.240
8	-0.109	-0.141	11.160	0.193
9	0.005	-0.008	11.165	0.265
10	0.085	0.028	12.391	0.260
11	-0.016	-0.069	12.434	0.332
12	-0.062	-0.055	13.089	0.363
13	0.013	-0.008	13.120	0.439

FTSE Real Estate Nominal Prices

	AC	PAC	Q-Stat	Prob
1	0.170	0.170	4.6000	0.032
2	-0.031	-0.061	4.7499	0.093
3	0.063	0.081	5.3826	0.146
4	0.034	0.006	5.5676	0.234
5	-0.027	-0.029	5.6906	0.337
6	-0.034	-0.027	5.8760	0.437
7	-0.098	-0.097	7.4732	0.381
8	-0.004	0.033	7.4763	0.486
9	0.047	0.039	7.8489	0.549
10	0.077	0.081	8.8474	0.547
11	-0.042	-0.067	9.1528	0.608
12	-0.156	-0.151	13.305	0.347
13	-0.015	0.017	13.343	0.422

FTSE Real Estate Nominal Returns

	AC	PAC	Q-Stat	Prob
1	0.170	0.170	4.6046	0.032
2	-0.032	-0.063	4.7714	0.092
3	0.058	0.077	5.3081	0.151
4	0.019	-0.008	5.3662	0.252
5	-0.017	-0.013	5.4139	0.367
6	-0.034	-0.033	5.5995	0.470
7	-0.095	-0.089	7.0785	0.421
8	-0.003	0.030	7.0801	0.528
9	0.046	0.036	7.4313	0.592
10	0.068	0.070	8.2072	0.609
11	-0.033	-0.057	8.3949	0.678
12	-0.164	-0.159	13.004	0.369
13	-0.010	0.030	13.020	0.446

IPDMI Nominal Prices

	AC	PAC	Q-Stat	Prob
1	0.895	0.895	127.49	0.000
2	0.849	0.237	242.76	0.000
3	0.812	0.106	348.91	0.000
4	0.747	-0.117	439.38	0.000
5	0.675	-0.140	513.73	0.000
6	0.603	-0.108	573.45	0.000
7	0.526	-0.089	619.20	0.000
8	0.453	-0.029	653.44	0.000
9	0.392	0.038	679.24	0.000
10	0.322	-0.031	696.80	0.000
11	0.257	-0.030	708.02	0.000

IPDMI Nominal Returns

	AC	PAC	Q-Stat	Prob
1	0.887	0.887	125.14	0.000
2	0.849	0.289	240.39	0.000
3	0.810	0.094	346.11	0.000
4	0.731	-0.190	432.64	0.000
5	0.660	-0.128	503.78	0.000
6	0.592	-0.065	561.33	0.000
7	0.517	-0.043	605.49	0.000
8	0.442	-0.046	638.08	0.000
9	0.364	-0.074	660.34	0.000
10	0.295	-0.024	675.01	0.000
11	0.225	-0.029	683.58	0.000

12	0.193	-0.058	714.39	0.000	12	0.152	-0.053	687.53	0.000
13	0.139	-0.002	717.73	0.000	13	0.096	0.011	689.12	0.000

REMI Nominal Prices

	AC	PAC	Q-Stat	Prob
1	0.831	0.831	109.94	0.000
2	0.782	0.294	207.87	0.000
3	0.691	-0.044	284.87	0.000
4	0.679	0.181	359.71	0.000
5	0.622	-0.011	422.91	0.000
6	0.557	-0.123	473.92	0.000
7	0.471	-0.111	510.66	0.000
8	0.406	-0.050	538.17	0.000
9	0.312	-0.167	554.44	0.000
10	0.263	0.015	566.11	0.000
11	0.215	0.069	573.93	0.000
12	0.151	-0.093	577.85	0.000
13	0.092	-0.012	579.32	0.000

REMI Nominal Returns

	AC	PAC	Q-Stat	Prob
1	0.818	0.818	106.28	0.000
2	0.771	0.310	201.43	0.000
3	0.672	-0.053	274.29	0.000
4	0.666	0.190	346.23	0.000
5	0.605	-0.010	405.98	0.000
6	0.540	-0.123	453.95	0.000
7	0.448	-0.120	487.13	0.000
8	0.386	-0.042	511.91	0.000
9	0.287	-0.169	525.68	0.000
10	0.240	0.010	535.42	0.000
11	0.188	0.064	541.45	0.000
12	0.122	-0.104	544.01	0.000
13	0.062	-0.012	544.67	0.000

It would be invalid to calculate ACF for the interpolated IPD series, IPDGeltR, given the method of construction.

Autocorrelation – Real Data

Real FTSE All Share Prices

	AC	PAC	Q-Stat	Prob
1	0.105	0.105	1.7477	0.186
2	-0.153	-0.165	5.4700	0.065
3	-0.116	-0.083	7.6222	0.055
4	0.012	0.010	7.6465	0.105
5	-0.047	-0.083	7.9999	0.156
6	-0.026	-0.019	8.1087	0.230
7	-0.055	-0.071	8.6104	0.282
8	-0.113	-0.128	10.727	0.218
9	-0.003	-0.002	10.728	0.295
10	0.081	0.029	11.845	0.296
11	-0.009	-0.054	11.858	0.374
12	-0.033	-0.018	12.049	0.442
13	0.011	-0.002	12.068	0.522

Real FTSE All Share Returns

	AC	PAC	Q-Stat	Prob
1	0.101	0.101	1.6278	0.202
2	-0.154	-0.166	5.4212	0.066
3	-0.114	-0.082	7.5007	0.058
4	0.013	0.009	7.5274	0.111
5	-0.049	-0.085	7.9209	0.161
6	-0.034	-0.028	8.1139	0.230
7	-0.057	-0.072	8.6561	0.278
8	-0.111	-0.130	10.709	0.219
9	-0.001	-0.004	10.710	0.296
10	0.081	0.027	11.815	0.298
11	-0.012	-0.058	11.839	0.376
12	-0.041	-0.028	12.123	0.436
13	0.013	-0.002	12.150	0.515

Real FTSE Real Estate Prices

	AC	PAC	Q-Stat	Prob
1	0.173	0.173	4.7727	0.029
2	-0.022	-0.054	4.8510	0.088
3	0.060	0.076	5.4375	0.142
4	0.039	0.014	5.6841	0.224
5	-0.027	-0.033	5.8072	0.325
6	-0.007	0.002	5.8159	0.444
7	-0.100	-0.110	7.4631	0.382
8	0.001	0.044	7.4632	0.488

Real FTSE Real Estate Returns

	AC	PAC	Q-Stat	Prob
1	0.176	0.176	4.8996	0.027
2	-0.027	-0.059	5.0138	0.082
3	0.056	0.074	5.5254	0.137
4	0.024	-0.001	5.6222	0.229
5	-0.017	-0.016	5.6681	0.340
6	-0.006	-0.002	5.6735	0.461
7	-0.095	-0.101	7.1530	0.413
8	0.001	0.041	7.1531	0.520

9	0.046	0.032	7.8209	0.552	9	0.044	0.028	7.4797	0.587
10	0.081	0.085	8.9413	0.538	10	0.072	0.075	8.3479	0.595
11	-0.045	-0.071	9.2827	0.596	11	-0.034	-0.060	8.5485	0.663
12	-0.146	-0.140	12.918	0.375	12	-0.154	-0.147	12.599	0.399
13	-0.019	0.019	12.978	0.450	13	-0.012	0.033	12.623	0.477

Real IPDMI Prices

	AC	PAC	Q-Stat	Prob
1	0.779	0.779	96.421	0.000
2	0.684	0.197	171.28	0.000
3	0.628	0.124	234.78	0.000
4	0.618	0.169	296.76	0.000
5	0.581	0.036	351.85	0.000
6	0.546	0.030	400.87	0.000
7	0.422	-0.233	430.30	0.000
8	0.352	-0.073	450.91	0.000
9	0.272	-0.127	463.30	0.000
10	0.246	0.017	473.51	0.000
11	0.229	0.084	482.46	0.000
12	0.280	0.281	495.84	0.000
13	0.127	-0.313	498.64	0.000

Real IPDMI Returns

	AC	PAC	Q-Stat	Prob
1	0.775	0.775	95.596	0.000
2	0.677	0.189	168.89	0.000
3	0.608	0.092	228.37	0.000
4	0.599	0.177	286.58	0.000
5	0.586	0.102	342.62	0.000
6	0.538	-0.020	390.14	0.000
7	0.439	-0.150	421.99	0.000
8	0.348	-0.127	442.12	0.000
9	0.253	-0.163	452.86	0.000
10	0.240	0.050	462.59	0.000
11	0.233	0.073	471.79	0.000
12	0.267	0.222	483.97	0.000
13	0.118	-0.293	486.37	0.000

Real REMI Prices

	AC	PAC	Q-Stat	Prob
1	0.743	0.743	87.782	0.000
2	0.629	0.173	151.19	0.000
3	0.518	0.007	194.46	0.000
4	0.578	0.342	248.59	0.000
5	0.572	0.091	301.98	0.000
6	0.534	-0.026	348.85	0.000
7	0.396	-0.170	374.81	0.000
8	0.320	-0.074	391.87	0.000
9	0.213	-0.210	399.52	0.000
10	0.225	0.031	408.08	0.000
11	0.201	0.034	414.94	0.000
12	0.222	0.132	423.39	0.000
13	0.082	-0.177	424.56	0.000

Real REMI Returns

	AC	PAC	Q-Stat	Prob
1	0.738	0.738	86.564	0.000
2	0.624	0.176	148.96	0.000
3	0.516	0.015	191.85	0.000
4	0.574	0.332	245.32	0.000
5	0.567	0.091	297.78	0.000
6	0.527	-0.023	343.41	0.000
7	0.388	-0.173	368.30	0.000
8	0.311	-0.080	384.41	0.000
9	0.204	-0.211	391.36	0.000
10	0.214	0.026	399.09	0.000
11	0.193	0.044	405.44	0.000
12	0.213	0.131	413.18	0.000
13	0.070	-0.178	414.03	0.000

Contemporaneous Correlations – Nominal Returns 1987-1999

	IPDMINR	*FTRENR*	*FTALLNR*	*REMINR*	*IPDMINP*	*FTRENP*	*FTALLNP*	*REMINP*	*IPDAGeltR*
IPDMINR	1.000								
FTRENR	-0.006	1.000							
FTALLNR	-0.086	0.764	1.000						
REMINR	0.883	0.120	-0.002	1.000					
IPDMINP	0.979	0.031	-0.049	0.870	1.000				
FTRENP	0.002	0.998	0.767	0.124	0.040	1.000			
FTALLNP	-0.080	0.763	0.999	0.004	-0.044	0.766	1.000		
REMINP	0.888	0.111	-0.006	0.996	0.883	0.116	0.000	1.000	
IPDAGeltR	0.799	0.202	0.047	0.744	0.804	0.212	0.053	0.750	1.000

Contemporaneous Correlations – Nominal Returns 1993-1999

	FTALLNP	*FTALLNR*	*FTRENP*	*FTRENR*	*IPDAGELTR*	*IPDMINP*	*IPDMINR*	*REMINP*	*REMINR*
FTALLNP	1.000								
FTALLNR	0.999	1.000							
FTRENP	0.513	0.518	1.000						
FTRENR	0.509	0.515	0.998	1.000					
IPDAGELTR	0.057	0.053	0.267	0.263	1.000				
IPDMINP	-0.045	-0.053	-0.124	-0.129	0.442	1.000			
IPDMINR	-0.081	-0.088	-0.133	-0.136	0.464	0.981	1.000		
REMINP	0.010	0.000	0.007	0.009	0.485	0.853	0.864	1.000	
REMINR	0.013	0.005	0.029	0.030	0.504	0.845	0.861	0.997	1.000

Contemporaneous Correlations – Real Returns 1987-1999

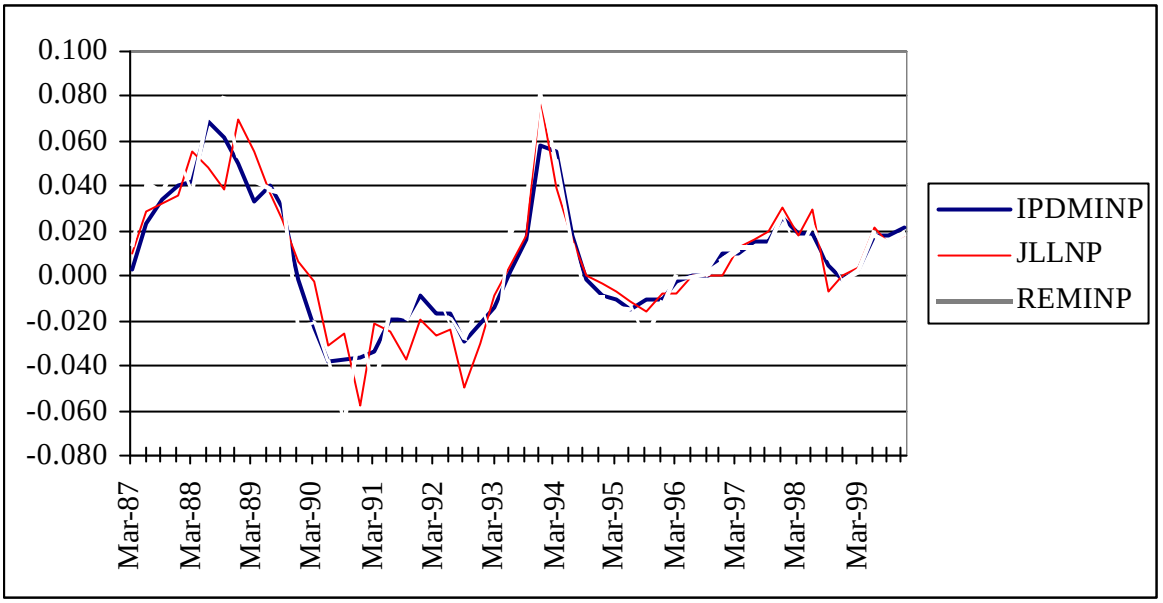
	RIPDMIR	*RFTRER*	*RFTALLR*	*RREMIR*	*RIPDAGelt*	*RIPDMIP*	*RFTREP*	*RFTALLP*	*RREMIP*
RIPDMIR	1.000								
RFTRER	0.066	1.000							
RFTALLR	0.018	0.769	1.000						
RREMIR	0.909	0.170	0.081	1.000					
RIPDAGelt	0.749	0.216	0.070	0.707	1.000				
RIPDMIP	0.983	0.096	0.045	0.899	0.752	1.000			
RFTREP	0.074	0.999	0.772	0.174	0.226	0.104	1.000		
RFTALLP	0.029	0.767	0.999	0.090	0.077	0.055	0.770	1.000	
RREMIP	0.909	0.161	0.074	0.996	0.708	0.906	0.166	0.083	1.000

Contemporaneous Correlations – Real Returns 1993-1999

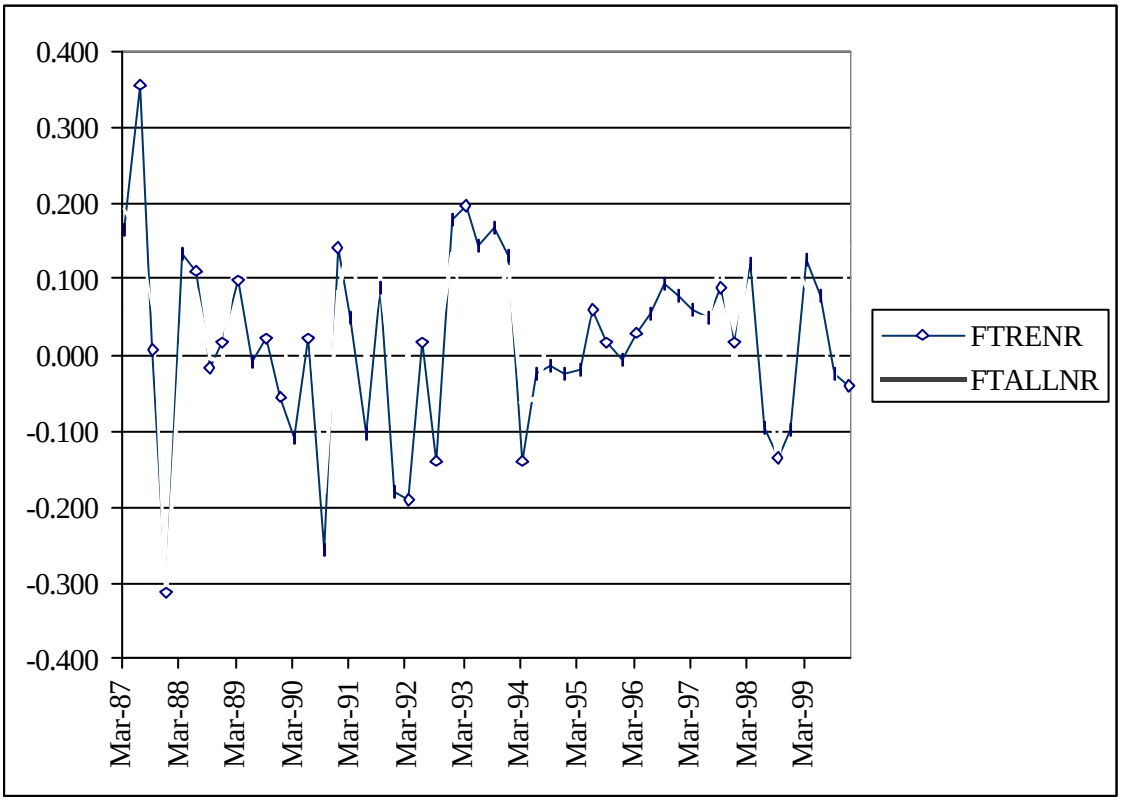
	RFTALLP	RFTALLR	RFTREP	RFTRER	RIPDAGELT	RIPDMIP	RIPDMIR	RREMIP	RREMIR
RFTALLP	1.000								
RFTALLR	0.999	1.000							
RFTREP	0.524	0.526	1.000						
RFTRER	0.520	0.522	0.998	1.000					
RIPDAGELT	0.064	0.057	0.273	0.269	1.000				
RIPDMIP	0.046	0.031	-0.054	-0.060	0.420	1.000			
RIPDMIR	0.017	0.002	-0.065	-0.071	0.441	0.987	1.000		
RREMIP	0.079	0.062	0.051	0.050	0.467	0.887	0.904	1.000	
RREMIR	0.087	0.070	0.072	0.072	0.476	0.876	0.897	0.998	1.000

APPENDIX A4: Additional Statistics, Quarterly Analysis

Quarterly Capital Growth, Appraisal Based Indices



Equity Market Returns: All Share and the Real Estate Sector



	RPI	*IPDMINP*	*FTRealNP*	*FTALLNP*	*JLLNP*	*REMINP*	*IPDMINR*	*REMINR*	*FTRENR*	*FTALLNR*	*IPDGeltNR*
Mean	0.0100	0.0071	0.0080	0.0261	0.0067	0.0076	0.0253	0.0257	0.0178	0.0362	0.0254
Median	0.0089	0.0028	0.0096	0.0334	0.0040	0.0069	0.0247	0.0263	0.0188	0.0442	0.0283
Standard Deviation	0.0086	0.0268	0.1217	0.0897	0.0290	0.0315	0.0256	0.0304	0.1219	0.0893	0.0251
Sample Variance	0.0001	0.0007	0.0148	0.0080	0.0008	0.0010	0.0007	0.0009	0.0149	0.0080	0.0006
Kurtosis	2.1724	-0.4412	0.8880	4.2082	0.0378	-0.0245	-0.2254	0.2225	0.8996	4.3525	-0.5595
Skewness	1.1763	0.3634	-0.2808	-1.4259	0.2033	0.2718	0.2450	0.1520	-0.2807	-1.4723	-0.4167
Range	0.0441	0.1068	0.6694	0.5085	0.1374	0.1459	0.1041	0.1499	0.6697	0.5084	0.0894
Minimum	-0.0028	-0.0381	-0.3255	-0.3287	-0.0577	-0.0654	-0.0236	-0.0492	-0.3132	-0.3200	-0.0244
Maximum	0.0413	0.0687	0.3439	0.1798	0.0797	0.0806	0.0805	0.1006	0.3565	0.1884	0.0650
Count	52	52	52	52	52	52	52	52	52	52	52

	RIPDMIP	*RFTRealP*	*RFTAP*	*RJLLP*	*RREMIP*	*RIPDMIR*	*RFTRER*	*RFTALLR*	*RREMIR*	*RIPDGeltR*
Mean	-0.0029	-0.0020	0.0161	-0.0033	-0.0024	0.0154	0.0078	0.0262	0.0158	0.0154
Median	-0.0013	0.0036	0.0244	-0.0018	0.0000	0.0167	0.0107	0.0350	0.0191	0.0211
Standard Deviation	0.0282	0.1235	0.0914	0.0296	0.0328	0.0274	0.1233	0.0907	0.0321	0.0274
Sample Variance	0.0008	0.0153	0.0083	0.0009	0.0011	0.0007	0.0152	0.0082	0.0010	0.0008
Kurtosis	0.2709	0.7352	3.8160	0.4724	0.6102	0.9630	0.7878	3.9898	1.0651	0.5860
Skewness	-0.1592	-0.2704	-1.3564	0.0741	-0.1332	-0.3291	-0.2610	-1.4078	-0.2963	-1.0197
Range	0.1377	0.6646	0.5082	0.1526	0.1677	0.1461	0.6656	0.5082	0.1703	0.1061
Minimum	-0.0794	-0.3345	-0.3378	-0.0729	-0.0872	-0.0663	-0.3219	-0.3287	-0.0696	-0.0577
Maximum	0.0582	0.3301	0.1705	0.0797	0.0806	0.0798	0.3436	0.1795	0.1007	0.0485
Count	52	52	52	52	52	52	52	52	52	52

Descriptives 1987-1992

	RPI	*IPDMINP*	*FTRealNP*	*FTALLNP*	*JLLNP*	*REMINP*	*IPDMINR*	*REMINR*	*FTRENR*	*FTALLNR*	*IPDGeltNR*
Mean	0.0139	0.0050	-0.0093	0.0204	0.0035	0.0067	0.0213	0.0230	0.0014	0.0320	0.0206
Median	0.0122	-0.0054	0.0017	0.0338	0.0016	-0.0078	0.0118	0.0129	0.0161	0.0458	0.0172
Standard Deviation	0.0097	0.0347	0.1525	0.1121	0.0373	0.0399	0.0323	0.0380	0.1526	0.1117	0.0347

Sample Variance	0.0001	0.0012	0.0233	0.0126	0.0014	0.0016	0.0010	0.0014	0.0233	0.0125	0.0012
Kurtosis	1.2332	-1.3703	0.2635	3.2702	-1.3203	-1.1105	-1.2132	-0.9502	0.3036	3.4627	-1.7554
Skewness	0.8609	0.3458	-0.0552	-1.4449	0.1231	0.1246	0.3064	0.0413	-0.0537	-1.4981	0.0609
Range	0.0413	0.1068	0.6694	0.5085	0.1267	0.1432	0.1041	0.1397	0.6697	0.5084	0.0894
Minimum	0.0000	-0.0381	-0.3255	-0.3287	-0.0577	-0.0654	-0.0236	-0.0492	-0.3132	-0.3200	-0.0244
Maximum	0.0413	0.0687	0.3439	0.1798	0.0690	0.0778	0.0805	0.0904	0.3565	0.1884	0.0650
Count	24	24	24	24	24	24	24	24	24	24	24

Descriptives 1993-1999

	RPI	*IPDMINP*	*FTRealNP*	*FTALLNP*	*JLLNP*	*REMINP*	*IPDMINR*	*REMINR*	*FTRENR*	*FTALLNR*	*IPDGeltNR*
Mean	0.0066	0.0089	0.0228	0.0309	0.0095	0.0083	0.0288	0.0281	0.0318	0.0398	0.0296
Median	0.0060	0.0071	0.0300	0.0334	0.0040	0.0089	0.0288	0.0279	0.0394	0.0442	0.0283
Standard Deviation	0.0057	0.0181	0.0875	0.0666	0.0197	0.0227	0.0180	0.0224	0.0882	0.0663	0.0111
Sample Variance	0.0000	0.0003	0.0077	0.0044	0.0004	0.0005	0.0003	0.0005	0.0078	0.0044	0.0001
Kurtosis	-0.3408	1.7845	-0.4780	1.2888	4.8123	2.8977	2.3227	3.1384	-0.4868	1.3561	-0.1464
Skewness	0.5257	1.1327	-0.1260	-0.5906	1.7460	1.0686	1.2777	1.1955	-0.1995	-0.6828	-0.5092
Range	0.0229	0.0738	0.3353	0.3000	0.0955	0.1125	0.0755	0.1092	0.3366	0.3006	0.0370
Minimum	-0.0028	-0.0156	-0.1413	-0.1570	-0.0157	-0.0319	0.0043	-0.0086	-0.1392	-0.1497	0.0086
Maximum	0.0201	0.0582	0.1940	0.1430	0.0797	0.0806	0.0798	0.1006	0.1973	0.1509	0.0456
Count	28	28	28	28	28	28	28	28	28	28	28

Descriptives 1987-1992 Real

	RIPDMIP	*RFTRealP*	*RFTAP*	*RJLLP*	*RREMIP*	*RIPDMIR*	*RFTRER*	*RFTALLR*	*RREMIR*	*RIPDGeltR*
Mean	-0.0090	-0.0232	0.0065	-0.0105	-0.0072	0.0074	-0.0125	0.0180	0.0091	0.0066
Median	-0.0188	-0.0234	0.0153	-0.0198	-0.0136	0.0022	-0.0020	0.0270	0.0084	0.0068
Standard Deviation	0.0355	0.1540	0.1137	0.0367	0.0412	0.0334	0.1537	0.1129	0.0397	0.0368
Sample Variance	0.0013	0.0237	0.0129	0.0013	0.0017	0.0011	0.0236	0.0127	0.0016	0.0014
Kurtosis	-1.0430	0.1447	2.8161	-1.2898	-0.8915	-0.6303	0.2263	3.0289	-0.6757	-1.2687
Skewness	-0.0329	-0.0076	-1.3368	0.1171	-0.2065	-0.1991	0.0094	-1.3886	-0.3538	-0.2585
Range	0.1260	0.6646	0.5082	0.1249	0.1477	0.1231	0.6656	0.5082	0.1432	0.1061

Minimum	-0.0794	-0.3345	-0.3378	-0.0729	-0.0872	-0.0663	-0.3219	-0.3287	-0.0696	-0.0577
Maximum	0.0466	0.3301	0.1705	0.0520	0.0605	0.0568	0.3436	0.1795	0.0737	0.0485
Count	24	24	24	24	24	24	24	24	24	24

Descriptives 1993-1999 Real

	RIPDMIP	*RFTRealP*	*RFTAP*	*RJLLP*	*RREMIP*	*RIPDMIR*	*RFTRER*	*RFTALLR*	*RREMIR*	*RIPDGeltR*
Mean	0.0023	0.0161	0.0243	0.0029	0.0017	0.0223	0.0252	0.0332	0.0215	0.0230
Median	0.0020	0.0208	0.0303	-0.0004	0.0001	0.0218	0.0301	0.0396	0.0203	0.0211
Standard Deviation	0.0191	0.0887	0.0679	0.0204	0.0233	0.0189	0.0888	0.0676	0.0231	0.0118
Sample Variance	0.0004	0.0079	0.0046	0.0004	0.0005	0.0004	0.0079	0.0046	0.0005	0.0001
Kurtosis	2.8456	-0.4812	0.8944	6.7878	4.1640	3.4872	-0.4721	1.1172	4.4416	-0.0120
Skewness	1.3107	-0.0712	-0.4900	2.0620	1.4583	1.4632	-0.1522	-0.6187	1.5305	-0.4575
Range	0.0895	0.3385	0.3000	0.1070	0.1125	0.0910	0.3401	0.3018	0.1132	0.0402
Minimum	-0.0312	-0.1445	-0.1598	-0.0273	-0.0319	-0.0111	-0.1435	-0.1558	-0.0125	0.0007
Maximum	0.0582	0.1940	0.1401	0.0797	0.0806	0.0798	0.1966	0.1460	0.1007	0.0410
Count	28	28	28	28	28	28	28	28	28	28

Autocorrelations, Quarterly Series, Total Returns (JLL: Capital Growth)
]

RFTAllR

	AC	*PAC*	Q-Stat	Prob
1	-0.092	-0.092	0.4666	0.495
2	-0.221	-0.231	3.2056	0.201
3	-0.016	-0.066	3.22	0.359
4	-0.063	-0.133	3.4553	0.485
5	-0.078	-0.133	3.8198	0.576
6	-0.107	-0.204	4.5123	0.608

FTAllNR

	AC	PAC	Q-Stat
1	-0.11	-0.11	0.6684
2	-0.235	-0.251	3.7814
3	-0.022	-0.089	3.8095
4	-0.076	-0.165	4.1467
5	-0.082	-0.164	4.5442
6	-0.121	-0.264	5.4428

RFTRER

	AC	PAC	Q-Stat	Prob
1	0.138	0.138	1.051	0.305
2	-0.12	-0.141	1.8553	0.395
3	0.065	0.108	2.1006	0.552
4	-0.166	-0.223	3.721	0.445
5	-0.082	0.013	4.1214	0.532
6	-0.029	-0.093	4.1729	0.653

FTRENR

	AC	PAC	Q-Stat
1	0.121	0.121	0.8088
2	-0.135	-0.152	1.8339
3	0.054	0.095	2.003
4	-0.17	-0.223	3.6937
5	-0.087	-0.002	4.1506
6	-0.04	-0.106	4.2484

RIPDMIR

	AC	PAC	Q-Stat	Prob
1	0.821	0.821	37.133	0.000
2	0.583	-0.281	56.218	0.000
3	0.385	0.008	64.704	0.000
4	0.211	-0.109	67.303	0.000
5	0.021	-0.201	67.33	0.000
6	-0.144	-0.074	68.599	0.000

IPDMINR

	AC	PAC	Q-Stat
1	0.855	0.855	40.278
2	0.642	-0.332	63.455
3	0.399	-0.204	72.591
4	0.184	-0.024	74.568
5	-0.005	-0.11	74.569
6	-0.134	0.015	75.664

RREMIR

	AC	PAC	Q-Stat	Prob
1	0.762	0.762	31.96	0.000
2	0.574	-0.016	50.437	0.000
3	0.359	-0.173	57.831	0.000
4	0.159	-0.131	59.319	0.000
5	0.02	-0.015	59.344	0.000
6	-0.183	-0.285	61.39	0.000

REMINR

	AC	PAC	Q-Stat
1	0.773	0.773	32.927
2	0.610	0.031	53.847
3	0.348	-0.331	60.802
4	0.153	-0.072	62.177
5	-0.006	0.003	62.179
6	-0.149	-0.144	63.532

RJLLP

	AC	PAC	Q-Stat	Prob
1	0.776	0.776	33.147	0.000
2	0.597	-0.014	53.135	0.000
3	0.436	-0.056	64.04	0.000
4	0.255	-0.158	67.839	0.000
5	0.06	-0.186	68.051	0.000
6	-0.056	0.018	68.245	0.000

JLLNP

	AC	PAC	Q-Stat
1	0.796	0.796	34.881
2	0.646	0.034	58.307
3	0.452	-0.194	70.034
4	0.261	-0.152	74.013
5	0.08	-0.116	74.391
6	-0.031	0.048	74.451

Contemporaneous Correlations, Full Sample, Nominal

	FTALLNP	FTALLNR	FTREALNP	FTRENR	IPDGELTNR	IPDMINP	IPDMINR	JLLNP	REMINP	REMINR
FTALLNP	1.000									
FTALLNR	0.999	1.000								
FTREALNP	0.747	0.748	1.000							
FTRENR	0.743	0.744	0.998	1.000						
IPDGELTNR	0.100	0.090	0.345	0.326	1.000					
IPDMINP	-0.031	-0.040	0.128	0.113	0.822	1.000				
IPDMINR	-0.050	-0.061	0.107	0.092	0.814	0.990	1.000			
JLLNP	0.028	0.016	0.182	0.165	0.811	0.930	0.922	1.000		
REMINP	0.019	0.009	0.196	0.186	0.785	0.957	0.952	0.876	1.000	
REMINR	0.028	0.017	0.212	0.203	0.780	0.946	0.949	0.858	0.995	1.000

Contemporaneous Correlations 1987-1992, Nominal

	FTALLNP	FTALLNR	FTREALNP	FTRENR	IPDGELTNR	IPDMINP	IPDMINR	JLLNP	REMINP	REMINR
FTALLNP	1.000									
FTALLNR	1.000	1.000								
FTREALNP	0.852	0.850	1.000							
FTRENR	0.849	0.848	0.998	1.000						
IPDGELTNR	0.094	0.088	0.318	0.296	1.000					
IPDMINP	-0.028	-0.033	0.199	0.183	0.907	1.000				
IPDMINR	-0.042	-0.048	0.159	0.143	0.894	0.993	1.000			
JLLNP	-0.008	-0.015	0.214	0.193	0.879	0.928	0.918	1.000		
REMINP	0.033	0.027	0.272	0.258	0.869	0.966	0.962	0.861	1.000	
REMINR	0.041	0.035	0.272	0.259	0.856	0.954	0.954	0.834	0.997	1.000

Contemporaneous Correlations 1993-1999, Nominal

	FTALLNP	FTALLNR	FTREALNP	FTRENR	IPDGELTNR	IPDMINP	IPDMINR	JLLNP	REMINP	REMINR
FTALLNP	1.000									
FTALLNR	0.999	1.000								
FTREALNP	0.486	0.499	1.000							
FTRENR	0.478	0.491	0.998	1.000						
IPDGELTNR	0.088	0.076	0.430	0.422	1.000					
IPDMINP	-0.055	-0.074	-0.106	-0.116	0.483	1.000				
IPDMINR	-0.102	-0.119	-0.095	-0.104	0.510	0.994	1.000			
JLLNP	0.101	0.083	0.049	0.044	0.550	0.937	0.933	1.000		
REMINP	-0.023	-0.041	-0.006	-0.005	0.550	0.938	0.949	0.929	1.000	
REMINR	-0.021	-0.037	0.033	0.034	0.562	0.927	0.942	0.924	0.998	1.000

Contemporaneous Correlations Full Sample, Real

	RFTAllR	RFTAP	RFTREALP	RFTRER	RIPDGELTR	RIPDMIP	RIPDMIR	RJLLP	RREMIP	RREMIR
RFTAllR	1.000									
RFTAP	1.000	1.000								
RFTREALP	0.756	0.756	1.000							
RFTRER	0.751	0.750	0.998	1.000						
RIPDGELTR	0.133	0.142	0.358	0.341	1.000					
RIPDMIP	0.031	0.044	0.194	0.173	0.773	1.000				
RIPDMIR	0.014	0.028	0.169	0.150	0.771	0.988	1.000			
RJLLP	0.074	0.088	0.241	0.220	0.776	0.932	0.927	1.000		
RREMIP	0.068	0.080	0.250	0.234	0.738	0.961	0.954	0.886	1.000	
RREMIR	0.080	0.092	0.261	0.248	0.739	0.949	0.955	0.870	0.994	1.000

Contemporaneous Correlations 1987-1992, Real

	RFTAllR	RFTAP	RFTREALP	RFTRER	RIPDGELTR	RIPDMIP	RIPDMIR	RJLLP	RREMIP	RREMIR
RFTAllR	1.000									
RFTAP	1.000	1.000								
RFTREALP	0.854	0.856	1.000							
RFTRER	0.850	0.852	0.998	1.000						
RIPDGELTR	0.123	0.128	0.312	0.294	1.000					
RIPDMIP	0.015	0.024	0.239	0.220	0.837	1.000				
RIPDMIR	-0.003	0.006	0.194	0.175	0.821	0.992	1.000			
RJLLP	0.017	0.027	0.250	0.227	0.826	0.926	0.916	1.000		
RREMIP	0.072	0.081	0.302	0.285	0.796	0.971	0.965	0.870	1.000	
RREMIR	0.079	0.087	0.300	0.286	0.783	0.960	0.960	0.843	0.996	1.000

Contemporaneous Correlations 1993-1999, Real

	RFTAllR	RFTAP	RFTREALP	RFTRER	RIPDGELTR	RIPDMIP	RIPDMIR	RJLLP	RREMIP	RREMIR
RFTAllR	1.000									
RFTAP	0.999	1.000								
RFTREALP	0.509	0.499	1.000							
RFTRER	0.502	0.491	0.997	1.000						
RIPDGELTR	0.090	0.098	0.451	0.445	1.000					
RIPDMIP	0.012	0.030	-0.028	-0.052	0.483	1.000				
RIPDMIR	-0.026	-0.010	-0.031	-0.048	0.523	0.988	1.000			
RJLLP	0.156	0.170	0.114	0.099	0.553	0.938	0.942	1.000		
RREMIP	0.020	0.035	0.053	0.043	0.568	0.937	0.951	0.930	1.000	
RREMIR	0.031	0.043	0.075	0.071	0.580	0.915	0.944	0.924	0.993	1.000

Price Discovery: Quarterly Granger Tests on Capital Appreciation

Pairwise Granger Causality Tests
Sample: 1987:1 1999:4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Probability
IPDMINP does not Granger Cause FTREALNP	47	0.42043	0.83138
FTREALNP does not Granger Cause IPDMINP		3.63055	0.00923

Pairwise Granger Causality Tests
Sample: 1987:1 1999:4
Lags: 5

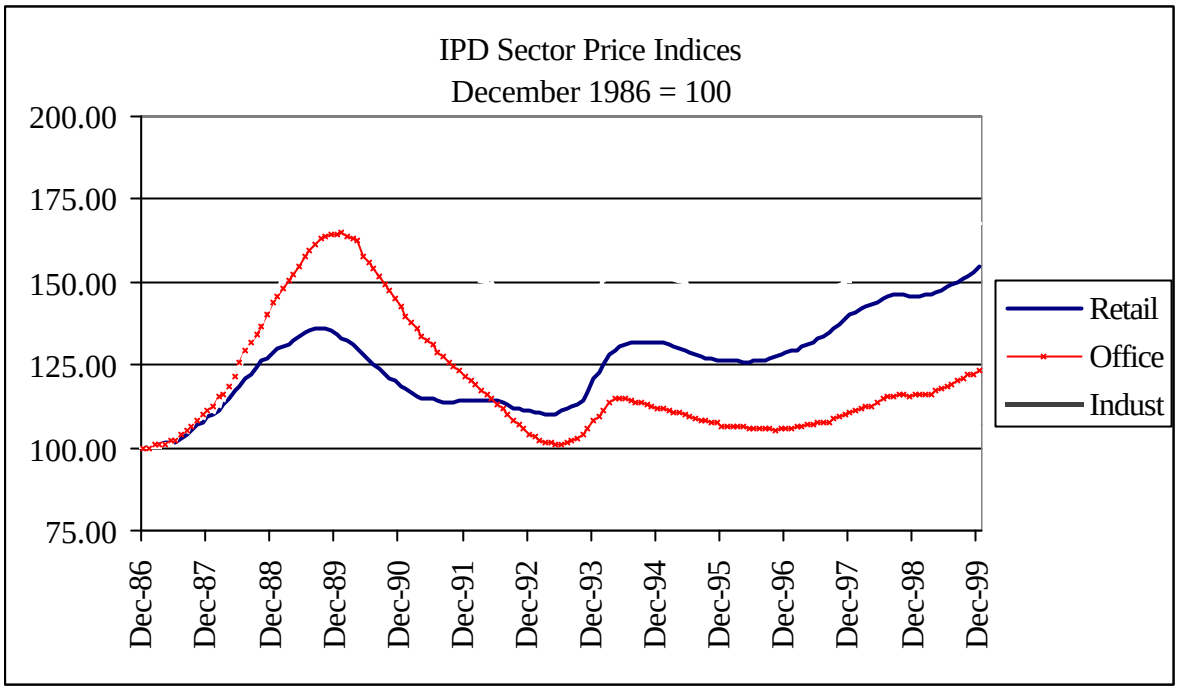
Null Hypothesis:	Obs	F-Statistic	Probability
FTREALNP does not Granger Cause JLLNP	47	6.86530	0.00014
JLLNP does not Granger Cause FTREALNP		0.56465	0.72636

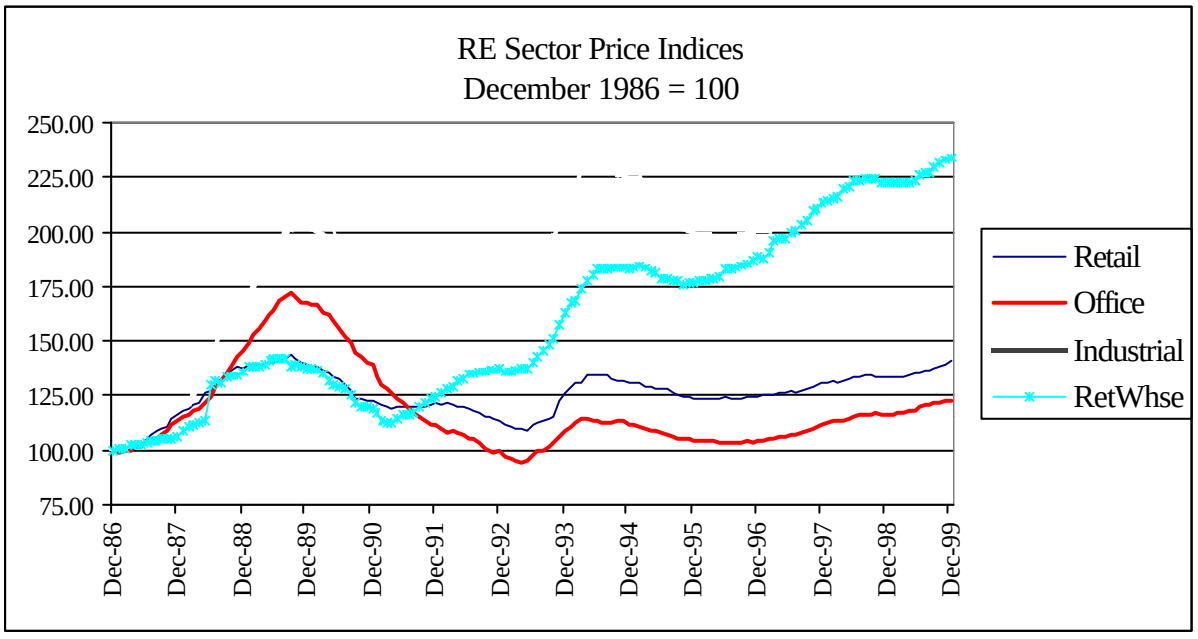
Pairwise Granger Causality Tests
Sample: 1987:1 1999:4
Lags: 5

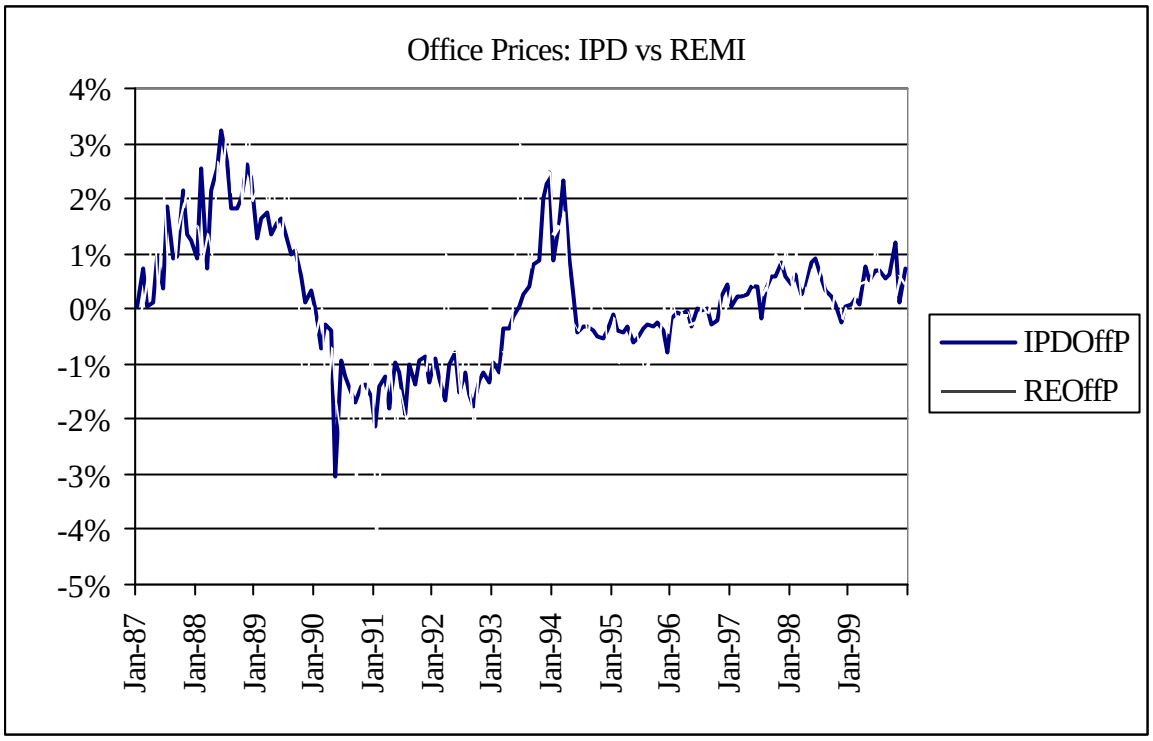
Null Hypothesis:	Obs	F-Statistic	Probability
REMINP does not Granger Cause FTREALNP	47	0.64027	0.67044
FTREALNP does not Granger Cause REMINP		2.35489	0.06003

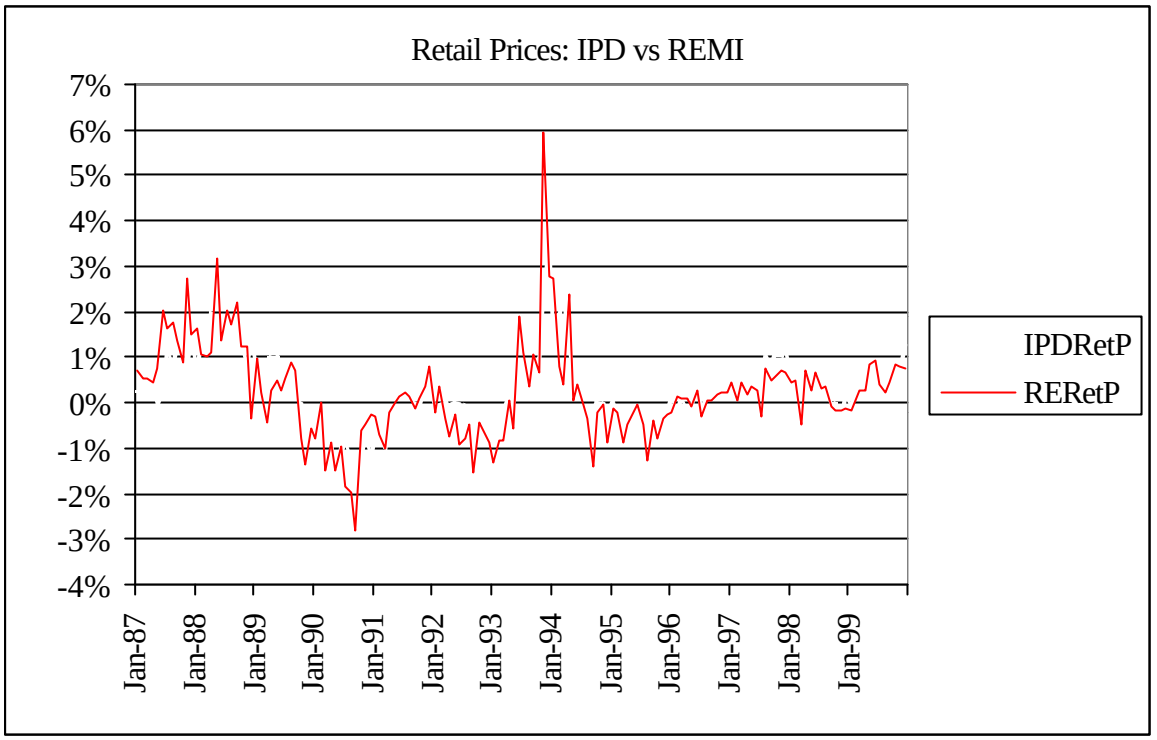
Appendix A6: Additional Statistics, Sectoral Analysis

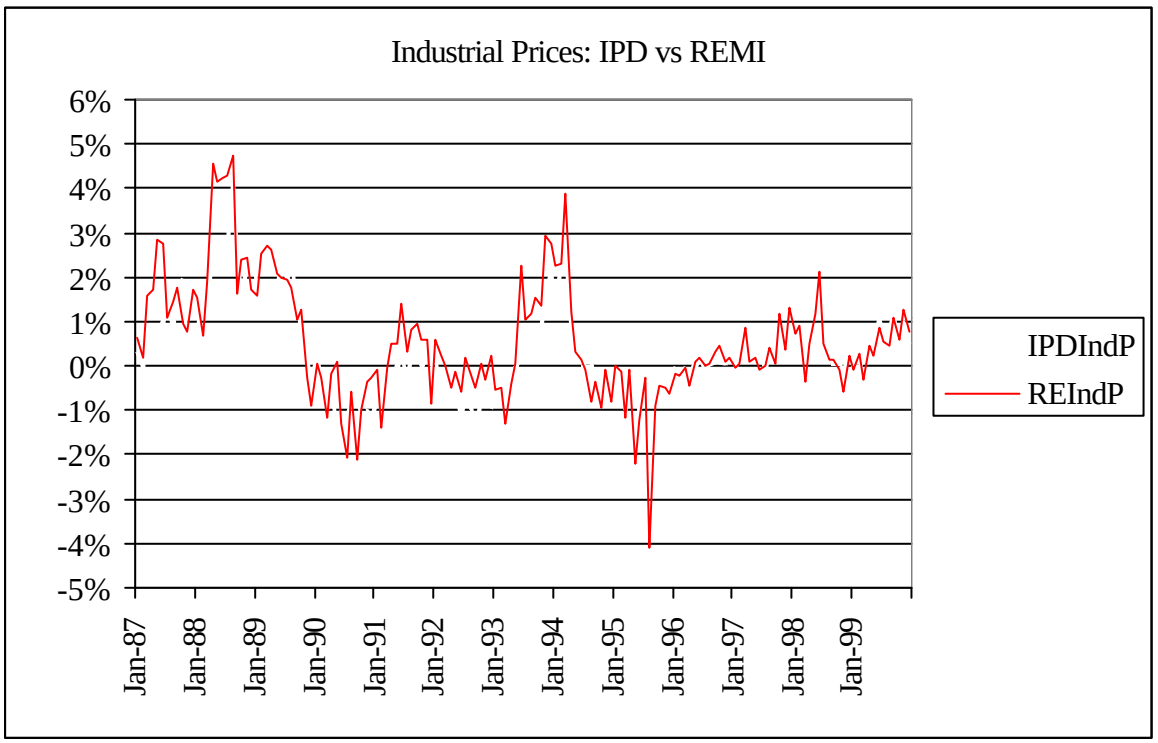
A6.1 Monthly Data






Office Prices: IPD vs REMI
4%
3%
2%
1%
0%
-1%
-2%
-3%
-4%
-5%
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
IPDOffP
REOffP


Retail Prices: IPD vs REMI
7%
6%
5%
4%
3%
2%
1%
0%
-1%
-2%
-3%
-4%
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
IPDRetP
RERetP


Industrial Prices: IPD vs REMI
6%
5%
4%
3%
2%
1%
0%
-1%
-2%
-3%
-4%
-5%
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
IPDIndP
REIndP

Descriptive Statistics, Monthly Total Return Series

	IPDRetR	*IPDOffR*	*IPDIndR*	*RERetR*	*REOffR*	*REIndR*	*RERWR*
Mean	0.008	0.008	0.011	0.007	0.008	0.012	0.012
Median	0.008	0.007	0.009	0.007	0.008	0.010	0.010
Standard Deviation	0.008	0.011	0.010	0.010	0.013	0.013	0.015
Sample Variance	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kurtosis	1.750	0.180	0.686	6.561	0.588	1.708	31.794
Skewness	0.510	0.071	0.757	1.265	-0.267	0.569	3.789
Range	0.052	0.063	0.058	0.088	0.078	0.086	0.159
Minimum	-0.012	-0.026	-0.011	-0.023	-0.038	-0.033	-0.021
Maximum	0.040	0.038	0.047	0.065	0.040	0.053	0.138
CV	95%	148%	92%	136%	173%	105%	123%
Mean Annualised	10.26%	9.42%	13.89%	9.39%	9.68%	16.15%	15.79%
St Dev Annualised	2.69%	3.88%	3.47%	3.55%	4.63%	4.55%	5.23%

IPD Industrial Prices; Serial Correlation				
	AC	PAC	Q-Stat	Prob
1	0.889	0.889	125.72	0.000
2	0.839	0.229	238.26	0.000
3	0.792	0.066	339.2	0.000
4	0.711	-0.162	421.27	0.000
5	0.624	-0.165	484.84	0.000
6	0.562	0.018	536.71	0.000
7	0.483	-0.05	575.37	0.000
8	0.413	-0.002	603.82	0.000
9	0.342	-0.059	623.46	0.000
10	0.302	0.105	638.84	0.000
11	0.234	-0.092	648.15	0.000
12	0.166	-0.115	652.83	0.000

IPD Office Prices; Serial Correlation				
	AC	PAC	Q-Stat	Prob
1	0.863	0.863	118.34	0.000
2	0.835	0.355	229.92	0.000
3	0.826	0.245	339.71	0.000
4	0.77	-0.055	435.83	0.000
5	0.717	-0.114	519.76	0.000
6	0.668	-0.109	592.98	0.000
7	0.608	-0.104	654.05	0.000
8	0.554	-0.046	705.11	0.000
9	0.499	-0.028	746.88	0.000
10	0.433	-0.068	778.56	0.000
11	0.389	0.023	804.29	0.000
12	0.329	-0.042	822.86	0.000

IPD Retail Prices; Serial Correlation				
	AC	PAC	Q-Stat	Prob
1	0.855	0.855	116.12	0.000
2	0.788	0.213	215.45	0.000
3	0.751	0.154	306.43	0.000
4	0.673	-0.102	379.83	0.000
5	0.605	-0.048	439.6	0.000
6	0.528	-0.105	485.48	0.000
7	0.438	-0.116	517.26	0.000
8	0.365	-0.044	539.4	0.000
9	0.275	-0.104	552.05	0.000
10	0.196	-0.033	558.54	0.000
11	0.118	-0.061	560.91	0.000
12	0.071	0.085	561.77	0.000

RE Industrial Prices; Serial Correlation				
	AC	PAC	Q-Stat	Prob
1	0.759	0.759	91.594	0.000
2	0.692	0.273	168.140	0.000
3	0.644	0.142	235.010	0.000
4	0.547	-0.068	283.460	0.000
5	0.450	-0.104	316.560	0.000
6	0.395	0.001	342.250	0.000
7	0.364	0.079	364.120	0.000
8	0.307	0.000	379.850	0.000
9	0.242	-0.078	389.640	0.000
10	0.243	0.072	399.630	0.000
11	0.200	-0.024	406.400	0.000
12	0.144	-0.060	409.950	0.000

RE Office Prices; Serial Correlation				
	AC	PAC	Q-Stat	Prob
1	0.779	0.779	96.493	0.000
2	0.739	0.337	183.94	0.000
3	0.677	0.095	257.82	0.000
4	0.699	0.243	337.01	0.000
5	0.624	-0.055	400.66	0.000
6	0.594	-0.006	458.64	0.000
7	0.554	0.014	509.47	0.000
8	0.506	-0.095	552.11	0.000
9	0.392	-0.243	577.82	0.000
10	0.34	-0.085	597.33	0.000
11	0.292	-0.042	611.81	0.000
12	0.258	-0.008	623.22	0.000

RE Retail Prices; Serial Correlation				
	AC	PAC	Q-Stat	Prob
1	0.641	0.641	65.377	0.000
2	0.612	0.341	125.33	0.000
3	0.475	-0.004	161.69	0.000
4	0.46	0.098	195.93	0.000
5	0.468	0.177	231.7	0.000
6	0.334	-0.165	250.03	0.000
7	0.251	-0.147	260.42	0.000
8	0.163	-0.041	264.82	0.000
9	0.092	-0.094	266.23	0.000
10	0.053	-0.06	266.71	0.000
11	0.016	0.042	266.75	0.000
12	-0.023	0.008	266.84	0.000

RE Retail Warehouse Prices; Serial Correlation				
	AC	PAC	Q-Stat	Prob
1	0.339	0.339	18.324	0.000
2	0.238	0.139	27.387	0.000
3	0.314	0.227	43.244	0.000
4	0.322	0.177	60.049	0.000
5	0.272	0.099	72.124	0.000
6	0.242	0.06	81.727	0.000
7	0.14	-0.074	84.985	0.000
8	0.031	-0.165	85.14	0.000
9	0.045	-0.084	85.487	0.000
10	0.04	-0.051	85.752	0.000
11	0.03	0.017	85.908	0.000
12	-0.083	-0.084	87.092	0.000

RE Retail Warehouse Prices; Serial Correlation excluding June 1988				
	AC	PAC	Q-Stat	Prob
1	0.559	0.559	49.333	0.000
2	0.490	0.258	87.466	0.000
3	0.463	0.181	121.810	0.000
4	0.490	0.208	160.550	0.000
5	0.429	0.056	190.480	0.000
6	0.361	-0.022	211.750	0.000
7	0.210	-0.207	219.030	0.000
8	0.102	-0.236	220.740	0.000
9	0.115	-0.038	222.930	0.000
10	0.071	-0.032	223.770	0.000
11	-0.042	-0.092	224.070	0.000
12	-0.106	-0.025	225.970	0.000

Correlation coefficients, total returns, monthly series

	IPDRetR	*IPDOffR*	*IPDIndR*	*RERetR*	*REOffR*	*REIndR*	*RERWR*
IPDRetR	1.000						
IPDOffR	0.792	1.000					
IPDIndR	0.810	0.870	1.000				
RERetR	0.777	0.632	0.654	1.000			
REOffR	0.766	0.810	0.769	0.684	1.000		
REIndR	0.691	0.687	0.833	0.669	0.683	1.000	
RERWR	0.576	0.433	0.434	0.492	0.392	0.489	1.000

Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
IPDOFFP does not Granger Cause IPDINDP	143	2.209	0.013
IPDINDP does not Granger Cause IPDOFFP		1.110	0.357

Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
IPDINDP does not Granger Cause REINDP	143	3.141	0.000
REINDP does not Granger Cause IPDINDP		0.942	0.513

Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
IPDRETP does not Granger Cause RERETP	143	2.823	0.002
RERETP does not Granger Cause IPDRETP		0.991	0.465

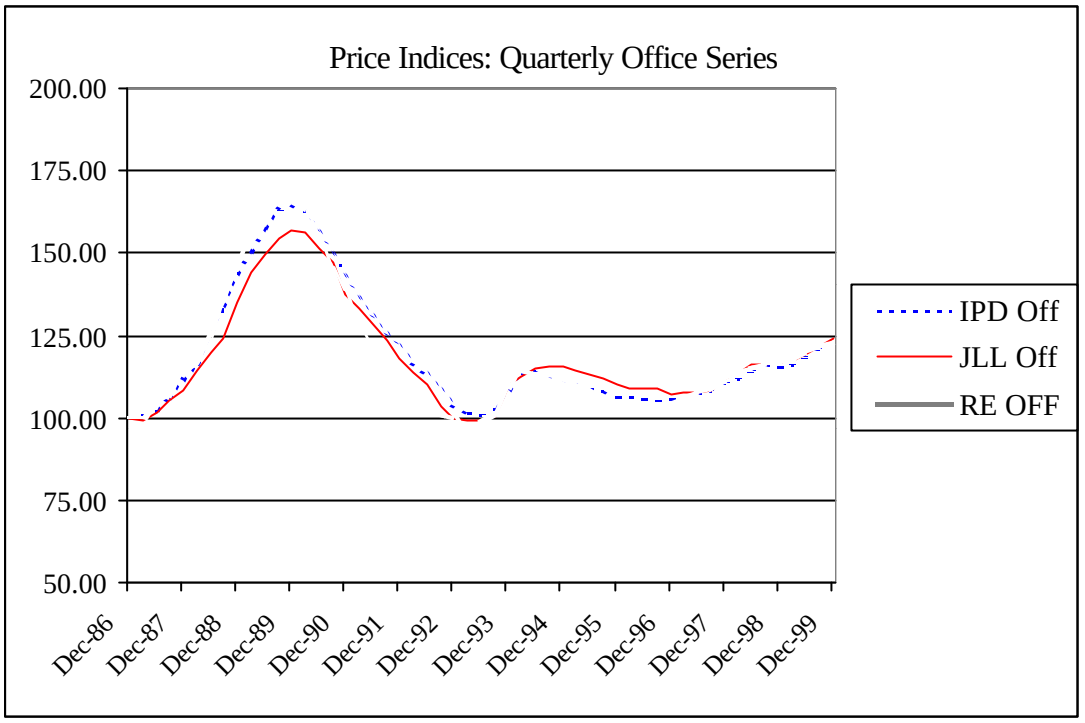
Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

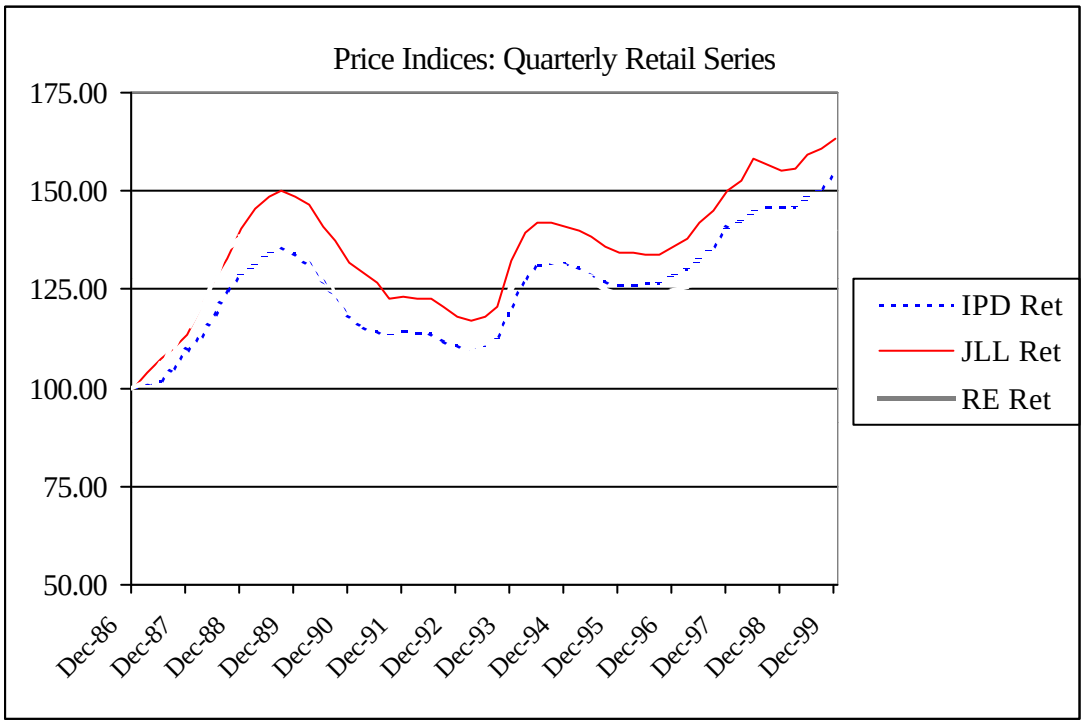
Null Hypothesis:	Obs	F-Statistic	Probability
IPDRETP does not Granger Cause RERWP	143	3.293	0.000
RERWP does not Granger Cause IPDRETP		1.156	0.321

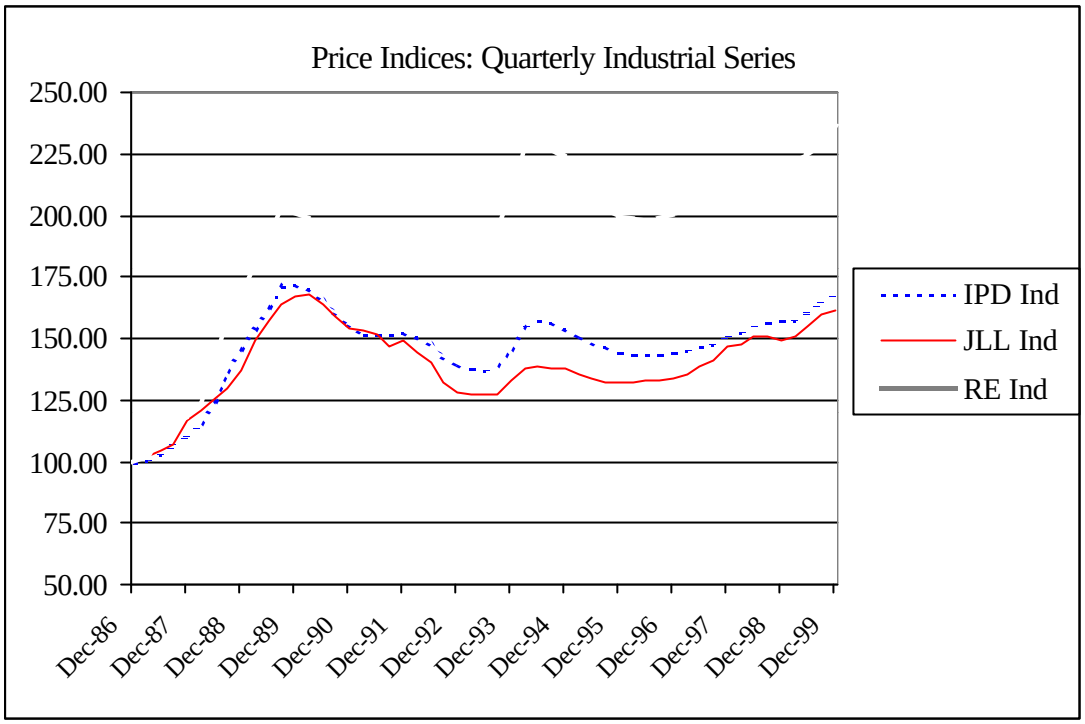
Pairwise Granger Causality Tests
Sample: 1987:01 1999:12
Lags: 13

Null Hypothesis:	Obs	F-Statistic	Probability
IPDOFFP does not Granger Cause REINDP	143	2.157	0.016
REINDP does not Granger Cause IPDOFFP		0.832	0.626

A6.2 Quarterly Data







Contemporaneous Correlation, Quarterly Price Change Series

	IPDRetP	*IPDOffP*	*IPDIndP*	*JLLRetP*	*JLLOffP*	*JLLIndP*	*RERetP*	*REOffP*	*REIndP*	*RERWP*
IPDRetP	1.000									
IPDOffP	0.870	1.000								
IPDIndP	0.854	0.924	1.000							
JLLRetP	0.921	0.858	0.789	1.000						
JLLOffP	0.789	0.916	0.825	0.836	1.000					
JLLIndP	0.744	0.867	0.820	0.773	0.831	1.000				
RERetP	0.905	0.787	0.794	0.841	0.701	0.686	1.000			
REOffP	0.858	0.929	0.863	0.840	0.850	0.804	0.805	1.000		
REIndP	0.803	0.803	0.903	0.763	0.691	0.675	0.816	0.794	1.000	
RERWP	0.757	0.542	0.560	0.680	0.430	0.349	0.706	0.536	0.673	1.000

Autocorrelation, IPD Quarterly Price Changes By Sector

IPD Industrial Prices

	AC	PAC	Q-Stat	Prob
1	0.846	0.846	39.363	0.00
2	0.599	-0.406	59.52	0.00
3	0.384	0.065	67.986	0.00
4	0.203	-0.123	70.408	0.00
5	0.005	-0.258	70.409	0.00

IPD Office Prices

	AC	PAC	Q-Stat	Prob
1	0.892	0.892	43.766	0.00
2	0.74	-0.265	74.557	0.00
3	0.543	-0.292	91.46	0.00
4	0.369	0.064	99.419	0.00
5	0.206	-0.068	101.96	0.00

IPD Retail Prices

	AC	PAC	Q-Stat	Prob
1	0.812	0.812	36.323	0.00
2	0.578	-0.241	55.068	0.00
3	0.307	-0.25	60.456	0.00
4	0.078	-0.053	60.814	0.00
5	-0.128	-0.155	61.793	0.00

Autocorrelation, JLL Quarterly Price Changes By Sector

JLL Industrial Prices

	AC	PAC	Q-Stat	Prob
1	0.707	0.707	27.52	0.00
2	0.562	0.123	45.232	0.00
3	0.372	-0.128	53.171	0.00
4	0.245	-0.032	56.671	0.00
5	0.139	-0.021	57.826	0.00

JLL Office Prices

	AC	PAC	Q-Stat	Prob
1	0.756	0.756	31.465	0.00
2	0.652	0.188	55.33	0.00
3	0.5	-0.103	69.631	0.00
4	0.302	-0.245	74.968	0.00
5	0.104	-0.22	75.613	0.00

JLL Retail Prices

	AC	PAC	Q-Stat	Prob
1	0.741	0.741	30.246	0.00
2	0.543	-0.014	46.815	0.00
3	0.324	-0.163	52.844	0.00
4	0.155	-0.059	54.253	0.00
5	0	-0.1	54.253	0.00

Autocorrelation, REMI Quarterly Price Changes By Sector

RE Industrial Prices

	AC	PAC	Q-Stat	Prob
1	0.739	0.739	30.075	0.00
2	0.484	-0.138	43.21	0.00
3	0.307	0.004	48.6	0.00
4	0.185	-0.019	50.592	0.00
5	0.028	-0.178	50.638	0.00

RE Office Prices

	AC	PAC	Q-Stat	Prob
1	0.796	0.796	34.928	0.00
2	0.703	0.187	62.659	0.00
3	0.488	-0.33	76.282	0.00
4	0.289	-0.241	81.162	0.00
5	0.153	0.111	82.569	0.00

RE Retail Prices

	AC	PAC	Q-Stat	Prob
1	0.68	0.68	25.45	0.00
2	0.484	0.04	38.583	0.00
3	0.174	-0.315	40.314	0.00
4	0.015	-0.011	40.327	0.00
5	-0.14	-0.077	41.506	0.00

RE Retail Warehouse Prices

	AC	PAC	Q-Stat	Prob
1	0.536	0.536	15.799	0.00
2	0.327	0.057	21.821	0.00
3	0.102	-0.132	22.417	0.00
4	-0.08	-0.146	22.792	0.00
5	-0.22	-0.143	25.674	0.00