Investment Property Forum

Investment Property Forum Educational Trust

Index Smoothing and the Volatility of UK Commercial Property

Research Findings

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March 2007

This research was commissioned by the IPFET
and IPF Joint Research Programme

INDEX SMOOTHING AND THE VOLATILITY OF UK COMMERCIAL PROPERTY

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The IPF Educational Trust and IPF Joint Research Programme

This research was commissioned and funded under the auspices of the IPF Educational Trust and IPF Joint Research Programme. The three-year programme supports the IPF's wider goals of enhancing the knowledge, understanding and efficiency of property as an investment class. The initiative provides the UK property investment market with the ability to deliver substantial, objective and high quality analysis on a structured basis. It will enable the whole industry to engage with other financial markets, the wider business community and government on a range of complementary issues.

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The research team

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The project steering group

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Disclaimer

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Executive summary

The study is an investigation of smoothing in UK valuation indices for commercial property. The report addresses four principal questions:

- Why do we think property indices are smoothed and understate risk?
- What alternative desmoothing techniques are available, and what is the best estimate of adjusted property risk?
- How much do upward revisions to property risk affect the weighting of property indicated by asset allocation models?
- What desmoothing methods are used by leading fund managers and investment advisors, and is there a consensus view on property risk?

Why do we think property indices are smoothed? (Section 2)

The view that valuation indices understate risk rests on several, mutually supporting, sources of evidence:

- The valuation process, which relies on backward-looking comparables and is surrounded by a substantial measure of uncertainty, and is therefore likely to result in individual property valuations which vary less than market prices.
- The aggregation of individual property valuations into an index may also introduce smoothing of the variation in market prices, because different valuers react with varying lags to price signals.
- Statistical analysis of index results shows characteristics consistent with those hypotheses: a degree of predictability, or serial correlation, in property performance from one period to the next.
- Comparisons against other asset classes, which on index results show property risk below that on gilts, whereas the fundamental nature of property cash flows and property's rate of return are both consistent with a risk above gilts.
- Finally, the practical consideration that asset allocation models fed with index results indicate implausibly and unattainably high weightings of property in mixed-asset portfolios.

Desmoothing techniques (Section 3)

The majority of desmoothing methods proposed by different authors rest on the theory that current property valuations are a weighted average of new market evidence and previous valuations. On this view, a desmoothed estimate of property can be recovered from a series of valuations by the formula:

$$\text{True Return}_t = \frac{(\text{Valuation Return}_t - k \times \text{Valuation Return}_{t-1})}{(1 - k)}$$

Where k is a desmoothing coefficient taking a value between 0 and 1, which represents the weighting in current valuations of new market evidence. We have tested five alternative desmoothing techniques using this basic formulation (described in full in Section 3.1). The results produced by desmoothing methods are influenced by several other choices such as the length of history used to calibrate the analysis, and the target characteristics of the desmoothed returns series.

Results from extensive tests of the full range of these alternative methods and data sets show that:

- With different choices of method and calibration, the indicated adjustments to property risk vary from a lower risk than shown by valuation index figures up to a multiple of nearly three times the risk shown by index figures.

- Because more sophisticated methods are more likely to produce extreme results, and often demand more judgemental input, the simplest Lag 1 autoregressive desmoothing technique is the most robust.
- Our central, or preferred, estimate of property's historic standard deviation in annual total returns is 13% to 15%, or 1.3 to 1.5 times that observed in the unadjusted index results.

Impacts of desmoothing (Section 4)

The dominant practical application of desmoothing property returns is to offer a more credible comparison of property with other asset classes, and to make property a better fit in standard asset allocation models. We have tested the impacts of varying desmoothing assumptions on the property weights indicated by models based on Mean Variance Portfolio Theory (MVPT) and Asset Liability Modelling (ALM).

Desmoothing results in a significant change in the relationship between property and competing asset classes:

- Our preferred estimate of property standard deviation at 13% to 15% puts property risk in its expected position between equities and gilts, and also results in higher correlations with equities and gilts returns.
- The increase in correlations with equities and gilts, however, tend toward upper limits well below 1, so that property retains substantial diversification benefits even at extreme levels of desmoothing.

MVPT models run on historic data and, in a variety of formulations, continue to indicate high property weights with all but the most extreme desmoothing assumptions:

- In models with varying specifications the indicated property weights remain in the range of 20% to 65% (depending on time period covered) when our preferred estimates of desmoothing are applied.
- The weight of property falls below 10% only if property risk is assumed to be over 20%, more than double that shown by index figures.

Tests of ALM models using different specifications of liabilities and degrees of risk tolerance show that:

- With property risk adjusted to our preferred level, the indicated property weight falls in the range of 12% to 20% in the different types of ALM portfolio, and the property weight falls below 10% only if the assumed property risk is doubled.
- Overall the property weights indicated by ALM methods are below those produced by MVPT models when run over the same period, but still above the typical weights of institutional investors.

Industry practice in desmoothing and asset allocation (Section 5)

A survey of 13 leading fund managers, asset allocators and advisors was undertaken to gather opinions on the importance of desmoothing, use of desmoothing methods, and the incorporation of property in multi-asset portfolios.

There was general agreement that the historic property risk is understated by valuations indices, and should be adjusted.

- A majority of firms use their own estimates of risk, mostly produced by the simplest Lag 1 autoregressive desmoothing method.
- Estimates of true property risk averaged 13.8%, with almost all in the range 13% to 15%, falling in line with our own preferred estimate of risk.

The forward-looking assumptions used in asset allocation modelling reflected this view:

- Over a five to 10 year horizon, property returns were on average expected to run just under 7%, with an expected standard deviation a little over 13%, slightly higher correlations between property and other assets from those observed historically.
- Run with these expected return profiles, quantitative asset allocation models indicated property weights from 15% to as high as 50%. The typical advice to clients offered by respondents was, however, a recommended property weight in the range 10% to 15%.

Findings and conclusions (Section 6)

There is an overwhelming case that property valuation indices are smoothed, and property risk should be adjusted. That case rests on the consistency between theoretical, empirical and practical perspectives rather than any one piece of evidence.

Desmoothing methods are, unfortunately, capable of producing a wide range of risk estimates, dependent upon the choice of method and data set. Our central, preferred estimate of historic property risk is 13% to 15%, or 1.3 to 1.5 times that observed in the valuation index. The most robust desmoothing method is the simplest Lag 1 autoregressive filter, calibrated over the period from 1971 onward.

The consensus among leading practitioners is that property risk should be adjusted, with historic estimates averaging 14%, and forward looking estimates averaging 13%. Both our own tests of asset allocation models under a range of formulations, and the results reported by practitioners, show that even after upward adjustments to property risk quantitative models indicate property weights of at least 10%, and usually significantly higher. Desmoothing does not, therefore, remove the case for property weights in multi-asset portfolios higher than currently held by all but the largest property investors.

1. INTRODUCTION

The property investment industry relies heavily on indices of market performance. Indeed, it is unlikely that commercial property could maintain a major role in investment portfolios without credible measures of the returns generated by the asset class.

This report addresses the major area of uncertainty in the use of property indices: the extent to which they may understate the risks of property investment.

1.1 Property indices: methods and confidence

At the aggregate level, property indices provide the essential basis for comparison of returns against equity and bond indices and underpin the case for property presented to investors. Within the industry, indices split by types of property and by location are a primary input to the market analysis and forecasting tools used to evaluate investments and to structure portfolios. And property fund managers often measure their performance – and in many cases scale their performance fees – against index benchmarks.

In short, measures of performance which are generally accepted as credible within the industry, and in the wider investment community, are the bedrock of quantitative analysis putting property on a comparable footing with the other established asset classes.

That acceptance and credibility does not come easily. Low liquidity and the heterogeneity of individual properties have, to date, meant that indices have not been based on actual transaction prices and in the absence of a central trading exchange, nor are there any quoted bid and offer prices.

For these reasons, the dominant indices for property in the most developed markets are all produced by aggregating the records of major property owners – essentially by survey of a sample of all investment owners. Recurrent valuations conducted by those owners are taken as the proxies for market price, a critical input for the measurement of returns. Records of capital and revenue flows provide the second input, the calculation of net cash flows.

Confidence in the accuracy of property indices depends, therefore, on several factors. First, on the size of the sample of owners whose records are captured (and how well that sample represents the total investment market); second, on the accuracy of valuations as an estimate of market values and third on the quality and consistency of the accounting records used to measure cash flows. In several respects, the construction of property indices has the character of an audit process. It has for example to ensure that owners provide records for all their properties, and not a self-selected sample, and to ensure that revenue and capital flows are consistently defined.

The process of index construction requires the collaboration of a large number of property investors; it is laborious and expensive compared to the construction of indices for centrally traded assets (though those barriers have been lowered by modern information technology). So the introduction of property indices lagged a long way behind those for financial assets. Although property indices are now available for close to 20 countries, only eight of them have a history running back more than 10 years. For many of the 20 countries, the reliability of the indices may still be subject to substantial reservations in the adequacy of market coverage, the quality of underlying valuations, or both.

But all these indices – even in the UK where the IPD Index is on balance the most broadly based, widely used and highly respected of all countries – are subject to one outstanding point of uncertainty: whether or not they give an accurate measure of the risk of property investment. In the UK, potential reservations over how well the index represents the total market and the accuracy of the valuations on which it rests have been addressed and largely alleviated by previous studies (IPF, 2005; RICS, 2005). Independent reviews for clients and regulatory bodies have also given a clean bill of health on the survey and audit processes used to compile data. Overall, extensive research and long familiarity has created a high level of general understanding of how the UK Index is constructed, a high level of confidence in its reliability, and acceptance of its fairness as the basis for portfolio benchmarks and derivative instruments.

1.2 The risk of property investment

Against that background, it is a surprising anomaly that there appears to be no consensus on whether the Index provides an accurate measure of the risk of property investment which, after the rate of return, is the most important measure of its characteristics. On this issue, there is a primary divide between academic and industry researchers. Academic researchers almost universally hold the view that valuation-based indices understate the true risk of property investment. They therefore apply adjustments to the Index result before comparing property with other assets, or investigating the role of property in mixed-asset portfolios. Generally published research and commentary on property from industry sources, however, at most notes the understatement of risk as a potential issue. It is unclear how much more attention may be paid to the issue in private client briefings and internal analysis (one of the questions this study aims to answer).

Even though academic researchers may agree that valuation based indices understate true property risk, after that there is very little agreement on the critical questions of how much riskier it really is. A recent review of several academic articles on the topic showed different authors recommended the risk as measured by the IPD UK Index should be multiplied by factors anywhere from 1.5 to 3.5 (Geltner et al, 2002). Nor is there an academic consensus on the methods which should be used to adjust the numbers. The leading UK textbook on property investment, after an extensive discussion of the question, concludes that 'we still don't know the best way to remove smoothing from a valuation index' (Brown and Matysiak, 2000).

All this leaves the topic of property risk in a state of considerable, and undesirable, uncertainty. The level of risk is, of course, a central input to the primary choice on which the property industry is expected to offer informed advice to investment clients: how much property should they hold in their portfolios? Different assumptions do more than change the direct comparison of the risk of property with other asset classes. They can also change the correlation between property returns with those on other asset classes, and thus the portfolio diversification benefit which is one of the primary attractions to investors. The lack of a well-informed and accessible view on the question, and if not a consensus view on what the true level of risk is then at least a well-justified range of estimates, is damaging to the credibility of property as an asset class. At worst, it could leave the industry open to the accusation of misrepresentation, particularly as property is being more widely marketed to small investors.

These issues set the agenda for this study. Its overall objective is to provide a basis for a broad industry consensus on the correct representation of property risk. Throughout, the approach to the research has been to synthesise previous work on the subject, and to clarify the implications of that work through clear applications to the key sources and methods used by practitioners. Only one issue – the impact of risk-correction methods to sector and segment return series – is taken a step further than previous researchers, because logic suggests that the degree to which risk is incorrectly measured by valuation indices may well vary across property markets.

We have not aimed to devise a new technique for adjusting risk, or to recommend the use of any one definitive method. As we will hope to prove in the following sections, the impacts of removing index smoothing on property risk and asset allocation are far more sensitive to time period chosen for analysis and the judgemental decisions that all techniques require than to the specific method used. In that spirit, the Desmoothing Project Spreadsheet available alongside this report includes all the property data sets used in the work, with tools to demonstrate the applications of different desmoothing methods to the data.

Following this introduction:

- Section 2 sets out the arguments and evidence which support the view that valuation indices understate the true level of risk.
- Section 3 identifies the methods which can be used to adjust risk and applies a set of different correction methods to the standard UK property indices; testing how far different methods, different index frequencies and the coverage of different time periods influence conclusions on true risk.
- Section 4 tests how far adjustments for risk affect the weighting of property in portfolios optimised using the standard mean-variance methods and asset liability matching methods.
- Section 5 presents the results of a survey of property investors and investment advisors on their treatment of risk, their use of risk-correction techniques in internal analysis and their advice to clients.
- Section 6 rounds up the findings of the analysis and offers recommendations on appropriate methods of adjusting property risk.

The study deals with the issue of risk-adjustment for UK property indices. Other countries, and other asset classes, are from time to time brought into the analysis for comparison and context. We believe the primary conclusions from the work, and the tools provided in the spreadsheet, can be easily generalised to property in other countries.

2. WHY DO VALUATION INDICES UNDERSTATE RISK?

Performance indices for property were first developed in the US and the UK in the early 1980s. Articles contending that they have an in-built tendency to understate the risk of property investment followed in fairly short order. The first methods for adjusting risk in a valuation index – or de-smoothing in property parlance – were described by Blundell and Ward (1987) in the UK, and by Quan and Quigley (1991) in the US. From those studies and subsequent work in the topic, the belief that valuation indices are smoothed, and therefore that adjustments are required, rests on five sources of evidence:

- The valuation process for individual properties, which tends to be backward looking and cautious because it relies on past comparables and on thin trading evidence.
- The index construction process, which tends to smooth out short-term market fluctuations into rolling average aggregates because it aggregates valuations constructed at different points in time, and has varying speeds of adjustment to underlying market movements.
- Statistical analysis of returns, which demonstrates that property returns in one period can to an extent be predicted from those in previous periods and which conflicts with central tenets of financial theory but falls in with predictions from the above views on valuation and index construction.
- The comparison of property returns with those on equities and bonds, which shows lower relative risk than expected from the characteristics of the different asset classes.
- Results from standard asset allocation models, which point to property weightings in mixed asset portfolios which are implausibly high – typically over 40% – and far above those actually held by investors.

2.1 The valuation process

The earliest diagnoses of smoothing start from a depiction of valuations as estimates of market prices subject to several types of uncertainty. Because every property and every deal is different, the transaction prices valuers observe and seek to interpret as indicators of market price are distributed around an unobservable 'true' market price. Given the low liquidity of property markets, very little new comparable information may arrive from one valuation to the next, especially for valuations done at monthly or quarterly intervals. A valuer who has not received sufficient new evidence to form a confident new estimate of value resting solely on new market information will tend revert to the figure produced in the last valuation.

In that case, Blundell and Ward (1987) suggest each valuation can be regarded a weighted average of two types of information: new market evidence and the last valuation:

$$V_t = (1 - k) \times P_t + k \times V_{t-1}$$

Where V_t is the current valuation, P_t the market price estimated only from new market evidence, V_{t-1} is the last valuation, and k is a 'desmoothing coefficient' with a value between 0 and 1. A value of k equal to 0 would indicate a valuation wholly based on current market evidence, and hence a 'true market price'. A value of k equal to 1 indicates an unchanged valuation which incorporates no new market evidence.

Quan and Quigley (1991) provide a more developed version of the same basic model. The valuer's task is seen as extracting estimates of market movements from transactions prices randomly distributed around true market prices because individual deals are concluded on different balances of information and negotiating power between buyers and sellers. This formulation gives a formal expression for the value of k which can be expressed as:

$$k = \sigma_m^2 / (\sigma_m^2 + \sigma_t^2)$$

Where k is the value of the desmoothing coefficient as before, σ_m^2 is the variance in true market prices, and σ_t^2 is the additional variance in transactions prices. When transactions prices are a perfect estimate of true market prices, k takes the value of 1 and valuation perfectly reflects market price.

The notion that valuers fall back on previous valuations may give an impression of laziness or professional incompetence. Quan and Quigley, however, suggest that under inevitable conditions of uncertainty surrounding true market prices, the weighting of old and new evidence is the most appropriate strategy. Because valuers have access to a wider range of transactions evidence than buyers and sellers, discarding the 'noise' in recent transactions in favour of previous valuations may be regarded as an optimal strategy for dealing with uncertainty.

This fundamental view of the valuation process seems plausible and has been the foundation for most subsequent work in smoothing valuation indices. Despite that importance, it is not easy to verify that it is an accurate description of how valuers and the valuations they produce actually behave.

A central prediction of the theory is, of course, that valuations will tend to be 'sticky', fixing on past valuations especially when they are separated by short periods of time. This simple proposition gets apparently powerful support from the observation that, over any one month, the majority of properties covered by the IPD Monthly Index show no change in capital value.

Several authors have attempted to test the accuracy of the valuation smoothing model by running behavioural experiments on groups of US valuers (Hanz, 2004; Diaz and Wolverton, 1998; Diaz, 1997). In outline, the experiments test the differences in valuation judgements produced by valuers fed with different information on previous valuations or with outside 'expert' evidence. Generally, the findings support the smoothing theory: valuers provided with evidence on past valuations will produce current valuations closer to those figures than control groups working without such information.

Clayton, Geltner and Hamilton (2001) take a quantitative approach to the question, using both valuation and transactions evidence from the Canadian market. Valuations were assumed to be based on sets of comparable transactions identified by the authors, and the reliance of valuers on previous valuations versus transactions evidence was estimated by statistical testing. As would be expected from the theory, the association between previous and new valuations was stronger in periods with lower volumes and lower quality of transaction comparables, and also when properties were valued by the same valuer rather than when considered by a new valuer.

In summary, valuation smoothing may in part be taken as a product of the valuation of individual properties. Following that theory, the degree of smoothing – the influence of past valuations on current valuations – will be expected to vary with the quantity and quality of transactions evidence. It will be stronger in periods, or in markets, where transactions evidence is thin and perhaps also when the speed or direction of market movements is more uncertain.

2.2 Index aggregation

Although the previous section concludes that valuations induce smoothing in the values of individual properties, smoothing at this level is in fact not essential to the argument that valuation based indices are smoothed. The second fundamental source of index smoothing lies in the process of aggregating of individual property valuations into an index. Brown and Matysiak (2000) provide a full coverage of the topic, summarised below.

As for individual properties, valuations are taken to be estimates of market price, which change over time with signals generated by new market evidence. An index notionally reflecting a specific point in time – the end of a month or year – is in fact based on valuations conducted over a period of time. In practice, valuations for a month-end are spread over a couple of weeks, valuations for a year-end over two or three months. So the valuations going into the index are to a degree a smoothed moving average of observations over a short period of time – a feature known as temporal aggregation.

It is, furthermore, possible that different valuers will show varying speed of reaction to new market evidence. If the values of individual buildings in an index are adjusted to the same new market information with lags of (say) one, two and three months, the aggregate index would show smoothing in values, even if the individual properties showed no smoothing.

2.3 Statistical evidence of index smoothing

Looking at the way valuations are done, and how indices are constructed from valuations, generates some strong suggestions that a property index may smooth valuations. As we have discussed above, however, it is quite difficult to prove that valuers tend to dwell on past valuations, or that they have varying reaction times to the same market signals. Behavioural studies or statistical inference from individual property data may back up the argument, but they are based on methods which are hard to reproduce, or on large data sets of individual valuations and transactions which are not in the public domain.

Simpler and more direct support for the smoothing hypothesis comes from the way property indices behave at the aggregate level, set against the way financial theory says they should behave. Expectations about the behaviour of an investment index are derived from the Efficient Markets Hypothesis (EMH). The EMH proposes that, in an active market populated by rational and well-informed investors:

> *'at any point in time, actual prices of individual securities already reflect the effects of information based both on events that have already occurred and on events which, as of now, the market expects to take place in the future.'* Fama, 1965

Or in other words, in an efficient market there is no available information on past or current market conditions, or on the likely future performance of the market, which would enable an individual investor to beat the market average. The degree of market efficiency can be classified into:

- Weak form: all information from past prices is fully incorporated into current prices, so analysts of trends and patterns will not be able to beat the market.
- Semi-strong form: all publicly available information is fully incorporated into current prices, so company analysts and forecasters will not be able to beat the market.
- Strong form: all information, including private information, is reflected in prices, so even insider traders will not be able to beat the market.

Markets are efficient only when there is a large population of intelligent investors with access to all relevant information at low cost, who can also act on that information by trading without significant delays or transactions costs. Under these conditions, prices will change only in response to new information, or 'news' strictly defined as new information which could not have been predicted. If news is equally likely to be good or bad – it is randomly distributed – then movements in prices will also be randomly distributed. Market prices will follow a 'random walk'.

Only large and highly active financial markets – large company stocks, bonds, major currencies – would be expected to achieve strong or semi-strong efficiency. Finance literature abounds in studies which search for exceptions to the EMH in particular trading conditions, or for lightly traded assets. Many features of the markets for direct investment in property clearly do not conform to the assumptions of the EMH, most obviously the long delays and high costs of transactions, and unequal access to market information. Applications of the EMH to property smoothing go no further than the weak-form, the contention that future property values cannot be predicted from past property values.

Translated into statistical measures, the weak form of EMH is that there is no identifiable relationship between past values or returns, and future values or returns. The simplest forms such relationship can take are momentum (high returns in one period tend to be followed by high returns in the next) or mean reversion (high returns in one period followed by low returns). Statistically, the association between returns in different periods is measured by the serial correlation between returns in one period and in previous periods. A high positive correlation indicates momentum, and high negative correlation indicates mean reversion.

Property indices do show this most obvious form of predictability – a positive serial correlation, so that high or low returns tend to persist from one period to the next. Figures 1 to 3 make the point graphically, plotting IPD annual, quarterly and monthly returns against those in the preceding period. (Quarterly returns are compounded from the IPD Monthly Index.) If returns were unrelated to those in the preceding period, the points would show a random scatter and the regression lines fitted through the observations would be flat. The upward slope from left to right indicates a positive association between returns in successive periods. The strength of that association is measured by the serial correlation coefficient, which is the slope to the line fitted through the observations.

Figure 1: IPD annual return vs previous year

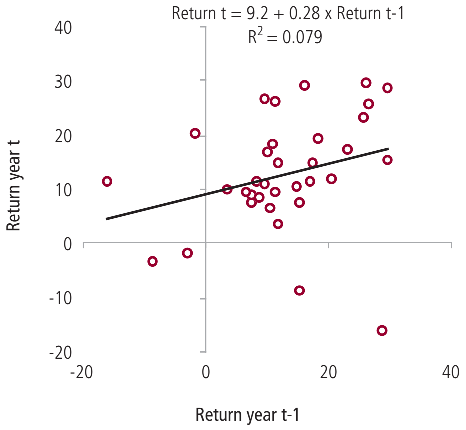


Figure 2: IPD monthly return vs previous month

Figure 3: IPD quarterly return vs previous quarter

Returns measured per month or per quarter show much higher levels of serial correlation than annual returns. This accords with predictions of the analysis of underlying sources of smoothing in valuation and index construction. From month to month or quarter to quarter, less new market evidence is available than over a full year so values are less likely to be moved from their previous level. Similarly, small differences in the speed with which valuers react to new market evidence will introduce more smoothing into the Monthly Index than the Annual Index.

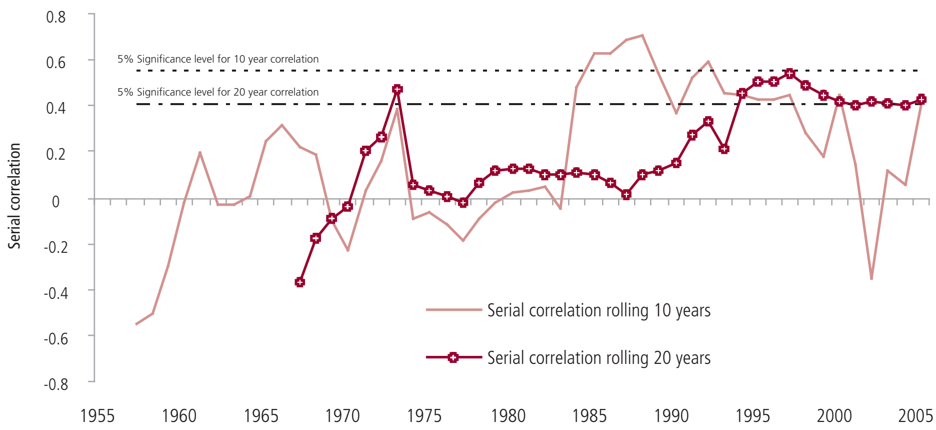
Table 1: Serial correlation in IPD returns

	Annual 1971 – 2005	Annual 1981 – 2005	Monthly 1987 – 2005	Quarterly 1987 – 2005
Serial correlation	0.28	0.42	0.87	0.85
t statistic	1.66	2.17	25.93	13.60
p value	0.06	0.02	0.00	0.00

Table 1 gives the serial correlation in returns at each frequency, with tests for the statistical significance of the serial correlation coefficient. At monthly and quarterly frequencies, the high levels of the serial correlation and large numbers of observations available mean the results are highly robust, significant at the 1% level of the standard t-test. In the case of the annual results, lower serial correlations and smaller numbers of observations mean that serial correlation over the period 1971 to 2005 is not quite significantly greater than zero at the 5% level. But measured from 1981 to 2005, serial correlation in annual returns is both much higher and significant at the 5% level.

As the results for the Annual Index over different periods suggest, the degree of serial correlation is not constant over time. Figure 4 measures serial correlation over 10 and 20 year rolling windows on the longest possible series of returns, adding estimates from Scott (1996) which extend the IPD series back to 1947.

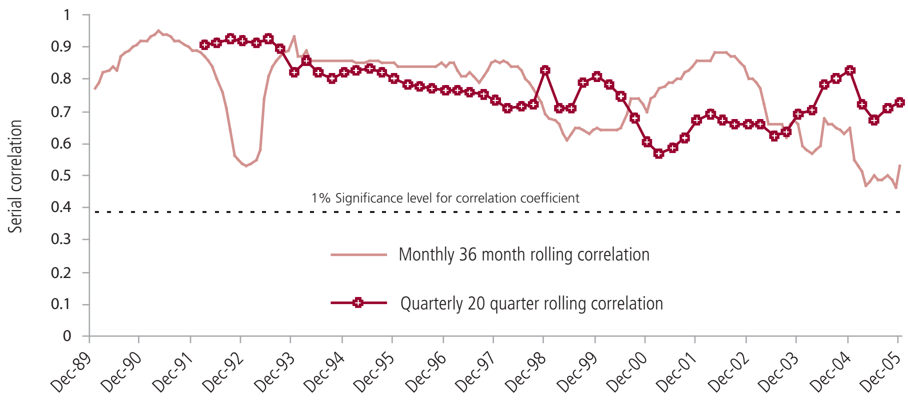
Figure 4: Serial correlation in annual returns – 10 and 20 year rolling windows



Source: Scott, IPD

On this evidence, there was little or no smoothing in Scott's pre-1971 Series (which in fact has a negative but statistically insignificant serial correlation over the whole period 1947 to 1970). In the post-1970 IPD series, the degree of smoothing indicated by serial correlation over a rolling 10-year window has been highly variable and, due to the low number of observations, it has rarely been statistically significant. Measured over 20 years, it is only when the period covered is wholly made up of the post-1971 IPD data that the indicator of smoothing becomes both stable and statistically significant. It may be that the strong differences between the Scott and IPD series arise from differences in coverage and methods, and perhaps also from changes in the structures of leases and investment markets, or in changes in valuation practice such as the shift from internal to external valuation, rather than to any real changes in the extent of smoothing.

Figure 5: Serial correlation in IPD monthly and quarterly returns – rolling windows



In the Monthly Index, monthly and quarterly serial correlation in returns (measured over 36-month and 20-quarter rolling windows respectively) have remained strongly positive and statistically significant at the 1% level throughout the last 20 years (Figure 5). On monthly returns, serial correlation has fallen sharply over the last three years. The level of serial correlation in quarterly returns trended down through the 1990s, but has run flat for the last five years.

The serially correlated characteristics of property returns are not generated by the low variability of income returns: the statistical results for capital growth rates are almost identical to those for total returns. Nor is serial correlation an artefact induced by inflation and property's (debatable) inflation hedging features. The results are, again, very little altered if total returns or capital growth are analysed in real terms.

Some variability in the degree of smoothing indicated by serial correlation is consistent with the analysis of valuation process. We would expect more smoothing in periods of low liquidity and greater market uncertainty. The observed changes in 12-month serial correlation in the Monthly Index (Table 2) do show a low negative serial correlation with a crude indicator of trading activity (turnover as a fraction of capital value by those investors covered by the Monthly Index itself). The degree of serial correlation shows no association with the rate of change in total return, taken as a proxy for uncertainty in the market, but does show a strong negative correlation with the simple level of return.

Table 2: Influences on IPD Monthly Index 12-month rolling serial correlation 1987 to 2005

	Correlation with serial correlation	t statistic	p probability
Average rate of return last 12 months	-0.55	9.74	0.00
Absolute rate of change in return over 12 months	-0.06	0.89	0.38
% stock turnover last three months	-0.29	4.49	0.00
Buying % stock, last 12 months	-0.18	2.72	0.01
Selling % stock, last 12 months	-0.22	3.28	0.00
Net investment % stock, last 12 months	-0.05	0.80	0.42

Taking serial correlation as an indicator of smoothing, in summary, seems to provide incontrovertible evidence in support of the smoothing hypothesis for indices based on monthly or quarterly valuations. The degree of serial correlation is high, and strongly significant. Changes in serial correlation over time also appear to be influenced by market liquidity, to the limited extent that can be tested.

Statistical tests give rather weaker back-up to the hypothesis that the IPD Annual Index is smoothed. A lower level of serial correlation in annual results is consistent with the theory. Both a lower level of correlation and the relatively small number of observations available inevitably mean that the statistical significance of results is lower. Meaningful changes in the level of serial correlation over time are, for the same reason, harder to identify on an annual frequency: the observed changes seem to have no clear relationship with changes in liquidity or market movements. A look at the statistical properties of property indices in other countries, or indices for other asset classes, may be helpful in putting the less than conclusive evidence of smoothing in the UK annual results into perspective.

Indices analogous to the IPD UK Index over a period of longer than 10 years are available for eight countries. They all show far higher levels of serial correlation than found in the UK (Table 3), all at very high levels of statistical significance. In France and the US, serial correlation in annual returns is nearly as high as in UK monthly returns. The comparison fairly conclusively demonstrates a general tendency to smoothing in property indices – and also raises interesting questions about the relationships between smoothing, valuation practice and index construction in each country which are beyond the scope of the present study.

Table 3: Serial correlation in property returns, varying periods to 2004

	Serial correlation	t statistic	Probability %	Years covered
France	0.84	6.11	0.00	19
USA	0.80	6.61	0.00	27
Canada	0.74	4.48	0.00	20
Sweden	0.72	4.34	0.00	21
Australia	0.71	4.17	0.00	20
Ireland	0.62	3.34	0.00	21
Netherlands	0.55	3.26	0.00	28
UK from 1981	0.40	2.41	0.01	24
UK from 1971	0.27	1.58	0.06	34

Source: UK, Ireland, France, Sweden from IPD. Canada from Russell / IPD. Netherlands IPD & RoZ. US from NCREIF. Australia from PCA.

Table 4 compares serial correlation in UK property with other mainstream asset classes, at monthly and annual frequencies. Even markets equity and gilts markets, which would be rated the most highly efficient, do not always show a perfect zero serial correlation. At an annual frequency, equity and gilts returns show negative or positive serial correlation varying over different periods of measurement, though they are never statistically significant at the 10% level. Gilts, however, do show a small statistically significant serial correlation in monthly returns.

Table 4: Serial correlation in returns / growth by asset class

	Property	Equities – All-Share	10 year gilts	Property shares	House prices
Annual returns / growth					
1951-2005	0.26 *	-0.15	0.02	..	0.51 ****
1971-2005	0.28	-0.25	-0.16	-0.27	0.47 ****
1981-2005	0.42 **	0.11	-0.20	-0.14	0.48 **
Annual returns / growth					
1986-2005	0.87 ***	0.07	0.12 **	0.16 ***	0.24 ***

Sources: IPD, Barclays Capital Equity-Gilt Study, Nationwide House Price Index, FTSE
Note: * Serial correlation coefficient is significant at 10% level, ** at 5% level, **** at 1% level

Nor is it the case that only valuation-based indices show evidence of smoothing. Changes in house prices, represented here by the transactions-based Nationwide Index, show considerably higher and strongly significant serial correlation at an annual frequency than commercial property returns, although paradoxically a lower serial correlation in monthly changes. Smoothing in house prices may, arguably, arise from the influence of valuations on asking prices and settlements, or the dual nature of housing as a consumption good and investment good.

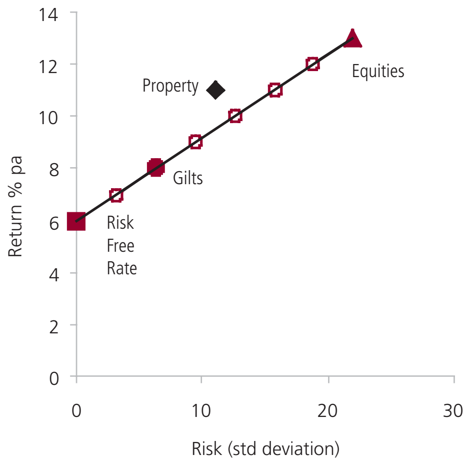
2.4 Property versus other assets

The statistical evidence on the existence of smoothing in UK annual property remains less than completely compelling. The smoothing hypothesis might, therefore, remain a debating point of mainly technical interest if estimates of property risk were not a critical element of the comparison with other asset classes and in associated conclusions on the role of property in wealth portfolios.

It is a central tenet of financial theory that returns on investment are the reward for delaying consumption into the future, with an added reward for the risk associated with an investment – ie the probability of earning returns above or below the expected rate. The return required to compensate for delay in consumption is the rate on a riskless investment – a government bond held to maturity. The risk of investment in an asset with variable payments of income and final capital value, conventionally measured by its standard deviation, will be offset by a rate of return above government bonds proportional to the degree of risk.

As indicated in Figure 6, we therefore expect to see a trade off between return and risk, with the lowest risk on short-term government-backed Treasury Bills and successively higher returns and risks for longer-term government backed bonds and equities. In broad terms, property returns and risks would be expected to fall between those on equities and bonds. Property's prospective cash flows are a mix of bond-like fixed income secured by existing leases and equity-like variable income dependent on changes in market rental values and occupancy, driven largely by the state of the economy. The fixed income element is clearly more risky than government bonds, because landlords face some risk of tenant default. The equity element is less risky than equities because property returns are measured unleveraged, while equity returns are a claim on company assets leveraged by corporate debt, among other factors. To compensate for risk between equities and bonds, we expect a return on property also between equities and bonds.

Figure 6: Schematic property return and risk vs other assets



On top of a compensation for risk as measured by standard deviation, investors will require an additional compensation for the lower liquidity and higher costs of holding property compared with bonds and equities – not least the higher transactions taxes at 4% for property against 0.5% for equities, but also including professional fees on transactions, and higher portfolio overhead costs than in other asset classes. In Figure 6, the additional premium in return to compensate for lower liquidity and higher costs shifts the required return on property above the straight line representing the pure return-risk trade off from fixed-income to equity investments.

The expected combination of risk and return can be expressed in the Sharpe ratio: the return for an asset over T-Bills taken as the risk free rate, divided by the standard deviation of the asset's returns – in other words the added return per unit of added risk. If the returns for gilts and equities over T-Bills are taken as pure compensation for added risk, while returns on property include the added premium for illiquidity and costs, we would expect to see similar Sharpe ratios for gilts and equities, but a slightly higher Sharpe ratio for property.

The familiar theory applies to expected returns. The returns realised by investors in any specific period may depart from the expected relationships with unexpected shocks. Researchers aiming to identify the genuine underlying characteristics of different asset classes, accordingly, rely heavily on the longest possible time series, over which periods of exceptionally good or bad performance for individual asset classes cancel out and their true characteristics are revealed. (See for example Dimson et al, 2002).

Reliable measures of property returns do not run back as far as those for other assets. On the longest available continuous figures, combining Scott (1996) with the standard IPD series back to 1971, it is hard to find periods over which both the return and the risk of property fall in the expected position between gilts and equities (Table 5). Gilts returns and risks are, as expected, higher than those on T-Bills through all periods, and equities returns and risks are as expected higher than gilts through all periods. Property has produced a return substantially higher than gilts when the two longer runs of returns are considered, and marginally above gilts in the latest period. But recorded property risk appears to have been substantially below gilts in all periods.

Table 5: UK property returns and risk vs other assets

	T Bill	Gilts	Property	Equities
Annualised (geometric) rate of return % pa				
1951-2005	6.9	6.8	10.6	12.3
1971-2005	9.0	10.9	12.4	13.9
1981-2005	8.5	11.2	10.9	13.8
1991-2005	6.3	10.1	10.4	10.5
Average (arithmetic) rate of return % pa				
1951-2005	7.5	8.1	11.0	16.2
1971-2005	9.1	11.8	12.9	17.5
1981-2005	8.6	11.8	11.2	14.8
1991-2005	6.3	10.7	10.6	11.7
Risk (standard deviation) %				
1951-2005	3.7	13.6	9.3	27.6
1971-2005	3.5	12.1	8.4	30.7
1981-2005	3.5	12.1	8.4	15.1
1991-2005	2.1	11.0	7.0	15.6
Sharpe ratio vs T Bill 1				
1951-2005	..	0.04	0.38	0.31
1971-2005	..	0.19	0.37	0.27
1981-2005	..	0.27	0.31	0.41
1991-2005	..	0.30	0.43	0.17

Source: Barclays Capital Equity / Gilt Study, Scott, IPD
Note 1: Sharpe Ratios calculated from arithmetic mean returns not the annualised returns shown in the table.

Property's performance comes a little closer to the expected pattern when measured by its Sharpe ratio, which is above that for gilts in all periods and above equities for the full run of years from 1951 and again for the last 15 years. As Figure 7 demonstrates, the lower than expected returns on property over the periods from 1971 or from 1981 to date were the product of a long run of weak returns relative to other assets from the early 1980s to the late 1990s. Ten-year returns ran consistently above gilts through the 1950s to the 1970s – and also above weakened equity returns through the 1970s. But through the 1980s and 1990s, returns on property were at or below those on gilts, and up to the mid-1990s at or below those on T–Bills, recovering to top those on all other assets only after 2001.

Figure 7: Ten year annualised rolling returns by asset class

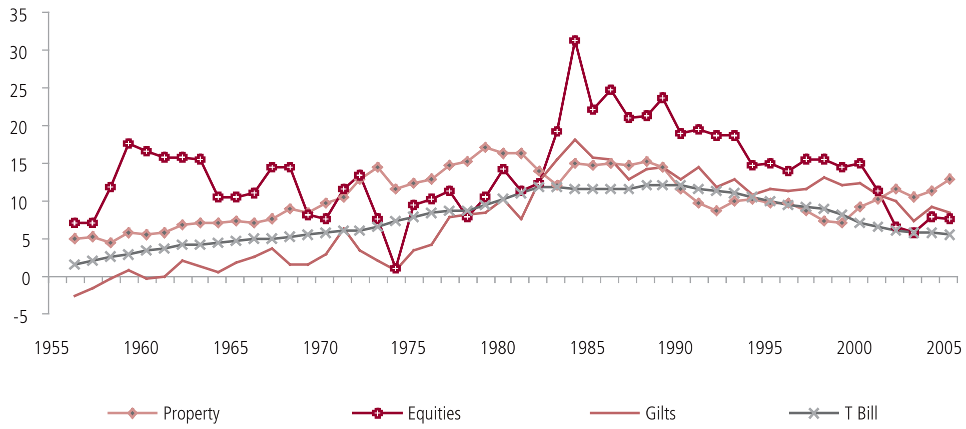


Figure 8: Ten year rolling standard deviation by asset class

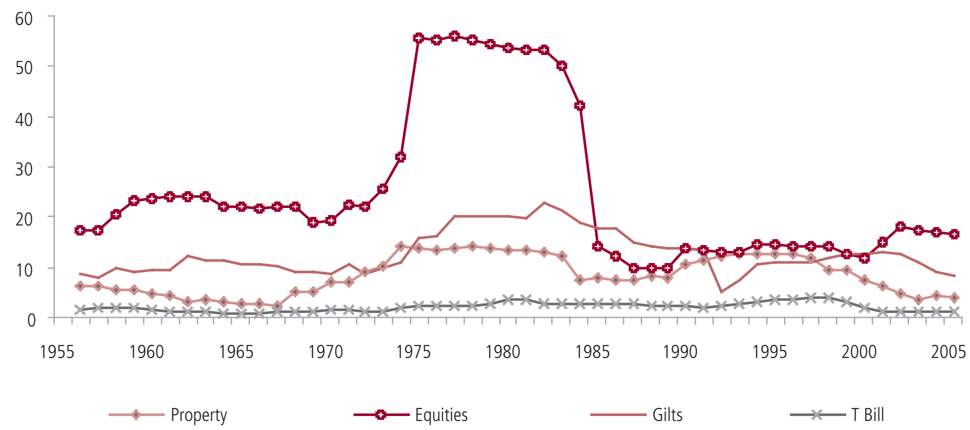
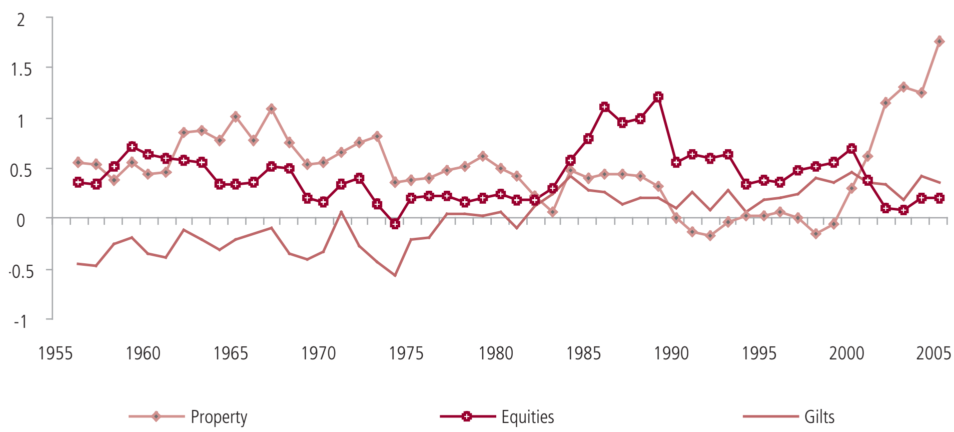


Figure 9: Ten year rolling Sharpe ratio by asset class



Source: Barclays Capital Equity / Gilt Study, Scott, IPD

The run of relatively weak compounded returns from the early 1970s to late 1990s was also a period of above average risk in property investment, generated by three major cycles in the space of 25 years. Taken together weak relative returns and high risk resulted in 10-year Sharpe ratios below equities through most of the 1980s and 1990s, and below gilts through most of the 1990s. Over the last 10 years, the Sharpe ratio on property has been lifted to a historic high by the combination of reasonable returns and unusually low risk.

Table 6: International comparison: Property return and risk vs other assets 1987 to 2004

	1 – 2 year gvt bonds	10 year gvt bonds	Property	Equities
Annualised return % pa				
UK	7.0	9.6	10.9	9.5
Ireland	6.4	10.5	15.3	10.8
France	5.8	8.4	7.0	8.5
Sweden	7.1	10.5	8.7	13.9
Netherlands	5.1	7.2	**9.7**	10.2
USA	5.3	7.5	7.3	12.0
Canada	6.2	8.9	8.1	9.7
Australia	7.5	10.7	9.5	10.5
Risk (standard deviation) %				
UK	2.7	7.8	**9.7**	15.8
Ireland	3.2	9.7	**11.8**	25.4
France	2.8	6.7	**8.3**	26.6
Sweden	3.7	10.1	**15.3**	33.8
Netherlands	2.2	6.5	3.7	22.2
USA	2.2	5.9	5.9	18.1
Canada	2.8	6.2	**7.4**	16.0
Australia	3.2	8.2	**9.5**	14.3
Sharpe ratio vs 1 – 2 year bonds				
UK	..	0.36	**0.44**	0.23
Ireland	..	0.45	**0.79**	0.29
France	..	0.42	0.18	0.22
Sweden	..	0.37	0.16	0.34
Netherlands	..	0.35	**1.24**	0.33
USA	..	0.40	0.37	0.45
Canada	..	0.46	0.30	0.29
Australia	..	0.43	0.25	0.27

Source: Property returns as Table 3. Equities from MSCI, Bonds from Datastream
Note: Property returns and risks in the expected range are shown in bold type.

A comparison of returns across asset classes for other countries shows that results for property contrary to expectation are not unique to the UK (Table 6). Across the eight countries where indices run back far enough for a reasonable statistical comparison, there is not a single one where the figures come out exactly in line with the expected property return and risks between equities and bonds, and a Sharpe ratio above both other assets.

Over this specific period, however, it is returns lying outside the expected range which is the most common anomaly. Property risk falls between that on equities and bonds in all but two countries. Weak returns in most countries mean that Sharpe ratios are below those on both other asset classes in five out of eight cases. As with the UK results, the comparisons seem to have been distorted by atypically weak property performance though the late 1980s and early 1990s.

It is unfortunate that the last 30 years, the period over which property performance can be reliably measured, is dominated by the record of the 1980s to early 1990s. This seems to have been a period through which property's relative investment performance has been abnormal against its expected profile, and also against its longer-run (but less reliable) history. Weak relative performance may be attributed to lower than expected property results, or to better than expected results for other assets – or to a combination of both.

Our own view is that property suffered from an exaggerated reputation as an inflation hedge in the 1970s and 1980s, and a high sensitivity to the strong economic cycles of the early 1970s, early 1980s and late 1980s. On the other hand, returns on equities and bonds have been flattered by the long downtrend in inflation rates and interest rates since the early 1980s. Whatever the explanation, the complexity of influences on all asset classes makes it impossible to infer a true underlying performance of any asset class from historic data. Property is not the only – and probably far from the worst – example of this difficulty. Similar uncertainties surround, for example, the estimation of the true equity risk premium (expected return on equities over the risk free rate) from historic data. On this most critical of financial questions, estimates produced by different authors run from 2.5% to 6.5% (Dimson et al, 2002).

Returns, risks and the relationships between asset classes form the critical inputs to quantitative analysis of the ideal weightings of different assets in a blended portfolio. Because historic performance results suffer from the problems of interpretation described above, the inputs to portfolio analysis should always be in the form of expected or forecast returns and risks, and not historic results. It is, nonetheless, common practice to use historic returns to illustrate the characteristics of asset classes. Even when forecasts of return are used, the difficulty of forecasting risk means that expectations of standard deviation will typically be taken directly from historic figures, or will at least be heavily influenced by them.

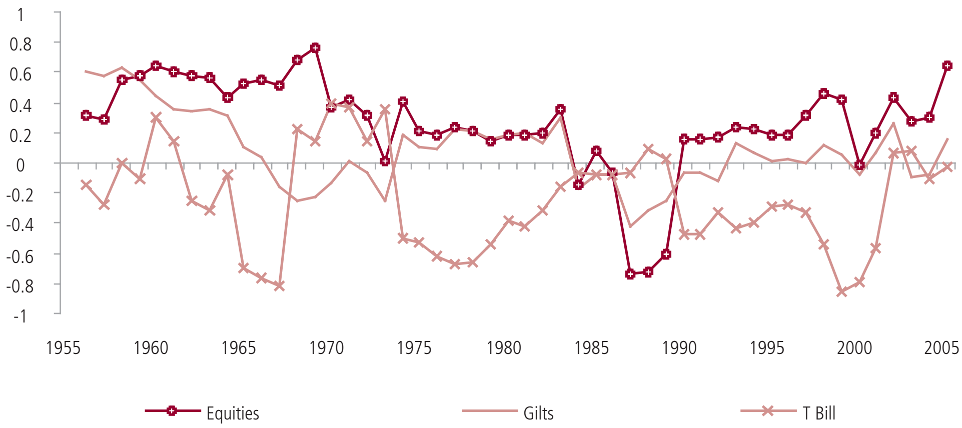
Table 7: UK returns and risks by asset class

	Property	Equities	Gilts	T Bill
Average returns % pa				
1951-2005	11.0	16.2	8.1	7.5
1971-2005	12.9	17.5	11.8	9.1
1981-2005	11.2	14.8	11.8	8.6
1991-2005	10.6	11.7	10.7	6.3
Risk (standard deviation) %				
1951-2005	9.4	27.6	13.6	3.7
1971-2005	10.3	30.7	14.5	3.6
1981-2005	8.4	15.1	12.1	3.5
1991-2005	9.9	30.7	14.2	3.6
Correlation with property				
1951-2005	1.0	0.23	0.16	0.07
1971-2005	1.00	0.19	0.05	-0.22
1981-2005	1.00	0.15	-0.07	-0.26
1991-2005	1.00	0.11	-0.11	-0.68

Source: Barclays Capital Equity / Gilt Study, Scott, IPD

Table 7 summarises inputs, based on from UK historic data, to a Markowitz mean-variance portfolio optimisation routine, one of the basic tools of the investment analysis industry. The procedure finds the weightings of assets which produce each achievable rate of return with the minimum level of portfolio risk. Because portfolio returns are simply the rate of return on each asset multiplied by its weight, achievable returns lie between the lowest and highest returning asset. Because portfolio risk can be reduced by combinations of assets on which returns do not move perfectly together, an optimised portfolio may show lower risks for a given return than any of the individual assets within it. For that reason, optimisation routines will favour assets which are correlated weakly with other assets, and diversify risk.

Figure 10: Ten year rolling correlations between property and other assets



Source: Barclays Capital Equity / Gilt Study, Scott, IPD

Property shows a low level of correlation with all other asset classes over all periods shown in Table 7, and a lower correlation than that between equities and gilts (which is 0.55 over the full period). Unlike relative rates of return and risk, which show varying profiles over time and across countries, a low correlation with other asset classes appears to be one of the most robust features of property performance: in the UK the correlation between property and equities has rarely exceeded 0.6, and its correlation with gilts and T-Bills has fluctuated around 0 (Figure 10). Across the eight countries listed in Table 6, the correlation between equities and property averages 0.11 and does not exceed 0.32; the correlation between property and government bonds averages -0.18 and never exceeds 0.11.

Figures 11 to 14 show, for optimisations calibrated with data from each period, the asset weights in efficient portfolios (ie all portfolios from the maximum return to the minimum risk portfolio) produced by a standard optimisation model. Table 8 summarises the asset weights in the portfolio from each period which yields the best Sharpe ratio – ie the highest portfolio return per unit of portfolio risk.

Figure 11: Asset weights in efficient portfolios – 1951 to 2005 data

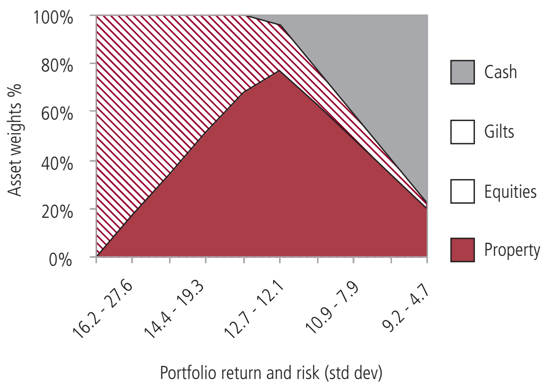


Figure 12: Asset weights in efficient portfolios – 1971 to 2005 data

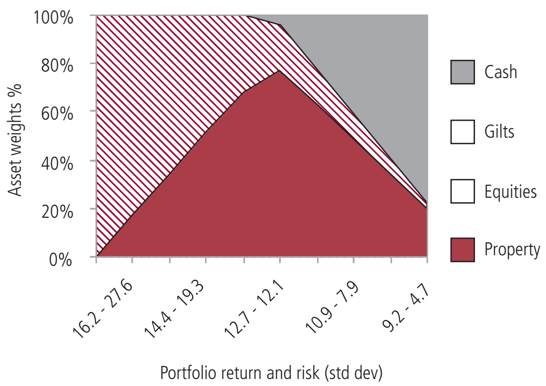


Figure 13: Asset weights in efficient portfolios – 1981 to 2005 data

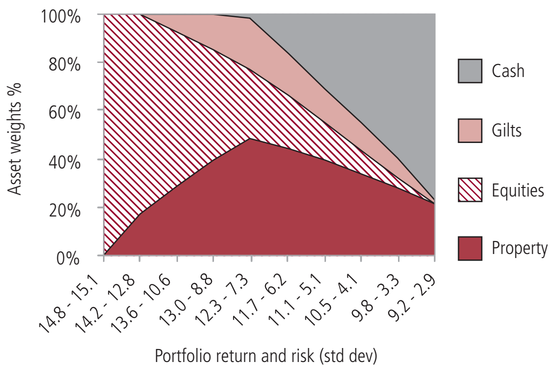


Figure 14: Asset weights in efficient portfolios – 1991 to 2005 data

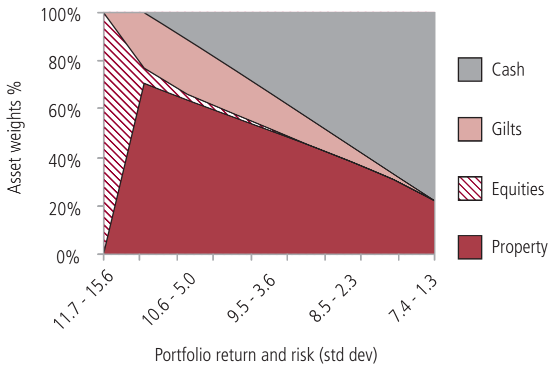


Table 8: UK optimised portfolio weights

		Weightings by asset class			
	Return% - Risk %	Property	Equities	Gilts	Cash
1951-2005	11.8 - 9.8	77%	19%	0%	4%
1971-2005	12.4 - 7.8	61%	10%	7%	22%
1981-2005	12.3 - 7.3	49%	29%	21%	2%
1991-2005	7.9 - 1.7	31%	0%	2%	67%

Source: Scott, IPD, Barclays Capital Equity-Gilt Study

For all periods used, as would be expected, high return and high risk portfolios are predominantly equities. Adding property and gilts reduces both returns and risks because those assets have lower returns and risks, and also offer diversification of equities risk. Property captures a very high weighting in all but the highest risk portfolios, even over two most recent periods when its average returns have been below gilts. In all the examples, property displaces gilts from all but the very low risk portfolios.

These results are in line with those produced by many previous studies using historic returns data for the UK and for other countries. Extremely high indicated weightings are, perhaps paradoxically, a major barrier to the full incorporation of property into modern methods of portfolio management. The fact that indicated weights are so far above those held by institutional investors could be explained either by believing that investors are massively irrational, or that the indicated weights are wrong because the history of returns does not reflect the true characteristics of property investment. Given the anomalous results on return and risk shown by property indices, and the supporting evidence on valuation smoothing, it is a systematic understatement of risk which is the primary candidate as the source of error in the historic results.

2.5 Summary

Together, there is a strong theoretical, empirical and practical case that valuation indices for property understate, offering a consistent picture from varying perspectives. Taken alone, the argument that smoothing is inherent in the valuation process would be hard to prove conclusively. It would be more difficult again to measure how much understatement of risk it would produce. But its predicted effects are borne out by statistical tests on the behaviour of index returns. And the behaviour of returns is such that in turn the property does not fit comfortably with the theories used to compare the performance of investments, or with the tools used to construct portfolios.

As we have seen, the case that property indices are smoothed and understate risk rests on a consistent set of conclusions from different approaches to the question.

- The way that individual property valuations are done and the way that property indices are compiled provide a basic case that smoothing may be introduced into valuation indices.
- But conclusive empirical proof of smoothing in those processes, how much smoothing those processes induce and therefore precisely how much risk is understated, is difficult to produce – mainly because it demands access to large amounts of individual property data which are not generally available.

These grounds for suspicion of valuation indices are taken closer to a case for conviction by a combination of statistical analysis and financial theory.

- Very high serial correlation in monthly and quarterly returns in the UK, and even in annual returns for other countries, provides strong evidence that property markets are highly inefficient, or that those indices do not accurately reflect movements in the market, or some combination of the two.
- Only the UK Annual Index shows evidence of persistent smoothing in returns which is less than compelling, with lower serial correlation than found in other countries at a lower level of statistical significance and some indications that the extent of serial correlation has varied widely over the available history.

International comparisons, therefore, suggest that UK valuations are a better measure of the underlying market, or that the UK market is more efficient than in other countries, or of course some combination of the two. But weaker statistical support for smoothing in returns does not get the UK Annual Index off the hook. Comparisons of returns with other asset classes, and the implications of those comparisons for the property weightings investors should hold, both depart from those expected from financial theory:

- In the UK and other countries, property returns and risks do conform to the expectation, falling somewhere between government bonds and equities.
- And the idealised weightings of property indicate by those figures look highly implausible against the weightings chosen by investors.

Overall, therefore, the evidence leaves the analyst faced with a choice. Either the application of a lot of the financial theories applied to all other asset classes to the analysis of property has to be abandoned, or index results have to be taken as an imperfect measure of property returns.

3. ADJUSTING PROPERTY INDICES: THEORY AND APPLICATIONS

The last section concluded that the results of valuation indices need to be adjusted to reflect the true characteristics of property performance. The various methods which can be used to adjust the observed returns all follow directly from the theories and techniques discussed in that section. They rest on estimates of the degree of smoothing introduced by individual valuations or index construction, or on purely statistical adjustments to observed results, backed up by the assumption that the adjusted results should provide a more plausible account of property returns relative to other asset classes.

This section provides a short review of the risk adjustments – desmoothing methods – proposed by different authors and then demonstrates the application of selected methods to UK property indices.

3.1 Desmoothing methods

Not all the methods described in the literature have been selected to apply to UK data. Our selection of methods rests mainly on practical grounds. The objective of the study is to demonstrate methods which can be easily reproduced by other researchers using basic spreadsheet tools, which can be readily generalised across a range of indices from data generally available in the public domain.

Desmoothing methods based on observation of valuer behaviour, or on access to the property level valuations underlying indices, are therefore outside our scope. This leaves open to us methods which rest on statistical adjustments to aggregate index results. We do not see this as unduly restrictive, since methods of this type are the mainstream of the desmoothing literature, accounting for the bulk of previously published work.

The five desmoothing methods, outlined below, all rest on arithmetic adjustments to remove the primary symptom of smoothing in indices, the serial correlation in time series of returns.

Lag 1 method – the first order auto-regressive filter

The earliest and most direct approach to desmoothing derives directly from Blundell and Ward's depiction of smoothed valuations as a weighted average of new market evidence and the last valuation, as described in Section 2.1. Geltner (1993a) provides the most commonly cited source for the method. If:

$$V_t = (1 - k) \times P_t + k \times V_{t-1}$$

Where V_t is the current valuation and V_{t-1}, P_t is the market price, and k is the weight placed in current market evidence in arriving at the current valuation, then the market price can be recovered by rearranging the terms to:

$$P_t = (V_t - k \times V_{t-1}) / (1 - k)$$

By extension, since desmoothed changes in capital value are the first differences between changes in market price, the formula can be applied directly to the capital growth component of a returns index in the form:

$$DCG_t = (VCG_t - k \times VCG_{t-1}) / (1 - k)$$

Where DCG is desmoothed capital growth and VCG is capital growth shown by the valuation index. The relationship between DCG and VCG is set by the value of k, in this context known as the desmoothing coefficient. With an appropriate value of k, therefore, a series of unsmoothed capital growth rates can easily be calculated from the observed index results.

Lags 1 – n method – nth order autoregressive filter

The Lag 1 method corrects for first order serial correlation – between capital growth or total return in one period and the next. In high-frequency monthly or quarterly indices, it is reasonable to expect linkages between current and previous valuations to extend back more than one period, particularly if all valuations are not uprated in every period (as in the US NCREIF index), or valuations are more fully scrutinised at quarter or year ends used in fund reporting (as may be the case in the UK Monthly Index).

Desmoothing which removes or reduces only the serial correlation observed at the first lag may, therefore, still leave substantial serial correlation effects at other lags. A more generalised version of the desmoothing formula, as reported in Fisher, Geltner and Webb (1994), deals with all lags at which significant serial correlation effects are found in the index results, and takes the form:

$$DCG_t = (VCG_t - k_1 \text{ x } VCG_{t-1} - k_2 \text{ x } VCG_{t-2} - \ldots\ldots k_n\ CVG_{t-n}) / (1 - k_1 - k_2 \ldots . - k_n)$$

where VCG and k are values for observed index capital growth and appropriate values of the desmoothing coefficient for all lags at which there is significant observed serial correlation. To determine appropriate lags to be used in the correction filter, the serial correlation at different lags should be calculated in combination, through a regression analysis run on all plausible lagged values and selecting those where t statistics show the regression coefficient is significant.

Equity Volatility method

The two pure autoreregressive methods described above leave the volatility in property values resulting from the desmoothing process as an isolated variable unrelated to anything else. As we noted in Section 2.4, the results of valuation indices are suspect not only because of their own statistical properties but also because they show volatilities which are implausible against those on other assets.

Fisher, Geltner and Webb (1994) offer a version of the desmoothing formula adapted to incorporate a relationship with the volatility of equities. The formula applied is:

$$DCG_t = (VCG_t - k\ VCG_{t-1}) / W_0$$

where, as before, DCG and VCG are desmoothed and index capital growth respectively and W_0 substitutes for the term (1 – k) in the Lag 1 method, and takes the value

$$W_0 = 2 \text{ x standard deviation } DCG_{L1} / \text{standard deviation equity capital values}$$

where DCG_{L1} is the desmoothed capital value series resulting from the application of the Lag 1 method with an appropriate value of k. As shown, W_0 takes a value below 1 when the volatility of equities is more than twice the volatility of desmoothed capital values resulting from the Lag 1 method, and results in a further desmoothing of the property values. When the volatility of equities is less than twice that of the desmoothed capital values from the Lag 1 method, W_0 is more than 1 and dampens the volatility in final desmoothed property values.

In any given period, the Equity Volatility procedure therefore anchors the final desmoothed volatility of capital values to a narrower range relative to the volatility of equities than pure Lag 1 method. The neutral value of 2 assigned to the ratio between equities and property volatility is however, like the appropriate value for the desmoothing coefficient k, a matter of judgement.

Market States method

Both the last two desmoothing methods take into account the plausible idea that the degree of desmoothing varies with states of the market. The Market States method, following Chaplin (1997), assumes that smoothing effects will be stronger with high rates of capital appreciation or depreciation because market evidence is less certain in periods of rapid price change and smoothing effects are likely to be stronger in falling than in rising markets.

The desmoothing coefficient for each period is therefore varied around a base value of k resulting from the Lag 1 method, with the largest additions to that base value for periods when returns are more than +/- 2 standard deviations from the mean, with smaller additions or deductions from that base value for periods with returns between 1 and 2 standard deviations from the mean, on within 1 standard deviation of mean. The size of the additions to or deductions from the base value of k used in each of the market states remains a matter of judgement, subject to the constraint that they sum to zero so that the average value of k applied remains unchanged.

Time Varying method

The final method, following Brown and Matysiak (1998), allows for variation in the extent of smoothing effects, which in this case is measured by the changes in observed serial correlation in results over a recent time period. Because a large number of observations is needed to produce a reasonably reliable estimate of changes in serial correlation the method is most appropriate for monthly and quarterly series, but has also been applied to annual results where the length of history permits. The calculations take exactly the same form as the Lag 1 method, but take the desmoothing coefficient as the coefficient of serial correlation observed over a preceding period.

3.2 Desmoothing: capital values or total returns?

The desmoothing methods described above have been set out in terms of capital values and capital growth. The final objective – a desmoothed series of total returns – can be constructed from any desmoothed capital growth series by adding back an income estimated from the original index. Because the valuation and desmoothed capital value series will have different levels, the calculation has to work through an absolute figure for income, calculated in three steps:

Absolute income = % income return$_t$ x capital value index$_{t-1}$

Desmoothed % income return = absolute income$_t$ / desmoothed capital value index $_{t-1}$

Desmoothed total return$_t$ = desmoothed % income return$_t$ + desmoothed capital growth$_t$

If the analysis is done using only the index information available in the public domain, the estimate of income return and reconstituted total return is subject to a degree of error. In the original index, the denominator of income return is capital employed which, in the formulae used by IPD, embodies income continuously accumulated through the period of measurement. So estimating absolute income from the capital value index at the previous year-end, as suggested above, is an approximation which will be close to the true value when capital growth is modest, but subject to a small error increasing with higher rates of change in capital values. When run over long periods of time, moreover, the errors may accumulate, producing increasingly unrealistic apparent rate of desmoothed income return.

To avoid this uncertainty around the correct rate of income return, and also to simplify the calculations, the desmoothing formulae can be applied directly to rates of total return in the place of rates of capital growth set out above. Our industry survey found that practitioners often conduct desmoothing directly on total returns, although some purists feel that a strict interpretation of the efficient markets hypothesis applies to values and not returns. Our initial tests comparing equivalent smoothing methods applied via capital growth or directly to total returns showed there were no statistically significant differences between the two sets of results. All analysis presented below has, therefore, for simplicity been produced by applying desmoothing methods directly to rates of total return.

3.3 Desmoothing applications: 1971 to 2005

This first part of the empirical analysis of UK data examines all-property returns using the longest available annual time-series, combining figures from Scott (1996) from 1951 to 1970 with the published IPD Long Term Index from 1971 onward. Results at this level are used to set out general principles of methodology before broadening the analysis to cover other index frequencies, index sources and segment disaggregations.

Table 9 is taken from the Desmoothing Project Spreadsheet available alongside this report. The spreadsheet is set up so that the five desmoothing methods can be tested over different time periods, with flexible assumptions on the values of desmoothing coefficients. The coefficients can be set to produce target values in the standard deviations, serial correlation, means of the desmoothed series – or indeed any other characteristic of the desmoothed series, such as the statistical significance of serial correlations.

The first column contains summary statistics on the original Index results, over four periods which might be used to represent long-run returns and risks: the full length of the combined Scott / IPD series from 1951; the IPD Long Term Index from 1971, based on a small sample of investors though the 1970s; the full length of the standard IPD Index which, because it covered a much larger fraction of the market from 1981, can be taken as the most robust of the measures. The final period from 1991 covers too few observations for any strong statistical conclusions, but is provided mainly to check for any change in smoothing characteristics in more recent history.

The Lag 1 serial correlation coefficients represent the target variable which desmoothing procedures aim to remove, or at least to reduce. As noted in Section 2, the degree of serial correlation has varied over time, showing up most strongly for the period 1981 to 2005 due mainly to successive years of very high returns in 1987 and 1988 and low returns in 1990 and 1991. The significance tests of the serial correlation coefficients show probabilities they are significantly different from zero: a low value indicates strong significance. Only the serial correlations over the periods 1951 to 2005 and 1981 to 2005 are significant at better than the 10% level.

Table 9: IPD annual returns - desmoothing set for period 1971 to 2005

		Lag 1 method	Lags 1 and 2 method	Equity Volatility	Market States	Time Varying
		0.28	0.34	0.28	0.36	1.00
			-0.26	2	0.26	
				0.89	0.16	
					0.21	
					0.31	
					0.41	

Desmoothed results:

		Lag 1 method	Lags 1 and 2 method	Equity Volatility	Market States	Time Varying
Annualised						
1951-2005	10.6	10.3	10.5	11.4	9.6	..
1971-2005	12.4	11.9	12.3	13.2	10.9	10.8
1981-2005	10.9	10.7	11.0	11.9	10.3	11.2
1991-2005	10.4	11.0	10.6	12.3	10.8	11.3
Mean						
1951-2005	11.0	11.0	10.9	12.3	10.5	..
1971-2005	12.9	12.9	12.8	14.4	12.2	12.3
1981-2005	11.2	11.3	11.3	12.6	10.9	11.7
1991-2005	10.6	11.4	10.8	12.7	11.0	11.7
Standard deviation						
1951-2005	9.4	12.4	9.9	13.9	13.3	..
1971-2005	10.3	13.8	10.7	15.4	15.3	15.8
1981-2005	8.4	10.8	7.7	12.0	11.1	10.5
1991-2005	7.0	8.6	6.6	9.6	7.6	10.3
Desmoothed standard deviation: Index standard deviation						
1951-2005	1.00	1.33	1.06	1.48	1.42	..
1971-2005	1.00	1.33	1.03	1.49	1.48	1.53
1981-2005	1.00	1.28	0.91	1.42	1.31	1.25
1991-2005	1.00	1.23	0.93	1.37	1.08	1.47
Serial correlation Lag 1						
1951-2005	0.31	0.06	-0.04	0.06	0.07	..
1971-2005	0.28	0.05	-0.09	0.05	0.05	0.02
1981-2005	0.42	0.29	0.20	0.29	0.30	0.19
1991-2005	0.27	-0.01	-0.12	-0.01	0.08	-0.07
Significance (p value) Lag 1 correlation						
1951-2005	0.02	0.69	0.75	0.69	0.64	..
1971-2005	0.11	0.76	0.61	0.76	0.78	0.91
1981-2005	0.04	0.17	0.35	0.17	0.16	0.36
1991-2005	0.36	0.97	0.69	0.97	0.79	0.82

Source: Scott, IPD

Desmoothing assumptions are shown in shaded area at the top of the table. For the Lag 1 method the single parameter is the desmoothing coefficient k. For the Lag 1 and 2 method the values are k_1 and k_2 desmoothing coefficients. For the Equity Volatility method, the first parameter is the value of k current selected for the Lag 1 method, the second is the target ratio of standard deviation in equity returns to standard deviation in desmoothed property returns from the Lag 1 method which is set at a default value of 2. The third parameter is the value of W_0 automatically calculated from the other inputs.

The Market States parameters reflect assumed variation in the degree of smoothing with rates of return. The top value is applied in years when the rate of return was more than 2 standard deviations above its mean over the whole period, the second value when it was 1 standard deviation above its mean, and so on to the bottom value applied in years when return was more than two standard deviations below its mean. These steps in the value of the desmoothing parameter are chosen by judgement.

For the Time Varying method, the varying default values of k are set each year at the level of serial correlation at Lag 1 observed over the preceding 20 years. Those default values can be factored up or down by increasing or decreasing the adjustment parameter, set at a default value of 1 (no adjustment).

This structure has been used to demonstrate the desmoothing effects of four different strategies for targeting serial correlation:

- Strong desmoothing: selecting parameters to produce zero serial correlation in desmoothed returns. This may be taken as an extreme assumption likely to produce an upper estimate of the true standard deviation in returns. As noted in Section 2, it would represent the underlying market in property as weak form efficient – a market with minimal frictions in the form of information costs, transactions costs and trading delays, whereas these frictions clearly exist in property.
- Moderate desmoothing: given the above, selecting parameters which permit a reasonable measure of serial correlation in desmoothed results to reflect frictions in the market, say 0.25 as suggested by Brown and Matysiak (2000).
- Weak desmoothing: selecting parameters which do not target a pre-specified level of residual serial correlation in desmoothed returns, but instead reduce that serial correlation to a value which is not statistically significantly different from zero at the 10% level.
- Neutral desmoothing: parameters set without judgemental inputs, setting desmoothing coefficients at the levels of observed serial correlation in returns, following Geltner (1993b).

Each of these strategies can be applied to generate target results over any of the four analysis periods, yielding a potential 4x4 matrix of results for alternative strategies and periods. As set out in Table 9, the results show the neutral desmoothing strategy set for 1971 to 2005 – the period taken as the best compromise between Index reliability and length of time series. All desmoothing coefficients are therefore based on the observed serial correlation in Index returns over that period, except the Time Varying method for which a value of k at the outset is set by the rolling serial correlation over the period 1951 to 1971, a window which is then rolled forward one year at a time.

For the 1971 to 2005 period, all five methods calibrated by the neutral strategy are equally effective in producing desmoothed returns with very low (and statistically insignificant) levels of residual serial correlation. All methods except Lag 1 and 2 also produce desmoothed standard deviations which are above that in the original Index by margins which are statistically significant at the 10% level or better. Over this period, the neutral version of the Lag 1 and 2 Method also removes most of the serial correlation at Lag 2, as would be expected, but shows only a marginal increase in desmoothed standard deviation.

Excluding the Lag 1 and 2 method, the desmoothed standard deviations run from 13.8% (1.33 times that in the Index) for the Lag 1 Method to 15.8% (1.53 times the Index) for the Time Varying method. The difference between those lower and upper estimates is, however, not statistically significant (p value = 16%).

Since, over the period 1971 to 2005, the residual serial correlation left by the neutral calibration is very close to zero, the output results are not much changed if the strong desmoothing strategy – removing all serial correlation – is adopted. In that case, desmoothed standard deviations run from 15.4% (1.49 times the Index value) for the Lag 1 and Equity Volatility methods, to 17.3% (1.67 times the Index value) for the Market States method. The other three methods yield very similar results, with standard deviations in the range 14.8% to 15.4%.

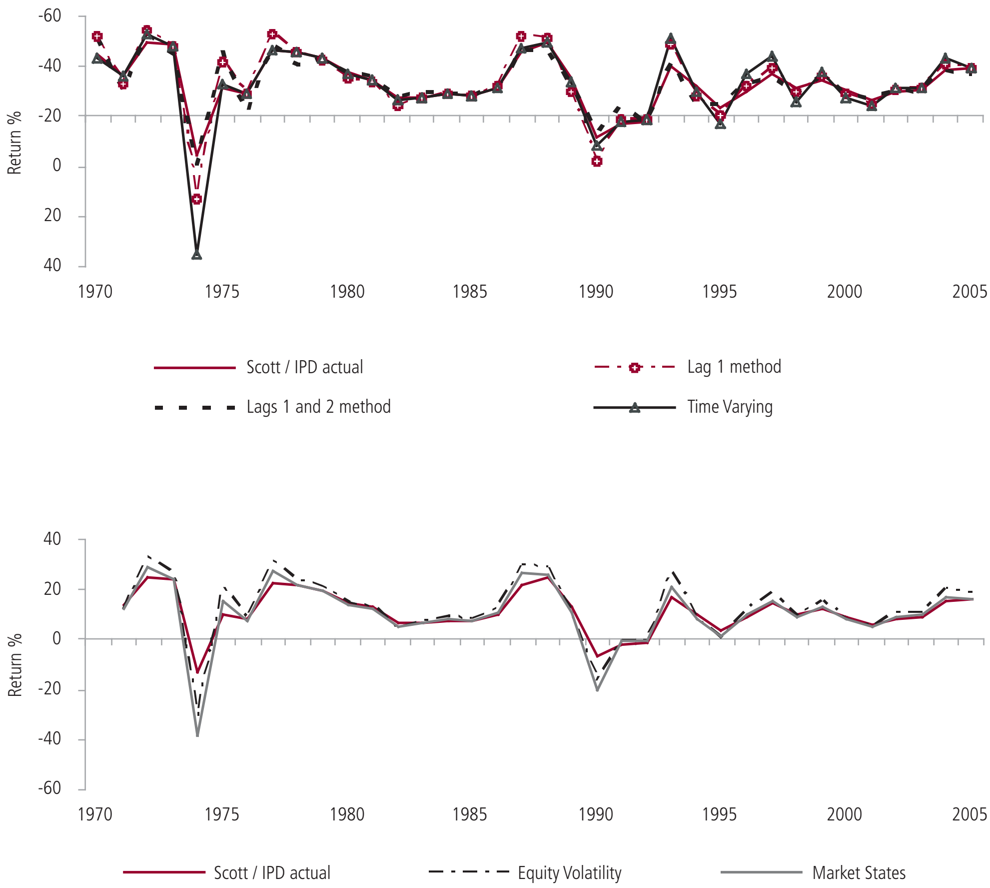
Because the observed serial correlation in Index returns from 1971 to 2005 is only 0.28, the weak desmoothing strategy of reducing residual serial correlation to 0.25 produces negligible increases in volatility using the Lags 1 and 2, Market States or Time Varying methods. The exception here is the Equity Volatility method which, because it imposes a relationship with an external constant factor, still produces a desmoothed standard deviation of 15.4% with a serial correlation of 0.25.

At the lower end of the range of possible strategies, the weakest desmoothing strategy of reducing the statistical significance of the residual serial correlation to the 10% level (or indeed any higher value) would have a negligible impact because the serial correlation in the original index is itself not significant at that level.

In summary, for the period 1971 to 2005, there are 10 unique combinations of methods and desmoothing strategies (all methods under strong desmoothing, all methods except Lag 1 and 2 under neutral desmoothing, the Equity Volatility method alone under moderate desmoothing) which produce estimates of volatility significantly different from that shown by the original Index. Across those 10 results, the average desmoothed standard deviation is 14.9% (1.44 times the Index value), and the range in indicated standard deviations runs from a minimum of 12.9% to a maximum of 16.9%. With only 35 annual observations to calculate standard deviations, the 10% confidence interval for significant differences in standard deviation around the mean of 14.9% runs from 11.9% to 18.6%. Strictly speaking, therefore, there are no statistical grounds for preferring any method or desmoothing strategy over another. In that case, the neutral strategy, calibrated primarily by the time series properties of the original index, might be taken as the preferred desmoothing strategy because it demands the minimum of judgemental input by the analyst.

In addition to the summary statistics, the plausibility of desmoothed results for individual years could be taken as an additional basis for discrimination between methods. Figure 15 compares de-smoothed annual results, calibrated on the neutral strategy, with the original Index. With the exception of the Market States method, the alternative methods produce fairly similar modifications to the Index returns. They increase the amplitude of peaks and troughs, but do not introduce any systematic leads or lags against the original Index. The Market States method is an exception because it makes asymmetric adjustments to the desmoothing coefficient, which takes a higher value in market downswings. It therefore raises the peaks of booms and deepens troughs when compared with both the original Index and other desmoothing methods. On this evidence, there are again no strong grounds for preferring one desmoothing method over another.

Figure 15: Desmoothed annual returns 1971 to 2005



The full discussion of results for the 1971 to 2005 period has, we hope, provided a sufficiently clear explanation of the issues involved in the choice of desmoothing methods for the analysis of other time periods to be given in a condensed form.

3.4 Results for all analysis periods

Three desmoothing strategies – the strong, moderate and neutral methods of calibration – have been applied to all four time periods shown in Table 9. The weak desmoothing strategy of reducing residual serial correlation to a statistically insignificant level has not been applied because in most cases it produces results very close to the moderate or neutral methods.

Table 10 shows the desmoothed standard deviations produced for all combinations of de-smoothing strategy and sub-period. Figures 16 to 18 show the same results in the form of a desmoothing factor – the ratio between desmoothed standard deviations and those in the original Index.

Figure 16: Impact on standard deviation – strong desmoothing

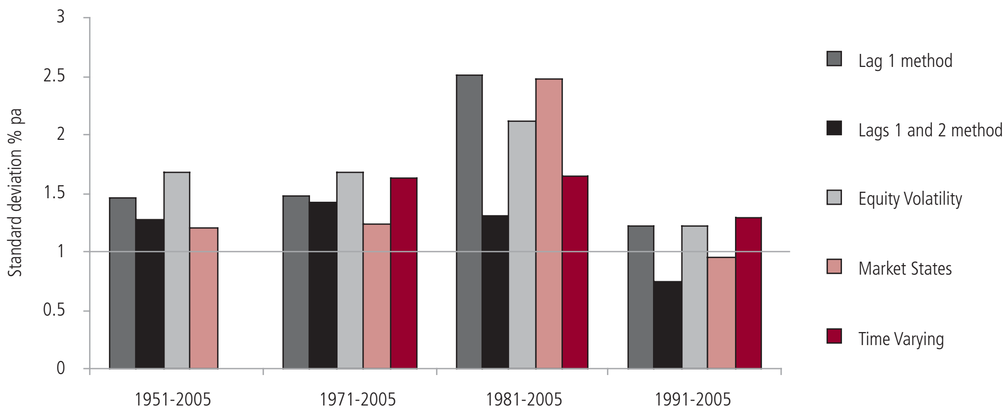


Figure 17: Impact on standard deviation – moderate desmoothing

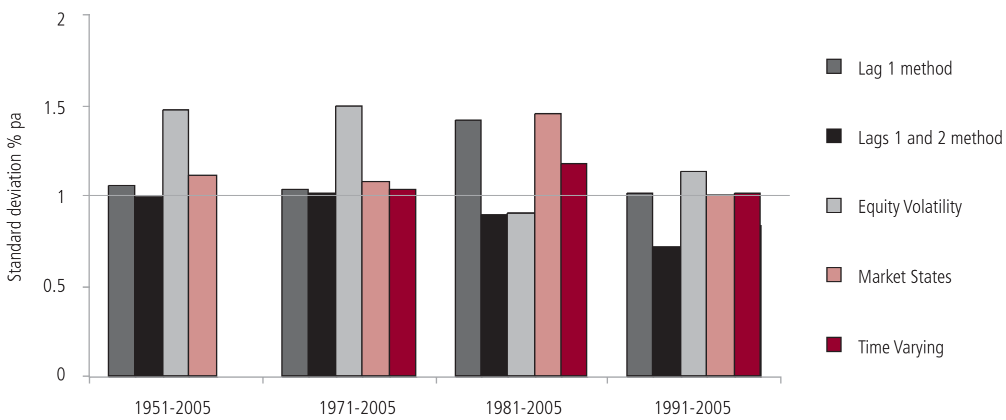
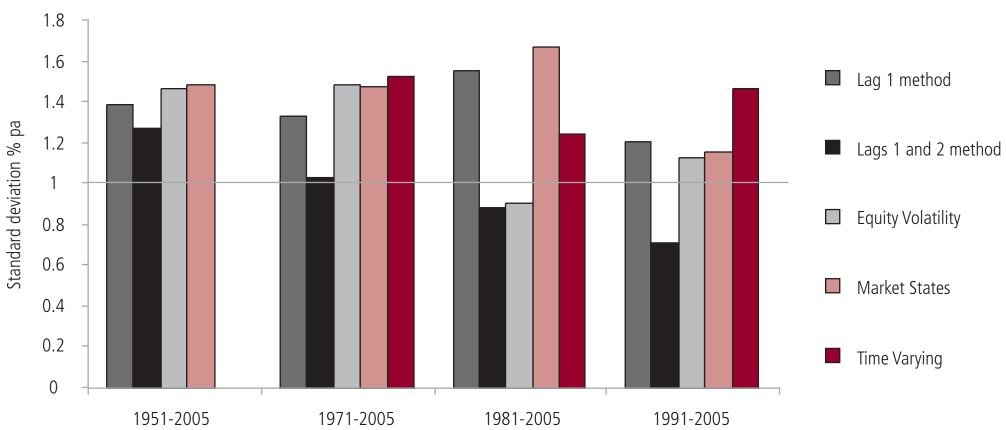


Figure 18: Impact on standard deviation – neutral desmoothing



Source: own calculations from IPD data

Table 10: **Standard deviations in desmoothed returns**

	Scott / IPD actual	Lag 1 method	Lags 1 and 2 method	Equity Volatility	Market States	Time Varying
Strong desmoothing (residual serial correlation = 0)						
1951-2005	9.4	**13.6**	**11.9**	**13.8**	**15.8**	..
1971-2005	10.3	**15.3**	**14.8**	**15.4**	10.4	**16.9**
1981-2005	8.4	**21.1**	**11.0**	7.6	**24.2**	**13.9**
1991-2005	7.0	8.5	5.3	7.9	8.5	9.1
Moderate desmoothing (residual serial correlation = 0.25)						
1951-2005	9.4	9.9	9.2	**13.8**	10.4	..
1971-2005	10.3	10.7	10.5	**15.4**	11.2	10.7
1981-2005	8.4	**12.0**	7.5	7.6	**12.2**	9.9
1991-2005	7.0	7.1	5.0	7.9	7.0	7.1
Neutral desmoothing (parameters set by Index serial correlation)						
1951-2005	9.4	**13.0**	**11.9**	**13.8**	**14.0**	..
1971-2005	10.3	**13.8**	**10.7**	**15.4**	**15.3**	**15.8**
1981-2005	8.4	**13.2**	7.5	7.6	**14.1**	10.5
1991-2005	7.0	8.5	5.0	7.9	8.1	**10.3**

Note: figures in bold show desmoothed volatility higher than Index at 10% significance level

Statistically, the results for the period 1991 to 1995 are the least interesting, since the desmoothed standard deviations are significantly different from the standard deviation of the original Index only for the neutral version of the Time Varying method, under which the desmoothing coefficient is heavily influenced by history prior to 1991. Leaving that latest period aside, the results cast some light on first, the robustness of different methods and second, the impact of the time period chosen for calibration on the results.

The Lag 1 and 2 method poses the biggest problems in calibration, because serial correlations in Index returns beyond the first lag show a marked change over time. Over the two longer analysis periods, serial correlation at Lag 2 is small and statistically insignificant. Post-1981, the Lag 2 serial correlation is large and negative, and also highly statistically significant. From 1981 onward, therefore, the use of multiple lags produces desmoothed volatility below the Index level in all except the strong desmoothing strategy. It is difficult to rationalise a negative serial correlation at Lag 2 in terms in terms of underlying smoothing processes arising from either valuation effects or index aggregation effects. The only conceivable mechanism would be a mean-reversion process, which systematically corrected overvaluation or undervaluation with a one year delay, which seems implausible. Inspection of the data shows that high recent Lag 2 serial correlation almost wholly generated by one pair of years (1991 and 1993) in the series, when a rapid shift from negative to positive returns was driven by major swings in bond yields rather than factors internal to the property market. We are therefore inclined to regard the high Lag 2 negative serial correlation in the later periods as a statistical quirk, which makes the use of the Lag 1 and 2 method inappropriate for annual data.

The Equity Volatility method suffers from a similar problem, generating desmoothed standard deviations below than the Index, or not significantly higher than the Index, over both more recent analysis periods. In this case, a perverse desmoothing result is produced by the narrow gap between the volatility of desmoothed returns produced by the Lag 1 method (13.4%) and those on equities over the same period (15.3%). So the value W_0 used in the second stage of the method rises above 1, dampening volatility to below that shown by the Lag 1 method and the Index.

This demonstrates a general point that the Equity Volatility method will yield results very similar to the simple Lag 1 method so long as the ratio of equity volatility to desmoothed volatility produced by the Lag 1 method is close to 2. This is the case for the periods from 1951 and 1971, so there is no significant difference between the desmoothed volatilities indicated by the two methods. When, as from 1981 onward, that condition is not true, a plausible result from the Equity Volatility method can be restored only by making arbitrary changes to the expected ratio between equity and desmoothed property volatilities. Since this introduces a judgement about the output of the desmoothing process – a pre-determined relationship to the volatility of equities – it seems to render the method largely redundant, and effectively no different from determining the volatility of property by a simple ratio to equities.

The other distinctive feature of the Equity Volatility method against the others arises from that inherent anchoring to an external indicator. As Table 10 demonstrates, that makes the Equity Volatility method totally insensitive to any target level of residual serial correlation in the desmoothed results. The indicated desmoothed volatility is identical with residual serial correlations set at zero or at 0.25. This insensitivity to the characteristics of the desmoothed series seems to us an additional weakness, because it divorces the final results from any theoretical viewpoint on the behaviour of the index.

Ruling out the Lag 1 and 2 and Equity Volatility results leaves three methods which are all variants on a first-order autoregressive process – the simple Lag 1 method itself plus Market States and Time Varying methods. Given their largely common basis, these methods produce similar results, and there are no strong grounds for preferring one over another. On the moderate and neutral desmoothing strategies, differences in desmoothed standard deviation across the three methods are statistically insignificant at the 5% level. Because the Time Varying method is calibrated with a 20-year rolling correlation window, it cannot be run over the full period 1951 to 2005 and the results are less variable across the other analysis periods, particularly if the strong desmoothing strategy is applied.

Differences between the Lag 1 and Market States methods lie primarily in the annual profile of returns rather than the estimate of volatility. As noted above, the Market States method assumes an asymmetry in smoothing between upswings and downswings, and therefore heightens peaks while deepening troughs. While this may be intuitively appealing, there is little empirical support for the hypothesis, and the calibration of desmoothing coefficients for each Market States is wholly a matter of judgement.

The Lag 1 method and the Time Varying method therefore remain as the choices which are least judgemental in nature and permit the widest range of alternative desmoothing strategies and time periods. The only major point of divergence between the two is with the application of strong desmoothing to the period 1981 to 2005. In this instance, there is in fact no value of a Lag 1 desmoothing coefficient which will reduce serial correlation to zero, because the extent of the serial correlation induced by successive years of very high return in 1987 and 1988, and low return in 1990 and 1991, is too large to be removed. (Those two year-pairs account for 79% of the total covariance between returns and Lag 1 returns over the whole period.) This demonstrates the danger of relying on short time series, when observed serial correlation may be dominated by one or two events, in this case the exceptional boom and slump of the late 1980s to early 1990s, rather than enduring characteristics of the Index.

Though extreme cycles of that type may well be a periodic tendency in property markets, if their likelihood of recurrence is less than once every 25 years, the 1981 to 2005 period overstates the extent of the serial correlation they induce.

Table 11: Preferred desmoothing results - annual total returns

	Standard deviations %				Ratio desmoothed: Index standard deviations	
	Scott / IPD actual	Lag 1 method	Time Varying		Lag 1 method	Time Varying
Strong desmoothing (residual serial correlation = 0)						
1951-2005	9.4	13.6	..		1.45	..
1971-2005	10.3	15.3	16.9		1.48	1.63
1981-2005	8.4	..	13.9			1.65
Neutral desmoothing (parameters set by Index serial correlation)						
1951-2005	9.4	13.0	..		1.39	..
1971-2005	10.3	13.8	15.8		1.33	1.53
1981-2005	8.4	13.2			1.56	1.25
Averages for each analysis period						
1951-2005	9.4		13.3		1.42	
1971-2005	10.3		15.4		1.49	
1981-2005	8.4		13.5		1.48	

On the above arguments, we would set aside three of the desmoothing methods (Lag 1 and 2, Equity Volatility, Market States), the analysis period 1991 to 2005 (too short to produce statistically significant results), and the strong desmoothing strategy for 1981 to 2005 (overly influenced by an exceptional cycle). In addition, the moderate desmoothing strategy fails to produce a significantly significant increase in volatility in all but one case.

Those exclusions leave nine combinations of desmoothing method, desmoothing strategy and analysis period which are the most robust, and also result in an estimate of property volatility which is higher than that in the original Index which by a margin which is statistically significant at the 10% level. As shown in Table 11, these preferred results show a reasonable degree of consistency. The desmoothing factor – the ratio between desmoothed and Index standard deviations – takes a minimum value of 1.25 and a maximum value of 1.65, with an overall average of 1.47. Averaged across methods within each period, the historic standard deviation in desmoothed property returns is in the range 13% to 15%, against the Index standard deviations of 8% to 10%. For the period 1971 to 2005, which offers the best combination of Index reliability and length of time series, in round terms the desmoothed standard deviation of 15% compares neatly with the observed standard deviation of 10%.

3.5 Desmoothing monthly and quarterly indices

Most discussion of returns and volatility in UK property rest on annual index results, because the IPD Annual Index is the most generally used indicator of long term performance. IPD's Monthly Index now has a history running back almost 20 years, and from 2006, IPD's publication of a Quarterly Index with a much larger coverage of the market than its current Monthly Index may lead to quarterly series becoming the index of record. We have therefore repeated the investigation of alternative desmoothing methods and desmoothing strategies applied using data from the IPD Monthly Index at both monthly and quarterly intervals. For completeness, we also briefly examine the results of applying desmoothing methods to the other standard indices of UK property performance apart from IPD's – those from Jones Lang LaSalle (JLLS), and CBRE. The full results from this higher frequency analysis are given in Appendix A, and only summarised here.

At both monthly and quarterly frequencies, the Monthly Index shows very high serial correlation at Lag 1 – close to 0.90 in both cases – decaying to around 0.20 after 12 lags on the monthly results, or four lags on the quarterly results. Higher frequency indices pose more problems in the calibration of desmoothing methods than are found in annual data. The extremely high Lag 1 correlations, and mix of positive and negative correlations at other lags, make it far more difficult to target specific values of residual serial correlation in desmoothed results without introducing other implausible characteristics such as major differences in the mean return from those in the original Index. The mid-1980s starting point for the Monthly Index, moreover, means that its serial correlation characteristics are dominated by the peak and trough late 1980s and early 1990s.

For these reasons, it is difficult to pick out a set of desmoothed figures at monthly and quarterly frequencies which look both reasonable in terms of the characteristics of the desmoothed series and fairly consistent in their implied increase in standard deviation. A simple average of results from different desmoothing methods at the monthly frequency indicates a standard deviation in monthly returns of 1.83% (2.57 times that seen in the Index). Because desmoothing decreases serial correlation in the monthly returns, desmoothing does not increase standard deviation in annual calendar year returns measured from the Monthly Index by the same factor. Annual standard deviation is put at 12.34%, only 1.67 times that seen in the Index – an estimate which falls at the lower end of the range produced by desmoothing on annual series.

Calibrated over the last 10 years, an average across the results of different desmoothing methods gives desmoothed standard deviation in quarterly returns of 2.1% against the Index 1.2% (a factor of 1.7). At an annual frequency, desmoothed standard deviation is 5.7% against the Index 4.0% (a desmoothing factor of 1.4). Though standard deviation over this period is low, measured by the desmoothing factor this estimate again falls within the range of the results found in the annual analysis.

Other valuation indices of UK quarterly or monthly property returns – from Jones Lang LaSalle and CBRE – show characteristics very similar to IPD's. Desmoothing run on the alternative indices, therefore, does not significantly change the general conclusions drawn from the IPD data.

Overall, it is more difficult to draw robust conclusions on risk from monthly and quarterly indices, because the period covered is shorter than the ideal, dominated by the single major cycle of the late 1980s and early 1990s, and because their serial correlation characteristics are more complex. Our tests show suggest that desmoothing at monthly and quarterly frequencies increases the standard deviations by a factor of roughly 2.5 times those observed in the Index results. But, because desmoothing also reduces the serial correlation in monthly and quarterly returns, the increase in standard deviation measured at an annual frequency is much lower, at 1.67 times that shown by the Index data. Though this desmoothing factor is higher than indicated by the use of Annual Index results, the resulting annual standard deviation at around 12% is slightly below the range produced by the analysis of the Annual Index in the last section.

3.6 Desmoothing market sectors and segments

All the published work we are aware of deals with index smoothing only at the all-property level, and primarily as a problem for the allocation to property in a multi-asset portfolio. It is not, however, inconsistent with the theories on the underlying causes of smoothing that the degree of smoothing is not uniform across different property markets. Smoothing originating in individual property valuations – the spillover from one valuation to the next – might be expected to be less severe in markets which are more liquid or better informed. These factors would create a higher rate of information arrival, thus increasing the weight of current market evidence available to the valuer, and decreasing the valuer's reliance on prior valuations.

If smoothing is thought of as arising from the process of index aggregation, however, it might be expected to be more severe in concentrated markets of densely packed properties than in those which are more widely dispersed. In the former, all properties are influenced to common market factors, to which their valuers may respond at different speeds. In segments made up of more widely spread investments, individual buildings are more subject to factors specific to their local markets, and less influenced by transmission of values from one building to the next.

Table 12: IPD annual sector indices - desmoothing results (Lag 1 neutral desmoothing)

	Index figures				Desmoothed results			
Period	All property	Retail	Office	Industrial	All property	Retail	Office	Industrial
Annualised								
1971-2005	12.4	13.4	11.2	13.9	11.4	13.0	8.9	13.6
1981-2005	10.9	12.1	9.5	12.3	10.5	11.8	8.7	11.9
Mean								
1971-2005	12.9	13.8	11.8	14.4	13.0	13.9	11.8	14.5
1981-2005	11.2	12.3	10.0	12.6	11.3	12.3	10.2	12.6
Standard deviation								
1971-2005	10.3	9.4	11.9	9.9	17.3	13.8	22.1	14.1
1981-2005	8.4	7.1	10.3	9.2	13.2	10.0	17.6	13.2
Ratio desmoothed: Index standard deviation								
1971-2005	..	..	..	..	1.7	1.5	1.9	1.4
1981-2005	..	..	..	..	1.6	1.4	1.7	1.4
Serial correlation Lag 1								
1971-2005	0.28	0.22	0.35	0.35	-0.03	-0.09	0.01	0.07
1981-2005	0.42	0.33	0.49	0.34	0.22	0.13	0.30	0.12
Significance								
1971-2005	0.11	0.22	0.04	0.04	0.85	0.62	0.93	0.68
1981-2005	0.04	0.11	0.01	0.10	0.30	0.53	0.15	0.59

Table 12 shows returns characteristics and desmoothing results for a split of the IPD Index by three main sectors – for which the history runs back to 1971. Within each of the two time periods shown, desmoothed results have been generated by the Lag 1 method and a neutral desmoothing strategy (ie setting the value of k as the observed serial correlation within each period).

Over both periods, the office sector shows the highest standard deviation. Differences between retail and office standard deviations are statistically significant at the 10% level, though differences between the retail and industrial standard deviations are not. The office sector also shows stronger evidence of smoothing, with Lag 1 serial correlation above retail in both periods, and above industrial in the second period. Only offices show a Lag 1 serial correlation which is statistically significant at better than 10% in both periods.

Applying a Lag 1 desmoothing method with a desmoothing coefficient set at the Lag 1 serial correlation therefore induces the largest increase in volatility for offices, already the most volatile sector. Office standard deviations are increased by a factor of 1.7 to 1.9, while retail and industrial standard deviations are increased by a factor of 1.4 to 1.5. As found at the all-property level, the neutral desmoothing strategy reduces serial correlation close to zero over the 1971 to 2005 period, and might therefore be taken as an over-correction. From 1981 to 2005, neutral desmoothing leaves some serial correlation, particularly in offices, but at statistically insignificant levels in all three sectors.

The same methods have been applied to a set of IPD's market segments defined by property type and broad location, using the standard classifications applied in for general market analysis and for portfolio reporting. Table 13 summarises Index characteristics and desmoothing results for the period 1981 to 2005.

On the Index results, segments show a wide range in standard deviation from 6.4% (Shopping Centres) to 13.6% (West End/Mid Town Offices). The degree of Lag 1 serial correlation runs from 0.12 (Other Retail Warehouse) to 0.55 (Central and Inner London Offices). Given the fairly small number of annual observations available, only levels of serial correlation greater than 0.34 are statistically significant at the 10% level. On this criterion, the statistical evidence for the existence of smoothing at the segment level is robust only for the Standard Shops segments (excluding Rest of UK), Shopping Centres, Offices in all London segments, and Standard Industrials (excluding Inner South East). For Retail Warehouses, Dept and Variety Stores, Supermarkets and all office markets outside London, there is no statistically conclusive evidence of smoothing effects.

The confidence which can be attached to differences in segment volatility shown by the Index is even weaker. Only the Central London office markets show standard deviations which are significantly different from the all-property average at the 10% level or better, and only Shopping Centres a standard deviation significantly below the all-property average. Standard Retails in Central London, all the London office markets and South East Standard Industrials are the only segments where standard deviations are significantly above the all-retail average at the 10% level.

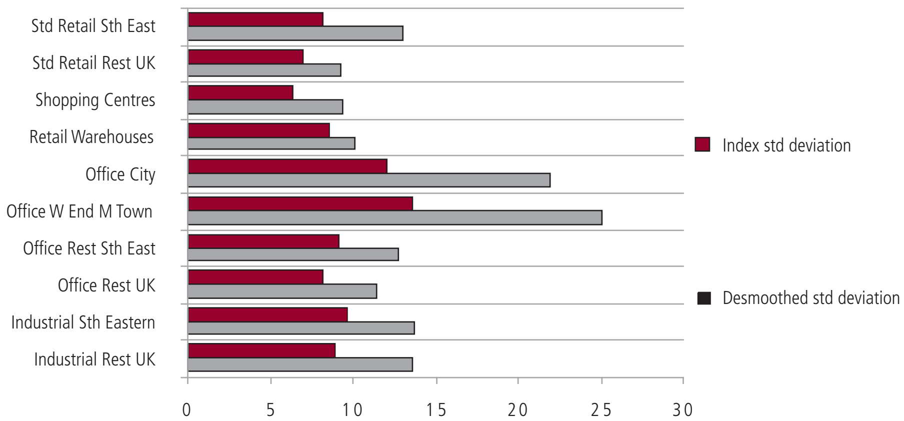
Markets showing higher standard deviation also tend show a higher degree of serial correlation: the two measures show a positive correlation of 0.57 across segments. In other words, and perhaps paradoxically, the riskiest segments appear to be most prone to smoothing effects. This effect is, however, picked up largely from the Central London office market segments and almost disappears if they are excluded from the analysis.

For many segments, therefore, the statistical case for desmoothing, or for taking differences in observed risk as meaningful, is fairly weak. The most robust evidence for differences in risk coupled with Index smoothing comes from the higher risk segments – Central London Office and Standard Shop, together with the London and South East Industrial market.

Turning to the desmoothed segment results, the Lag 1 method calibrated on a neutral desmoothing strategy generally steps up the estimate of volatility, mostly in markets which appeared to be most volatile on the original Index figures. For Central London Standard Shops and Central London Offices, desmoothed standard deviations are ramped up close to 20% pa or higher, 1.7 to 1.8 times the standard deviations shown by the Index. For other segments, desmoothed standard deviations are is 1.3 to 1.5 times that shown by the Index. Only Retail Warehouses and Supermarkets show a lower adjustment factor, also showing desmoothed standard deviations which are not significantly different from those in the Index at the 10% level.

As Figure 19 indicates, desmoothing at the segment level does little to change the rank ordering of segments by their volatility. The ordering from the most risky (Central London offices) to least risky (Shopping Centres and Standard Retail outside the South East) is exaggerated rather than changed by desmoothing.

Figure 19: IPD segment returns: standard deviation 1981 to 2005



It could be argued that a simple Lag 1 neutral desmoothing has not done enough to discriminate between segments. In most cases, that method leaves serial correlation in the desmoothed returns close to zero, and far from statistically significant. In the segments where the Index is most volatile and apparently smoothed, however, desmoothing leaves larger values of serial correlation, although they are significant at the 10% level only for the Office West End and Mid Town segment. Setting a target for tolerable serial correlation in desmoothed returns at, say, 0.25 would therefore exaggerate the contrasts across segments even further. Setting desmoothing coefficients in each segment to meet that criterion would raise the standard deviation in the Central London office and retail segments still further, while actually reducing standard deviation in all other segments.

Table 13: **IPD segment indices 1981 to 2005 - desmoothing results**

Market segments

Standard Shops	7.9	11.8	1.49	0.39	0.14	0.51
Central London	10.7	19.0	1.78	0.52	0.26	0.22
Rest of London	8.5	13.2	1.56	0.43	0.12	0.57
South East & Eastern	8.5	13.4	1.57	0.44	0.10	0.64
Rest of UK	7.2	9.8	1.35	0.31	0.10	0.65
Shopping Centres	6.4	9.4	1.46	0.37	0.16	0.45
Retail Warehouses	8.6	10.1	1.17	0.16	0.05	0.83
Retail Parks	8.9	10.5	1.18	0.17	0.04	0.84
Other Ret W'house	8.4	9.5	1.13	0.12	0.04	0.84
Dept / Variety Stores	6.6	8.8	1.34	0.28	0.11	0.60
Supermarkets	6.5	7.9	1.21	0.19	0.04	0.86
Standard Offices	10.4	17.8	1.71	0.49	0.31	0.14
Cent & Inner London	12.5	23.0	1.84	0.55	0.35	0.09
Rest of London	9.5	14.0	1.47	0.37	0.19	0.37
Inner South Eastern	8.6	11.6	1.35	0.29	0.14	0.51
Outer South Eastern	8.3	10.7	1.28	0.25	0.11	0.62
Rest of UK	8.3	11.6	1.41	0.33	0.13	0.55
Standard Industrials	9.3	13.5	1.45	0.35	0.12	0.59
London	9.6	14.2	1.48	0.37	0.13	0.56
Inner South Eastern	9.2	11.9	1.30	0.26	0.07	0.74
Outer South Eastern	10.6	16.5	1.56	0.42	0.15	0.47
Rest of UK	9.0	13.9	1.56	0.42	0.11	0.60
Distn Warehouses	8.8	11.3	1.29	0.25	0.05	0.82

Market segments

Std Retails: S East	8.2	13.0	1.58	0.43	0.17	0.44
Std Retails: Rest UK	7.0	9.3	1.33	0.29	0.10	0.65
Shopping Centres	6.4	9.4	1.46	0.37	0.16	0.45
Retail Warehouses	8.6	10.1	1.17	0.16	0.05	0.83
Office: City	12.0	21.9	1.83	0.54	0.30	0.16
Office: W End M Town	13.6	25.1	1.84	0.54	0.36	0.09
Office: Rest S East	9.2	12.8	1.39	0.32	0.16	0.45
Office: Rest of UK	8.2	11.4	1.39	0.32	0.13	0.55
Industrial: S Eastern	9.6	13.7	1.43	0.34	0.11	0.60
Industrial: Rest of UK	8.9	13.6	1.52	0.40	0.09	0.66
All Retail	7.1	10.0	1.41	0.33	0.13	0.54
All Office	10.3	17.6	1.71	0.49	0.30	0.15
All Industrial	9.2	13.2	1.43	0.34	0.11	0.61
All Property	**8.4**	**13.1**	**1.56**	**0.42**	**0.22**	**0.30**

Why there is stronger evidence of smoothing in some markets, particularly in Central London retails and offices, remains an open question. Since these are clearly markets which are among the most closely monitored and which generate large volumes of transactions (though not necessarily high transactions rates than other markets), it is unlikely smoothing at the level of individual valuations is stronger than elsewhere. Index aggregation effects are a stronger candidate. It might be argued that the investment stock in these locations, especially for offices, is more widely spread across sub-segments defined by size, age and quality of building than in the rest of the country. A form of aggregation effect could therefore arise if cycles flowed with differential timing through those different grades of stock – say initial recoveries in new Grade A buildings in core locations spreading through lower grades of stock and more peripheral locations.

Tests at the level of data disaggregations available to us – classifications within Central London by broad size and age band on annual data – do not pick up any ripple effects of that type. A conclusive analysis would require the comparison of the time-series features of individual property valuations in Central London with other markets, and more detailed splits of the stock, beyond the scope of this study.

3.7 Summary

The section has demonstrated the range of options available to those seeking to desmooth UK property indices. These cover the choice of desmoothing techniques, the use of returns measured at annual, quarterly and monthly frequencies, and the various runs of history which may be taken as representing long-term property returns. For each combination of index frequency and time period, the final level choice is the value of desmoothing coefficients, which may be based on target values for the serial correlation remaining in the desmoothed results, or other characteristics of the desmoothed returns.

Taken in combination, these options form a large matrix of results and potential conclusions on desmoothing and adjusted property risk. Our analysis has aimed to select the most robust methods, and results which are most consistent across index frequencies, runs of history, and choice of calibration strategy.

On the choice of methods, our general conclusions run in favour of simplicity:

- The more elaborate desmoothing methods (which use multiple lags, desmoothing coefficients varying with market states, or impose a relationship with equity volatility) are the most unstable, tending to produce extreme results and the least consistency over varying time periods and methods of calibration.
- The more elaborate methods also demand more additional assumptions and judgemental inputs which have to be overlaid on the underlying characteristics of the index series.
- The Lag 1 desmoothing method therefore offers the best combination of simplicity and consistency in results across the choices of index frequency and time period.

In principle, the choice of historic time period would favour the longest available history, to measure the fundamental characteristics across the largest set of economic conditions, and cycles with varying individual characteristics. In the case of UK property:

- The longest continuous history – covering the post-war period – shows a distinct break-point in the character of serial correlation which coincides with the switch from Scott's historic series to the IPD Long Term Index in 1971.
- There are several factors which may account for the different behaviour of the pre-1971 series – a much smaller sample, pricing based on very long leases, a market with a more limited set of investors and lower liquidity. On any or all counts, it may be taken as unrepresentative of current market conditions, better captured by the period from 1971 onward.

- More recent periods – say from 1981 onward – produce results dominated by the major cycle late-1980s to early-1990s cycle, which raises observed smoothing in the Index over that seen in longer histories. If such extreme and protracted cycles are likely to occur at a lower frequency than once every 25 years – which is largely a matter of judgement – estimates of adjusted property risk based on this period may be overstated.

Although alternative choices of method, time period and desmoothing strategies produce a range of results, there is a central tendency toward estimates of adjusted risk which, in terms of standard deviation, fall in the range 13% to 15% per year, or 1.3 to 1.5 times the standard deviation seen in the original Index. These results form our preferred estimates of the range in adjusted property risk.

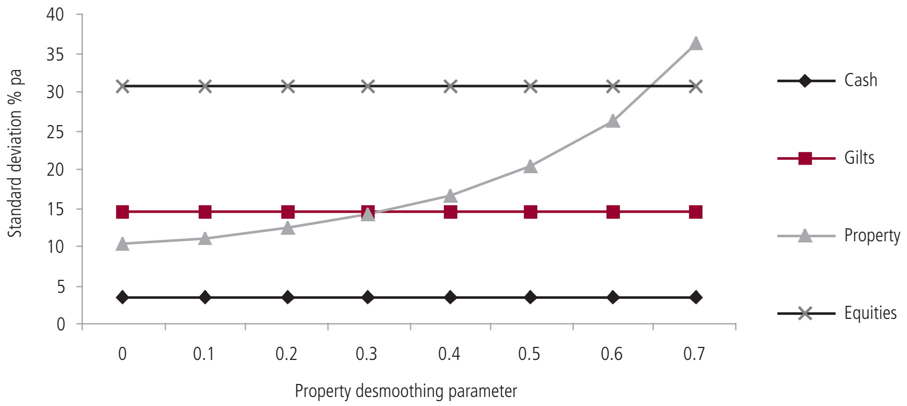
The last section looked at volatility and smoothing of property indices in isolation. From that perspective, smoothing in property returns might be taken as a feature of marginal interest. As we have discussed, there is generally weak statistical evidence that smoothing exists in annual returns, and there is no conclusive method for arriving at a robust estimate of desmoothed volatility. It is only when historic property returns and risks are used as the basis for estimates of future performance and applied in asset allocation modelling that smoothing issues become more critical.

This section therefore tests how sensitive property's place in a mixed-asset portfolio is to the choice of desmoothing methods and parameters. We first take a general look at the impact of desmoothing property returns on the key relationships – relative risk, and correlations – between property and competing asset classes. Those relationships are then used to construct optimised multi-asset portfolios using standard Mean Variance Portfolio Theory (MVPT), and Asset Liability Matching (ALM) models.

4.1 Desmoothing and other assets

A primary purpose of desmoothing returns is to place property risk in a relationship with other assets which is more compatible with financial theory, and more comfortable when used in asset allocation modelling, than the observed Index figures. That implies an acceptable estimate of risk on which property, broadly speaking, sits between equities and gilts to reflect an inherent risk in property income streams and values that is higher than gilts but less than equities, plus a property premium for added illiquidity and costs over gilts.

Figure 20: Standard deviation in asset returns 1971 to 2005



As a by-product of increasing the volatility of property, we also expect desmoothing to change its correlation with other asset classes. Since low apparent correlations with other assets are partly due to the lack of movement in the unadjusted property Index, any additional variation is more likely to pick up an increased correlation with other assets than the reverse.

Figure 20 shows estimates of property standard deviation over the period 1971 to 2005 varying with an increasing Lag 1 desmoothing parameter, plotted against standard deviations for equities, gilts and cash (the latter approximated by T-Bill returns). Standard deviation is a rising function of the desmoothing parameter, rising to very high levels at values of the latter over 0.7. To set the broadest reasonable range, values of the desmoothing parameter between 0.32 and 0.62 produce an adjusted property standard deviation somewhere between gilts (14.5%) and equities (30.7%) over the same period.

The volatility of listed property company returns may offer a further useful benchmark for the plausibility of desmoothed estimate of the volatility of direct property, if it is believed that the stock market is a more efficient processor of market evidence than valuations (Barkham and Geltner, 1995). To provide a like-for-like comparison with the unleveraged IPD returns, the observed volatility of returns on listed property companies has to be adjusted for their use of leverage. We have taken estimates of property company returns from 1980 to 2004, adjusted for leverage at the weighted average cost of capital, from Booth and Marcato (2004). These show a standard deviation in unleveraged property company returns of 15.1%, against the standard deviation in leveraged returns of 25%. The unleveraged figure falls close to the 13% to 15% range in our preferred estimates of standard deviation in the IPD Annual Index. It is equivalent to setting a Lag 1 desmoothing coefficient over the period 1981 to 2005 of 0.5, slightly above the neutral desmoothing coefficient of 0.42 and its associated standard deviation of 13.2%.

As an additional benchmark for estimated property risk, IPD have kindly given us access to work in progress on a transactions based index, applying a method of Geltner and Goetzmann (2000) on US data to the UK. The technique estimates true transactions prices by a repeat sales method, identifying all buildings recorded by IPD which have been transacted at least twice between 1985 and 2004. Though this remains work in progress, a provisional estimate of standard deviation from that analysis is 12.5% per year, compared with a standard deviation of 9.2% in the IPD Annual Index over the same period. The transactions-based standard deviation, and its ratio to the Index standard deviation of 1.35, is a good match with results produced by a Lag 1 method and neutral desmoothing strategy.

Figure 21: Correlation between property and other assets 1971 to 2005

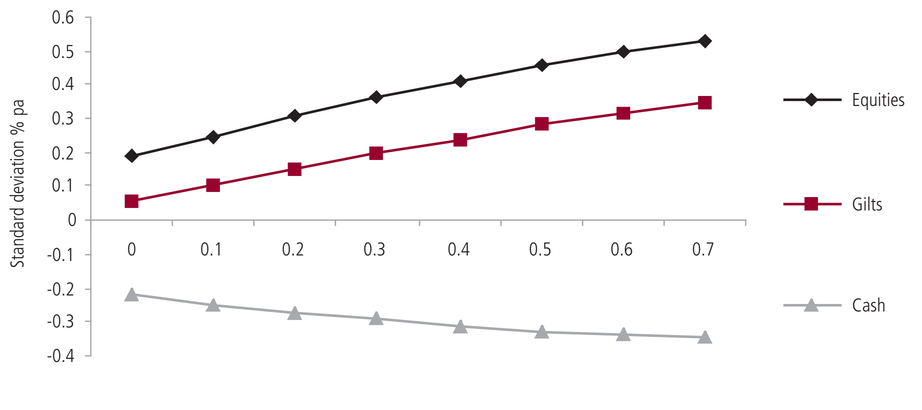


Figure 22: Standard deviation in asset returns 1981 to 2005

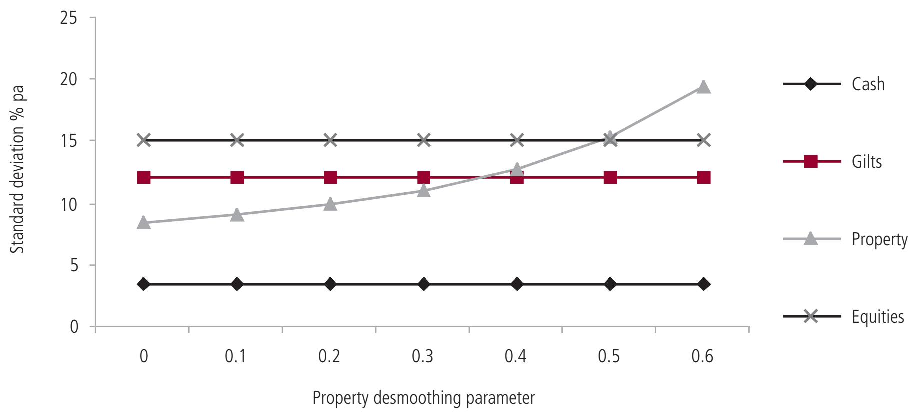


Figure 23: **Correlation between property and other assets 1981 to 2005**

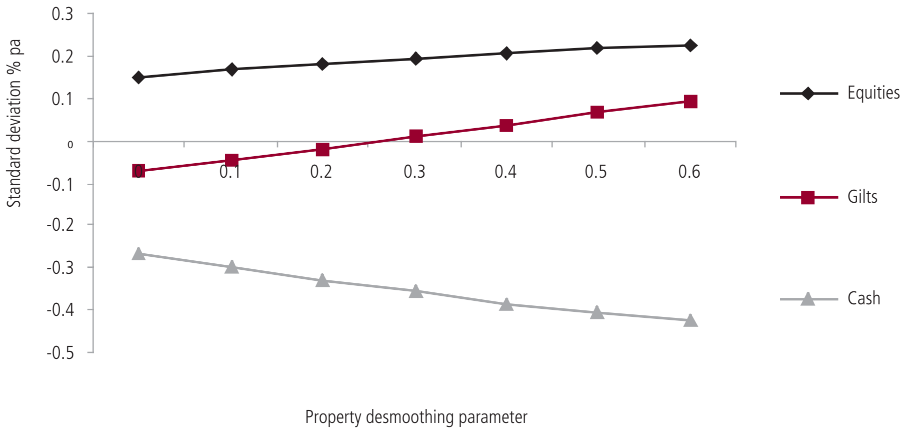


Figure 21 plots the changes in correlations with other asset classes as the desmoothing parameter and standard deviation are increased. Correlations between property and equities and property and gilts increase as desmoothing is introduced, but both tend towards maxima, at 0.6 for equities and 0.42 for gilts. The correlation with cash, by contrast, decreases with increased desmoothing, tending toward a minimum of -0.35. For values of property standard deviation which sit between equities and bonds, the property correlation with equities sits between 0.37 and 0.51 compared to the 0.19 shown by Index figures. The correlation with gilts is between 0.20 and 0.34 against the observed 0.05, and that with cash is between -0.30 and -0.34 against the observed -0.22.

Figures 22 and 23 repeat the exercise for the period 1981 to 2005. The gap in standard deviation between gilts and equities is extremely compressed, and probably unusually compressed because this period includes high gilts volatility induced by the major swing from high to low inflation rates. But the values of property desmoothing parameter which result in a standard deviation between the other assets are, at 0.3 to 0.5, of the same order as found over the longer period. At those levels of desmoothing, the correlation between property and other assets is increased for equities and bonds, although by much smaller amounts than over the period 1971 to 2005, and again decreased for cash.

Setting desmoothed results against other assets, and against estimates of standard deviation produced from listed stocks and a transactions based index, provides additional support for the preferred degrees of desmoothing suggested in the last section. On all these comparisons, desmoothing which raises property standard deviation to 13% to 15%, or by a factor of 1.3 to 1.5 over Index standard deviation, is enough to lift property into its expected position between equities and bonds.

4.2 Desmoothing and property weight: MVPT

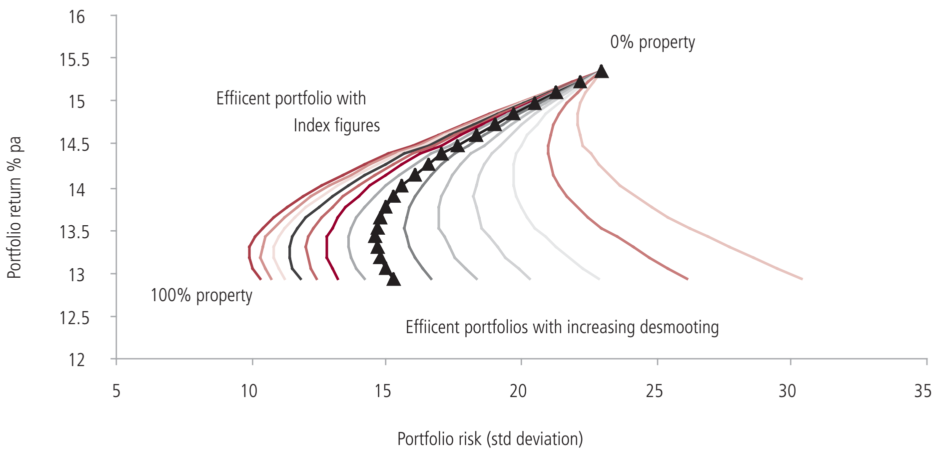
A primary purpose of apply desmoothing methods is to arrive at indicated weights for property in optimised portfolios which are a better fit with financial theory and investor behaviour. In the academic literature a large number of studies, based on data for the UK and other countries, suggest that desmoothing does produce a reduction in property weights in the optimal portfolio, as we would expect from the relative risk and correlation impacts illustrated in the last section. Although property weightings are significantly reduced, however, the general conclusion of UK studies is that the indicated weight still lies in the range 10% to 25%, well above the average exposure of institutional investors which remains around 7% (Lee, 2003).

Academic studies on the topic typically use specific estimates of desmoothed volatility and relate to single time periods. Here, to provide a more general view, we have tested the impacts on indicated weightings across the plausible range of desmoothing assumptions, and over different time periods for the calibration of historic optimised portfolios.

The optimisation tools employed have been developed in Excel. Returns on a mixed asset portfolio with varying weights are calculated as the weighted average of their components. Portfolio risk is calculated from a matrix of weights and co-variances between all pairs of assets. Excel Solver functions are used to generate combinations of weights which meet specified targets, such as minimum risk (standard deviation) for a specified return, or the maximum Sharpe ratio for all attainable portfolios with minimum risk for a specified return.

Figure 24 provides the most basic illustration of the impact of property desmoothing on indicated weightings, based on historic results for 1971 to 2005. It plots efficient frontiers (all attainable rates of portfolio return with minimum risk) for portfolios which are made up of equities:gilts:cash in the fixed relative weights 60%:35%:5%,and with a variable property weight from 0% to 100%. The frontier at the top right is generated with the original Index data for property returns and risks. Successive frontiers moving anticlockwise have been generated using property returns desmoothed by the Lag 1 method with desmoothing coefficients rising from 0.05 (ie very little increase in property volatility) in steps of 0.05 up to a value of 0.65 (ie very strong desmoothing which increases property standard deviation to 30% in line with equities over the same period). With each level of desmoothing, the mean property return is held constant at the Index value, but property's standard deviation and correlations with other assets are allowed to vary as described in the last section.

Figure 24: Efficient frontier with varying desmoothing 1971 to 2005



Source: own calculations from IPD, Barclays Capital Equity Gilt Study

The top right frontier shows a fairly flat profile. Adding property to a mixed asset portfolio results in a small reduction in returns, since over this period the mean property return of 12.9% per year was below the mean return on a fixed-weight mixed asset portfolio of 15.3%. Adding property to the portfolio yields a much larger reduction in risk, because property standard deviation measured by the Index (10.3%) was less than half that of the mixed asset portfolio (23.0%), and also because of the weak correlations between property and other assets.

Table 14: Desmoothing and the property weight 1971 to 2005

Desmoothing coefficient	Property standard deviation	Property weight %	Portfolio return	Portfolio risk	Sharpe ratio
0.00	10.3	0.80	13.4	10.1	0.43
0.05	10.7	0.75	13.5	10.8	0.41
0.10	11.2	0.75	13.5	11.2	0.40
0.15	11.8	0.75	13.5	11.7	0.38
0.20	12.4	0.70	13.7	12.6	0.36
0.25	13.2	0.65	13.8	13.5	0.35
0.30	14.2	0.60	13.9	14.5	0.33
0.35	15.3	0.55	14.0	15.6	0.32
0.40	16.6	0.50	14.1	16.7	0.30
0.45	18.3	0.40	14.4	18.2	0.29
0.50	20.3	0.30	14.6	19.6	0.28
0.55	22.9	0.15	15.0	21.4	0.3
0.60	26.1	0.05	15.2	22.5	0.27
0.65	30.4	0.00	15.3	23.0	0.27

Source: own calculations from IPD, Barclays Capital Equity Gilt Study

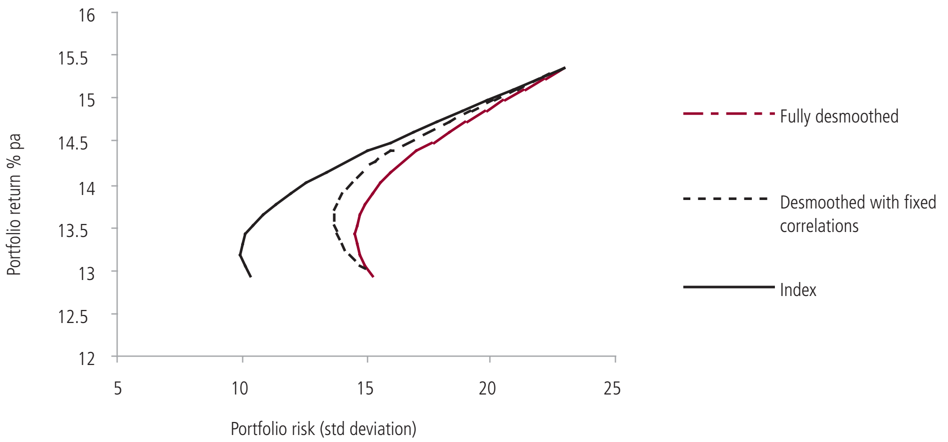
Desmoothing property returns decreases the risk reduction and diversification benefits. Because standard deviation is a rising function of the desmoothing coefficient, the shift in the efficient frontier accelerates with equal incremental steps in the desmoothing coefficient. As Figure 24 indicates, the efficient frontiers hold their flat profile, suggesting large benefits from adding property, up to high levels of desmoothing. Using property returns desmoothed to a standard deviation 1.5 times that shown by the Index – the central case from Section 3.5 – produces the efficient frontier indicated by the triangle markers in Figure 24.

The optimum position on the efficient frontier for a fully diversified investor is the portfolio which produces the maximum Sharpe ratio – the excess return over T-Bills divided by the portfolio standard deviation. Table 14 gives, for each level of desmoothing, the property weighting (to the nearest 5%) in the portfolio with the maximum Sharpe ratio.

The optimal property weight generated by the original Index figures is no less than 80%. At a central case level of desmoothing – property volatility increased by a factor of 1.5 over that shown by the Index, which also leaves zero serial correlation in the desmoothed results – the indicated property weight is heavily reduced but still stands at 55%. Property weights fall below 15% only on very extreme desmoothing assumptions, which push property standard deviation close to equities and induce substantial negative serial correlation in the desmoothed results.

Shifts in the efficient frontier induced by desmoothing are the joint product of increased volatility and increased correlation with equities and gilts. To demonstrate the impacts of those two factors separately, Figure 25 compares the efficient frontier produced by the Index figures with two desmoothed frontiers. The 'fully desmoothed' version shows results from a desmoothing parameter which increases property standard deviation by a factor of 1.5, with the corresponding changes in correlations between property and other assets. The 'de-smoothed with fixed correlations' is based on the same change in property standard deviation, but holds correlations with other assets unchanged from those shown by the Index figures.

Figure 25: Efficient frontier – impact of standard deviation and correlation



Source: own calculations from IPD, Barclays Capital Equity Gilt Study

The relative size of the impacts varies with the property weight. At low weights (the top right of the frontier), most of the inward shift in the frontier is attributable to the induced increase in property correlation with equities and bonds. As weightings are raised, the impact of increased property standard deviation becomes relatively more important. At a 55% property weight, which produces the maximum Sharpe ratio for both fully and partially desmoothed results, 60% of the shift in the frontier is produced by the increase in standard deviation, and 40% by the increase in property correlation with equities and bonds.

Table 15: Desmoothing and property weights 1951 to 2005, 1971 to 2005 and 1981 to 2005

	Desmoothing coefficient	Property standard deviation	Property weight %	Portfolio return	Portfolio risk	Sharpe ratio
1951-2005						
Index	0.00	9.4	0.80	11.5	9.3	0.43
Neutral desmoothing	0.31	13.0	0.60	11.9	13.3	0.34
Extreme desmoothing	0.54	20.0	0.20	12.8	18.6	0.29
1971-2005						
Index	0.00	10.3	0.75	13.5	10.4	0.43
Neutral desmoothing	0.28	13.8	0.65	13.8	13.9	0.34
Extreme desmoothing	0.49	20.0	0.30	14.6	19.5	0.28
1981-2005						
Index	0.00	8.4	0.50	12.4	7.5	0.51
Neutral desmoothing	0.42	13.2	0.20	13.1	10.2	0.45
Extreme desmoothing	0.61	20.0	0.05	13.5	11.4	0.43

Source: own calculations from IPD, Barclays Capital Equity Gilt Study

Based on the period 1971 to 2005, desmoothing therefore reduces the indicated property weighting, but still leaves very high weights on all but most extreme desmoothing assumptions. Choosing other time periods to calibrate the allocation model leads to the same general conclusion. Table 15 summarises results based on the two other long time periods available, from 1951 and from 1981. Table 16 shows the limiting cases, the degree of desmoothing required to cut the indicated property weight to 10% of total assets, or to zero.

Table 16: Limiting cases for desmoothing and property weight

	Desmoothing coefficient	Property standard deviation
1951-2005		
10% portfolio weight	0.58	18.4
0% portfolio weight	0.65	22.4
1971-2005		
10% portfolio weight	0.59	25.4
0% portfolio weight	0.61	26.9
1981-2005		
10% portfolio weight	0.57	21.6
0% portfolio weight	0.61	24.1

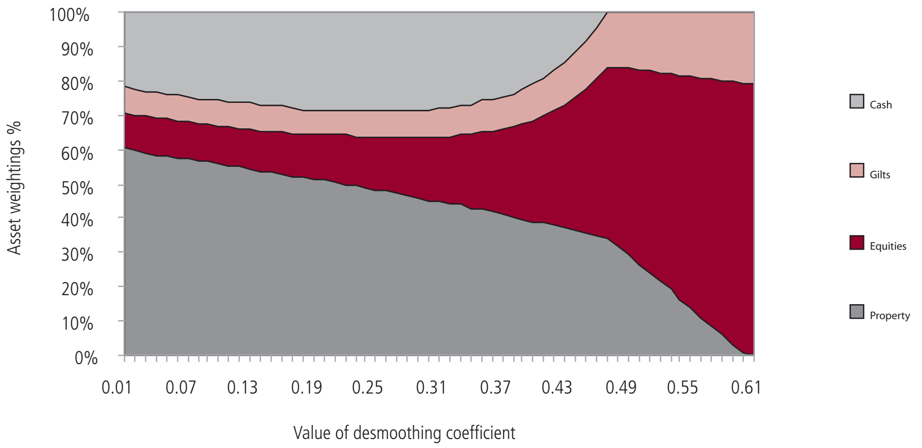
Source: own calculations from IPD, Barclays Capital Equity Gilt Study

For each period, the portfolio mix with the optimum Sharpe ratio has been calculated on the Index figures, with a neutral desmoothing setting the desmoothing coefficient at the Lag 1 serial correlation, and an extreme desmoothing set produce a property standard deviation at an arbitrarily high level of 20%. The indicated property weights are lower for the last time period, primarily due to relatively lower property returns against other assets than over the longer periods. Otherwise the results are broadly consistent, in that neutral desmoothing methods produce an increase in standard deviation of 1.3 to 1.6 times the Index figures and reduce serial correlation in desmoothed returns to low and statistically insignificant levels (0.05 for the two longer periods, 0.22 for 1981 to 2005).

In all three cases, neutral desmoothing cuts the indicated property weights but still leaves them at levels well above those actually held by institutional investors. For the earlier periods, even extreme desmoothing leaves indicated weights at 20% to 30%. It is only for the most recent period than an extreme desmoothing assumption cuts the property weight below 10%. In the lower ranges of indicated weights, property allocations are extremely sensitive to small changes in the desmoothing coefficient. A change in desmoothed standard deviation of two to four percentage points is enough to make the difference between an indicated property weight of 10% and an indicated weight of 0% (Table 16).

We have also tested the impact of desmoothing on property allocations in a more general case, where the weights on all assets are allowed to vary freely. Figure 26 gives a broad illustration of desmoothing impacts under these conditions, showing the weightings in portfolios with the maximum Sharpe ratio over the period 1971 to 2005 generated by varying values of the property desmoothing coefficient.

Figure 26: Asset weights 1971 to 2005 with varying property desmoothing



Source: own calculations from IPD, Barclays Capital Equity Gilt Study

With no desmoothing, the indicated weight of property in the Sharpe maximum portfolio, at 60%, remains very high, although rather lower than the 80% indicated in the fixed asset case. At low levels of desmoothing, increasing the property standard deviation cuts the property weight and shifts the allocation primarily into increased holdings of cash. At higher levels of desmoothing, as the desmoothed volatility approaches that of equities, equities increasingly act as the substitute for the falling property weight. At high levels of desmoothing, the property weight falls precipitately, in favour of equities and bonds.

The same exercise with freely variable weights has been repeated for the periods 1951 to 2005 and 1981 to 2005, yielding the results summarised in Table 17. For each period, asset weightings in a full set of efficient portfolios have been created using Index figures plus the neutral and extreme desmoothing assumptions. Figures 25 to 27 illustrate the full set of results for the period 1971 to 2005. Efficient portfolios are ranked from the maximum return and maximum risk asset mix on the left to the minimum risk asset mix on the right. Vertical lines indicate the maximum Sharpe ratio portfolios.

Table 17: **Property and desmoothing – indicated property weights**

	Index figures	Neutral desmoothing	Extreme desmoothing
Period: 1951-2005			
Desmoothing coefficient	0.00	0.31	0.54
Property std dev	9.4	13.0	20.0
Portfolio return:			
16.2	0.00	0.00	0.00
15.3	0.17	0.17	**0.17**
14.4	0.34	0.34	0.16
13.5	0.51	0.51	0.14
12.7	0.68	**0.58**	0.13
11.8	**0.77**	0.49	0.12
10.9	0.63	0.41	0.11
10.1	0.48	0.32	0.09
9.2	0.34	0.24	0.08
8.3	0.20	0.15	0.07
7.5	0.00	0.00	0.00
Period: 1971-2005			
Desmoothing coefficient	0.00	0.28	0.49
Property std dev	10.3	13.8	20.0
Portfolio return:			
17.5	0.00	0.00	0.00
16.6	0.18	0.18	0.18
15.8	0.37	0.37	0.33
14.9	0.55	0.55	**0.32**
14.1	0.74	0.66	0.29
13.3	0.74	0.57	0.25
12.4	**0.61**	**0.47**	0.22
11.6	0.47	0.38	0.19
10.8	0.34	0.28	0.16
9.9	0.20	0.19	0.12
9.1	0.00	0.00	0.00
Period: 1981-2005			
Desmoothing coefficient	0.00	0.42	0.61
Property std dev	8.4	13.2	20.0
Portfolio return:			
14.8	0.00	0.00	0.00
14.2	0.17	0.08	0.01
13.6	0.29	0.17	**0.07**
13.0	0.40	**0.23**	0.07
12.3	**0.49**	0.22	0.07
11.7	0.44	0.20	0.08
11.1	0.39	0.19	0.08
10.5	0.33	0.18	0.09
9.8	0.28	0.17	0.09
9.2	0.21	0.16	0.09
8.6	0.00	0.00	0.00

Source: own calculations from IPD, Barclays Capital Equity Gilt Study
Note: Bold figures are maximum sharpe ratio portfolios

Figure 27: Asset weights 1971 to 2005: Index figures

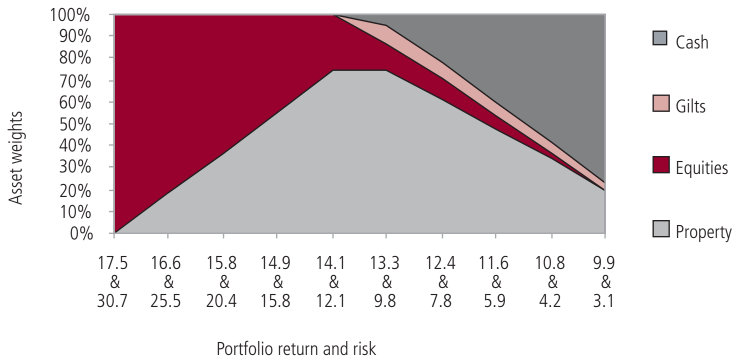


Figure 28: Asset weights 1971 to 2005: Moderate desmoothing

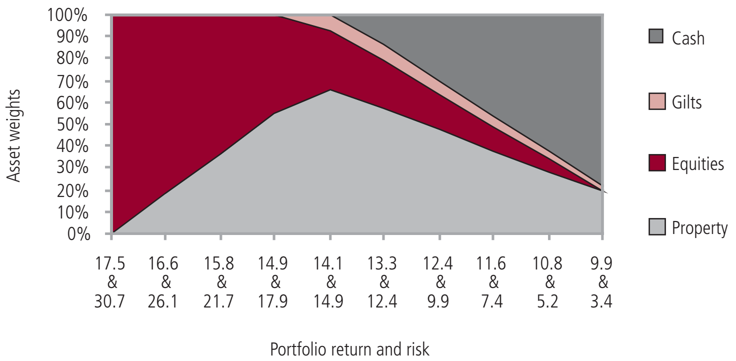
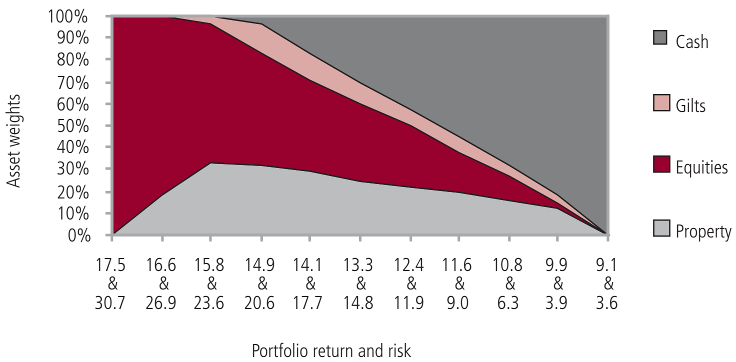


Figure 29: Asset weights 1971 to 2005: Extreme desmoothing



Source: Own calculations from Barclays Capital Equity/Gilt Study, IPD

For the two additional periods, the results are again fairly similar to those found in the equivalent versions using fixed weights for non-property assets. On neutral desmoothing assumptions, in all three periods property retains a minimum weighting of 15% in all but the highest risk and lowest return portfolios. Even on extreme desmoothing assumptions, the property weight falls below 10% only for the period 1981 to 2005, and the lowest risk portfolios over the period 1951 to 2005.

Allowing weights of other assets to vary, therefore, modifies but does not fundamentally change the strong case in favour of property. It is only on extreme desmoothing assumptions, and only over the most recent time period, that indicated property weights are pushed below 15%. In many cases they remain much higher than that.

Decreases in the property weighting induced by desmoothing are the joint product of the increase in standard deviation and changes in cross-correlations with other assets. The cross-correlation effects are not all in one direction: desmoothing increases property correlations with equities and bonds, but decreases the already low or negative correlation with cash. The separate contributions of increased volatility and changes in cross-correlations to shifts in indicated property weights have been tested by optimisations in which correlations are held fixed at those indicated by Index figures while allowing standard deviation to vary.

The results show splits between the volatility effect and the correlation effect on property weights which are highly variable across time periods, degrees of desmoothing and the mix of other assets in optimised portfolios. In cash-heavy portfolios at the low risk end of the spectrum, for example, the correlation impacts of desmoothing may actually be positive on the property weight, due to the reduced correlation with cash.

Generally, however, desmoothing induces falls in the property weighting predominantly through the increase in standard deviation, and relatively little through changes in correlations with other assets. On the neutral desmoothing cases shown in Table 17, changes in correlations induced by desmoothing never account for more than four percentage points of the total reduction in property weights which run in the range 18 to 25 percentage points. Correlation effects account for more than one-fifth of the total desmoothing impact only in very high risk portfolios.

More aggressive desmoothing assumptions increase the absolute change in portfolio weights attributable to correlation effects, and also slightly increases the share of total changes accounted for by correlation effects rather than volatility effects. But the general conclusion that changes in property weighting produced by desmoothing are predominantly due to increased standard deviation remains unchanged.

4.3 Desmoothing and property weights: ALM

Mean variance portfolio optimisation maximises the value of a portfolio of assets for a given risk. For investors with a well-defined set of liabilities, such as insurance and pension funds, the optimised asset portfolio may still carry a large risk of shortfall against liabilities which also change in value over time. Regulatory requirements which seek to minimise the risk of pension funding deficits, and the experience of high equities volatility through the late 1990s and early 2000s, have pushed asset allocators toward models which take into account the risk of a shortfall in asset values against liabilities rather than the simple volatility of the value of assets.

How liabilities are defined, and how their value varies over time, are different for each investor, varying for example with the maturity of pension schemes. This section gives two broad general examples of liability matching to examine the impacts of desmoothing on portfolios constructed under an ALM framework.

In the first case, liabilities are represented by a very general investor objective, to maintain the purchasing power of scheme beneficiaries in line with that of the general population, taken as per capita National Income (PCNI). In the second case, liabilities are represented by a portfolio of index-linked gilts. This is based on the proposition that any defined stream of future payments in real terms could be funded by a riskless portfolio of index-linked gilts with the same durations as the stream of liabilities. An index-linked gilts (ILG) portfolio therefore represents the benchmark against which investments in assets which carry some risk of not matching liabilities should be assessed. For both cases, the analysis has been limited to the years from 1982 onward because UK Index Linked Gilts were not issued before that date.

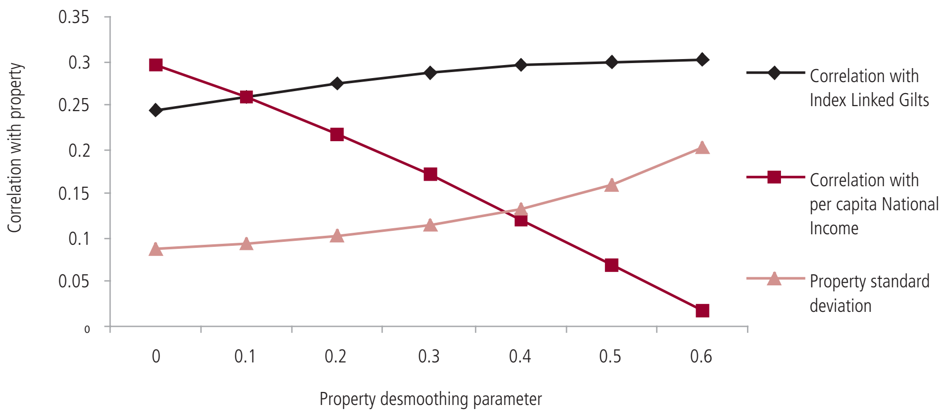
Portfolios optimised in an ALM framework will be those which minimise the risk of a difference between the value of assets and the value of liabilities. Compared to MVPT, therefore, ALM will tend to favour assets which show a high correlation with liabilities, so that periods of weak performance from assets will be offset by similar movements in the value of liabilities. On Index figures, property shows a lower correlation with ILGs than either equities or conventional gilts (Table 18). Against PCNI, property has the second highest correlation after cash. Desmoothing property slightly increases the correlation with ILGs, to no more than 0.30 even on extreme desmoothing assumptions (Figure 30). Desmoothing does, however, rapidly decrease the correlation with PCNI.

Table 18: Asset correlations with liability indicators 1983 to 2005

	Correlation with Index Linked Gilts	Correlation with per capita National Incomes
Property	0.25	0.30
Equities	0.39	0.06
Gilts	0.71	0.06
Cash	0.05	0.62

Source: Barclays Capital Equity / Gilt Study, IPD, ONS

Figure 30: Impact of desmoothing on property correlations with liability indicators



Source: Barclays Capital Equity / Gilt Study, IPD, ONS

For the two ways in which liabilities may be defined (a PCNI target or an ILG target), we have defined two types of investor objective. The first objective, representing the most risk averse investors, simply minimises the risk of a shortfall in assets against liabilities, as measured by the standard deviation in the surplus of assets over liabilities. The second objective represents a more typical investor with a moderate tolerance for risk. Risk tolerance is defined by a utility function of the form:

Maximum utility = Average surplus – risk aversion x standard deviation of surplus

The utility function represents an investor aiming to maximise returns over liabilities as indicated by the average surplus, subject to an aversion to risk indicated by a risk aversion coefficient. We have taken the risk aversion coefficient to be 0.5, representing the typical institutional investor.

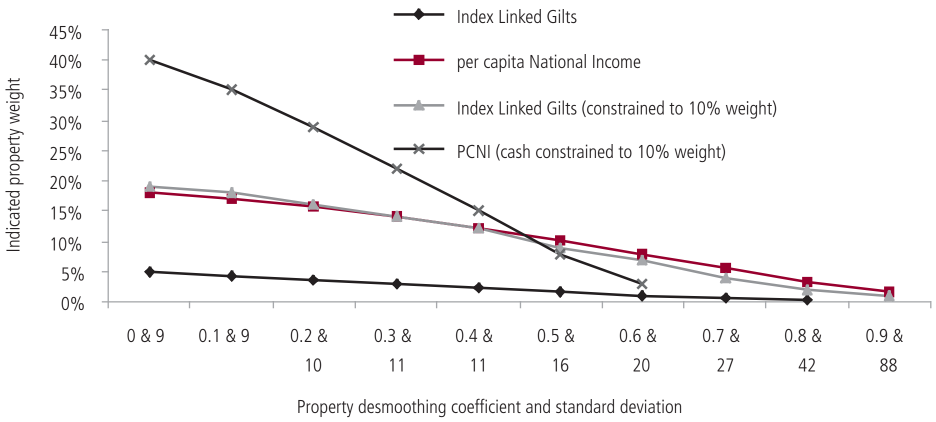
For this matrix of two liability targets (PCNI or ILG) and degrees of risk tolerance (low or average), optimised ALM portfolios have been created using Excel Solver to find portfolio weights which minimise the standard deviation between the value of asset portfolios and the two types of liability target for the low risk investor, or maximise utility assuming a risk aversion of 0.5 for the average investor. Asset portfolios are constructed from a mix of property, equities, gilts, cash and index linked gilts.

Under ALM, the portfolios of extremely risk averse investors will be dominated by assets with low risk and a high correlation with their liabilities. If liabilities are defined by PCNI, cash is therefore the predominant asset in the portfolio with a weighting of 80%, due to its low risk and high correlation (0.62) with liabilities. Property is the only other asset which finds a place in the minimum risk portfolio, due to its low correlation with cash (-0.30) and a higher correlation with PCNI liabilities (0.30) than other assets. On Index figures, with no desmoothing, property commands an 18% weight in the minimum risk portfolio. Since desmoothing increases the property risk while decreasing its correlations with both cash and PCNI liabilities, progressively increasing the degree of property desmoothing results in gentle decline in the indicated property weight. At our preferred degree of desmoothing, raising standard deviation by a factor of 1.5 to 13%, the indicated property weight falls to 12%. Even at extreme desmoothing, setting property standard deviation at 20%, property still holds an 8% weighting alongside cash. Figure 31 plots the change in property weight with varying desmoothing.

In the case of an investor defining liabilities by Index Linked Gilts and seeking minimum risk, the optimum portfolio consists almost exclusively of ILGs themselves – a 90% weight – due to their exact correlation with liabilities. Other assets would be held in very low weightings, achieving a small reduction in the risk of a shortfall in the surplus produced by their lack of correlation with ILG returns. On Index figures, smoothed property would hold a 5% weighting, falling with increased desmoothing (Figure 31).

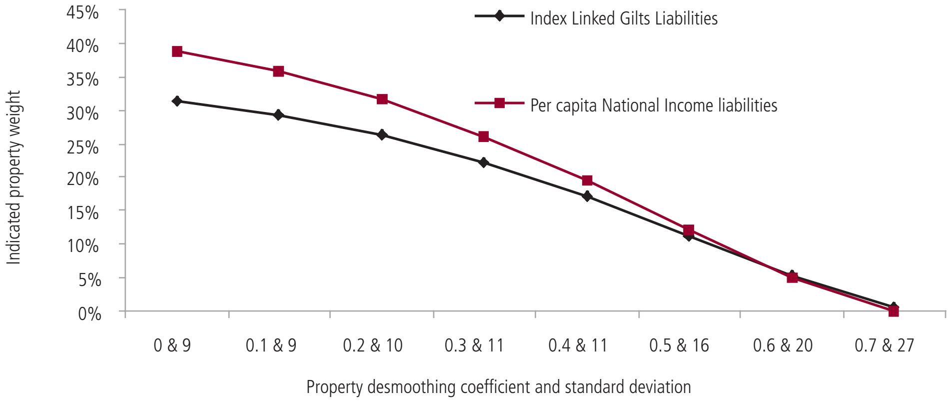
It is unlikely that even the most risk averse investors would hold the extremely high weightings of cash or ILG indicated by these simulations. The implications for property weightings of more broadly spread low risk portfolios have been explored by constraining the holdings of cash to 10% in the PCNI liability case, and of ILG to 10% in the ILG liability case. For PCNI liabilities, a constraint on cash holdings shifts the portfolio toward other low risk assets – property, ILG and gilts. On Index figures, the indicated property weight would be 40%, falling with increased desmoothing to 15% on our preferred estimate of property risk and disappearing from the portfolio at the extreme desmoothing level of 20% property risk. If liabilities are defined by ILG with a 10% constraint on ILG weights, the indicated property weight runs from 19% with no desmoothing to a 12% weight at our preferred estimate of 13% property risk.

Figure 31: Desmoothing and property weights in low risk ALM portfolios



Source: own calculations from IPD, Barclays Capital Equity Gilt Study, ONS

Figure 32: Desmoothing and property weights in medium risk ALM portfolios



Source: own calculations from IPD, Barclays Capital Equity Gilt Study, ONS

Turning to investors with a more typical risk tolerance, the indicated property weight and its sensitivity to varying degrees of desmoothing has been tested for portfolios defined by PCNI or by ILG and with a risk aversion coefficient of 0.5. The indicated property weights are plotted in Figure 32. The introduction of some risk tolerance naturally shifts portfolios toward equities, which hold a weighting of around 50%. With no desmoothing, property secures a high weighting of 31% in an ALM portfolio where liabilities are defined by ILG and 39% where liabilities are defined by PCNI. Weightings remain high but rather below the 48% allocation to property in a Sharpe-optimised portfolio produced by MVPT over the same period. Our preferred level of desmoothing, setting property risk at 13%, still maintains high property weightings at 20% in the PCNI case, and 17% in the ILG case. Pushing desmoothing to an extreme level, setting property standard deviation of 20%, cuts property weightings close to 5% in both cases. There is a steeper fall-off in the weightings when liabilities are defined by PCNI due to the reduction in correlation between PCNI and property at higher levels of desmoothing. Again, the results are similar to those found using MVPT, in that the limiting case at which property disappears from the portfolio is at the extreme desmoothing setting property standard deviation at 20%.

Table 19: Property desmoothing and weights ALM portfolios 1983 to 2005

	Index - no desmoothing	Preferred desmoothing	Extreme desmoothing
Desmoothing coefficient	0.0	0.4	0.6
Property std deviation	8.7	13.0	20.0
Case 1: Liabilities defined by PCNI, minimum risk and no constraints			
Funding surplus			
Mean growth % pa	3.4	3.3	3.1
Std deviation %	1.6	1.6	1.8
Asset weights %			
Property	18	12	8
Equities	0	0	0
Gilts	0	0	0
Cash	82	88	92
Index Linked Gilts	0	0	0
Case 2: Liabilities defined by ILG, minimum risk and no constraints			
Funding surplus			
Mean growth % pa	0.5	0.3	0.2
Std deviation %	1.0	1.0	1.1
Asset weights %			
Property	5	2	1
Equities	1	1	1
Gilts	3	2	1
Cash	2	3	3
Index Linked Gilts	89	92	94
Case 3: Liabilities defined by PCNI, minimum risk, 10% maximum cash weight			
Funding surplus			
Mean growth % pa	4.4	2.7	2.2
Std deviation %	5.3	6.3	6.5
Asset weights %			
Property	40	15	3
Equities	2	3	5
Gilts	20	8	7
Cash	10	10	10
Index Linked Gilts	29	63	75
Case 4: Liabilities defined by ILG, minimum risk, 10% maximum ILG weight			
Funding surplus			
Mean growth % pa	4.3	4.0	3.9
Std deviation %	2.9	3.1	3.2
Asset weights %			
Property	19	12	7
Equities	5	5	5
Gilts	32	29	29
Cash	34	44	49
Index Linked Gilts	10	10	10

	Index - no desmoothing	Preferred desmoothing	Extreme desmoothing
Desmoothing coefficient	0.0	0.4	0.6
Property std deviation	8.7	13.0	20.0

Case 5: Liabilities defined by PCNI, moderate risk tolerance

Funding surplus			
Mean growth % pa	9.2	9.8	10.0
Std deviation %	9.4	11.3	12.1
Asset weights %			
Property	39	20	5
Equities	55	68	74
Gilts	6	13	21
Cash	0	0	0
Index Linked Gilts	0	0	0

Case 6: Liabilities defined by ILG, moderate risk tolerance

Funding surplus			
Mean growth % pa	8.6	9.2	9.5
Std deviation %	7.5	9.2	10.0
Asset weights %			
Property	31	17	5
Equities	47	57	64
Gilts	22	26	31
Cash	0	0	0
Index Linked Gilts	0	0	0

Source: own calculations from IPD, Barclays Capital Equity Gilt Study, ONS

Table 19 gives summary statistics for six types of ALM portfolio generated by three levels of property desmoothing: the Index figures, our preferred level of desmoothing which raises standard deviation by a factor of 1.5 from 8.7% to 13.3%, and extreme desmoothing which sets standard deviation at 20%.

For the minimum risk cases (Cases 1 to 4), portfolios are naturally dominated by the lowest risk assets with the highest correlation to liabilities – cash when liabilities are defined by PCNI, ILG when liabilities are defined by ILG. In both cases, however, property commands the second highest weight in unconstrained portfolios. When holdings of cash or ILG are constrained, the property weight is increased, alongside fixed income investments. Desmoothing property reduces the property weighting, with a corresponding rise in holdings of cash or ILG. For investors with moderate risk tolerance (Cases 5 and 6), equities are the dominant asset class. With no desmoothing, property is the second highest weighted asset. As desmoothing reduces the property weight, the exposure to both gilts and equities increases.

Within the ALM framework, therefore, when smoothed Index returns are used, property commands a substantial allocation – from 18% to 40% – in all forms of portfolio tested, except the extreme case of a minimum risk portfolio with liabilities defined by ILG. For all other cases, with desmoothing set at the preferred desmoothing factor of 1.5, the indicated property weight across different types of portfolio falls in a fairly narrow range from 12% to 20%. And in all forms of ALM portfolio, the property weight is pushed to minimal levels – 8% or less – only with extreme desmoothing of returns to a standard deviation of 20%.

These ALM results put indicated property weights in optimised portfolios some way below the results from the MVPT modelling in the preceding section, which put the property weight in maximum Sharpe portfolios (for the period 1981 to 2005) at 49% on smoothed Index figures, 23% with moderate desmoothing, and 7% with extreme desmoothing. The MVPT and ALM approaches are, however, consistent in suggesting high property weights are maintained in portfolios constructed on different models with moderate desmoothing factors of around 1.5 times the Index standard deviation, and that property weights drop below 10% only on extreme desmoothing assumptions which double the observed standard deviation.

4.4 Summary

This section has set the central estimates of adjusted property risk produced in Section 3 against the performance of other assets. It has tested effect of desmoothing returns on the property portfolio weight indicated by Mean Variance Portfolio Theory and by Asset Liability Matching methods.

The comparison with other assets shows that:

- Desmoothing which increases the standard deviation of property into our central range of 13% to 15% moves property closer to its expected relationship with other assets, setting property risk close to or slightly above gilts over the last 35 and 25 years.
- These adjustments, however, leave the Sharpe ratio on property close to or slightly below that on equities over periods longer than 25 years, without the added premium for property illiquidity and costs expected from fundamental pricing theory.
- Desmoothing also dilutes some of the diversification benefits of property against other assets, increasing its correlation with gilts and equities, but decreasing its correlation with cash.
- Even at extreme levels of desmoothing, however, property's correlations with gilts and equities tend toward an upper limit, so substantial diversification benefits are retained.

Desmoothing increases property risk and reduces diversification benefits against gilts and equities, therefore reducing the weighting to property indicated by Mean Variance Portfolio optimisations. The impacts on property weightings in a portfolio otherwise made up of UK gilts, equities and cash have been tested over historic periods from 25 to 55 years.

- Overall, it is clear that desmoothing modifies the case for property in a mixed-asset portfolio, but falls a long way short of destroying that case.
- Over runs of history tested, the property weight in optimal portfolios falls much below 10% only if extreme desmoothing assumptions – more than doubling property standard deviation – are applied over the last 25 years.
- Applying desmoothing assumptions in our preferred range, the indicated property weighting sits between a minimum of 8% and a maximum of 60% across portfolios optimised for a wide spread of returns and risks.
- The property weights in the portfolios providing the maximum Sharpe ratio run from 23% over the last 25 years up to 58% over the last 55 years. Though these weightings are 15% to 20% below those indicated if original Index figures are used, they remain far above the weights actually held by investors over any of those periods.

Parallel tests using a several forms of asset liability matching (ALM) model – which minimises the risk of a shortfall against liabilities – have been run for the period from 1982 onward. The results are similar to those from the mean variance exercises.

- Indicated property weightings in the optimal portfolio again fall below 10% only when extreme desmoothing assumptions are applied, raising standard deviation to more than double that observed in the Index.
- Apart from the most extreme risk-averse portfolios, applying desmoothing assumptions in our preferred range indicates an optimal property weighting in the range 12% to 20% with varying forms of liability definition and levels of risk tolerance.

On these results, desmoothing returns is a partial rather than a complete solution to the property asset allocation problem. It reduces indicated property weightings from the highly implausible levels produced by unadjusted Index figures, but leaves them still uncomfortably in excess of the average exposure of institutional investors. These average weightings reflect, however, the lower liquidity and higher costs of investment in property than in other assets. It is notable that the larger insurance and pension funds more able to carry those disadvantages have been more likely to hold property weightings over 10% through the last decade.

5. SURVEY OF INDUSTRY ATTITUDES AND PRACTICE

The survey element of the study was designed to cast more light on the perceptions of index smoothing issues by leading property analysts or asset allocation specialists, the desmoothing methods and assumptions they use, and their implications for recommended property weightings.

The survey was limited to larger, prominent property fund managers (eight interviews), advisors on asset allocation working in investment houses or as consultants (three interviews) and general property market forecasters and advisors (two interviews). All businesses interviewed devote substantial resources to research. The responses therefore intentionally capture best practice as represented by leading businesses and not a span or average across the whole of the industry. Within each firm, interviews were conducted with the senior researchers, strategists, managers or consultants best placed to comment on both the technical work on property performance and how property is presented to their in-house or third-party investment clients. Appendix B gives a full list of respondents. Collectively, the fund managers and asset allocators interviewed manage funds or advise clients with UK property investments of £85 billion.

Interviews were conducted face to face using a questionnaire with a mix of structured and open-ended questions. The analysis of responses in this follows the format of the questionnaire, taking first general attitudes toward index smoothing, then examining the use of desmoothing techniques and finally the results of using desmoothed property results in asset allocation modelling.

5.1 Attitudes to property index smoothing

All respondents were clearly well aware of index smoothing as an issue for property. When asked a broad question on what they took property smoothing to mean, most unprompted responses centred on the valuation base of property indices. The emphasis varied between a process view of 'failure to move values fully in line with market movements' and outcomes such as 'understatement of volatility and mis-statement of correlations with other asset classes'. For all respondents, inertia in individual property valuations is taken as the primary cause of index smoothing, with the infrequency of valuations also being cited by some. None of the respondents volunteered the view that smoothing is generated by the process of index construction, indeed many seemed to be unfamiliar with the concept.

A first set of questions, with responses summarised in Table 20, elicited general views on the smoothing debate. Overall the consensus was that true property risk is an important and unresolved issue for the industry, though on balance not a burning or critical problem. Those who did not agree or had no strong views, on the contention that the property industry has not paid enough attention to the question, noted that investors and their advisors are now generally well aware that index results understate property risk. Only two felt that lack of clarity on property risk – especially for new private investors rather than established institutional investors – left the industry open to the accusation of misrepresentation.

Table 20: Attitudes to property index smoothing issues

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total
The property industry has **not** paid enough attention to index smoothing	0	2	3	7	1	13
The property industry should have a consensus view on property risk	0	6	1	5	1	13
My business has investigated the smoothing issue thoroughly	1	1	0	9	2	13
Our view is that historic figures on property risk should always be adjusted	0	0	3	9	1	13

Opinions were most widely spread on the value of a consensus estimate of true property risk. Some of the arguments against this contention were technical, that there is no one definitive answer on true property risk and that it remains an area of legitimate technical debate. Others felt that in many cases, notably for investors in unitised vehicles which trade off prices based on valuations, the true risk is not an issue.

Most respondents – perhaps naturally – felt their own business had investigated smoothing thoroughly. Only two had done no research of their own on the subject. For the rest, the answer was often qualified with the observation that they had not done a lot of work on desmoothing, or arrived at a wholly satisfactory answer, but additional analysis would not produce a better answer.

On the question of whether statements on historic property risk should always qualify or adjust index figures, there was a strong supporting majority – though with the frequent qualification that historic risk should be no more than a guide to anticipated risk. Responses in the 'Neither agree nor disagree' category were based on the view that for some applications and types of investor – again those in unitised funds – such qualifications were not necessary.

5.2 Desmoothing methods

All but one of the respondents use some form of desmoothed property results, the majority of them produced in-house (Table 21). All respondents acknowledged the academic literature as the original source of awareness on the topic and the majority could cite specific references. Blundell and Ward's (1987) early work on the UK and Brown and Matysiaks's (2000) standard textbook were most often given as primary sources. Beyond that, the depth of knowledge of academic sources was limited to one or two early sources in most cases, running up to thorough and up to date knowledge of both the US and US desmoothing literature in a few cases. The depth of reading varied more with the background and interests of individual researchers than with house decisions to devote resources to the subject.

Irrespective of the extent of knowledge, however, the literature had been tapped primarily for a general awareness of desmoothing as an issue, and not for advanced desmoothing techniques. Several respondents had found the academic literature generally obscure or unhelpful on specific methods.

Table 21: Use of desmoothing methods

	Responses
Never use adjusted risk figures	1
Unquantified qualifications	2
Quantified adjustments from external source	1
Quantified adjustment from own estimates	9
Total	**13**

In line with that view, only one firm actually uses anything more refined than a basic autoregressive desmoothing method. The one exception applies desmoothing to the yield movement component of total returns to arrive at a desmoothed estimate of capital growth with a volatility set to a relationship with the volatility of equity prices – a variant of the equity volatility method described in Section 3.2. For the rest, six respondents were using a simple Lag 1 method. There was an even split between those applying desmoothing directly to total returns, or to capital growth with a subsequent recombination with income returns. Several observed that desmoothing applied to capital growth is technically more correct, but that the choice of capital values or total returns makes no difference to the final results.

Only one respondent used a completely different desmoothing approach, backing an implied annual volatility out of the volatility observed over three-year periods. This was rationalised by the argument that no valuation inertia would be present over that period, which also reflects a reasonable holding period for property investments.

IPD indices provided the data source for desmoothing analysis in all cases. Responses on the time period most often used in that analysis, and the method of calibrating the degree of desmoothing (such as a level of residual serial correlation in the desmoothed results) were generally imprecise. A period back to 1971, calibrated by the neutral setting of the desmoothing parameter at the level of Lag 1 serial correlation, or accepting a maximum residual serial correlation of 0.25 were most often mentioned. But overall, as respondents often mentioned, the final estimate of desmoothed volatility resulted from bracketing over different periods, including a measure of judgement, and not from a purely technical calibration.

Despite the spread of methods and periods employed, the respondents' estimates of true all-property volatility were highly consensual. Across 11 offering a figure, the average historic standard deviation was 13.8%, with a maximum of 15% and a minimum of 10%. Ten of the 11 were in the range 13% to 15%. Most respondents did not apply any further interpretation to the desmoothed results beyond the estimate of standard deviation. Four felt that the desmoothed results contained some information about the year on year behaviour of property values, and thus the difference between valuations and true prices at specific points of time. They were almost balanced by three respondents who took desmoothed results with a degree of scepticism – not really a better picture of true property risk, more an arbitrary adjustment required to make sense of property in asset allocation models.

In that spirit, only two of the respondents would take an estimate of desmoothed average returns different from the Index as meaningful. All of them, however, do revise estimates of correlations with other assets in the light of the desmoothed results.

Use of desmoothing below the all-property level was limited to three respondents who had looked at desmoothed results at the three-sector level. None had paid any serious attention to desmoothing below that level.

5.3 Asset allocation

All but one of the respondents applies property risk and return figures in multi-asset portfolio modelling in some way. Three are directly responsible for running full models for in-house or external clients; five provide inputs and advice on property performance to in-house or external asset allocators; four run some form of allocation modelling for general information or advice to third-party clients. Eleven respondents run or contribute inputs to MVPT modelling methods, six to ALM modelling methods.

Despite the common use of these quantitative methods, many respondents emphasised that their own decisions or advice to clients are at most partially driven by formal asset allocation procedures which depend on assumptions about property risk. For many, strategic asset allocations are primarily set by peer-group benchmarks, with tactical variations from that benchmark dictated by a short-term view of current asset pricing versus fair equilibrium values. Those equilibrium fair values may, in turn, be set by judgements of an appropriate property risk premium which do not depend on an explicit estimate of property volatility.

All but one respondent, however, offered a view on expected future property returns, and all but two a view on expected property risk. Between six and nine also offered figures on expected returns and risks on equities and bonds. In all cases, responses related to medium-long term equilibrium returns – ie for five to 10 years ahead, and not three to five year prospects dominated by the current cycle and market pricing. Table 22 summarises the responses.

The respondents were keen to emphasise that expected returns, risks and correlations are forward looking, informed by but not heavily dependent on historical results. Expected returns are clearly somewhat lower in real terms (around 4.2%) than seen historically and show a lower risk premium over gilts (around 2.3%) than observed over the last 30 years. Expected risks, however, were in almost all cases the same as those given as the best estimate of desmoothed historic risk, all but two of them falling in the range 13% to 15%. Several respondents noted changes in market structure – shortened lease lengths, wider investor based and more accessible vehicles, the narrowed yield premium over gilts, a more stable economic environment – which may have changed inherent property volatility. But only one provided a figure for expected risk significantly different from their estimated of desmoothed historic risk.

Views on expected correlations between property and other assets were more widely spread than views on risk, and generally advanced with rather less confidence. As the specialist asset allocators noted, asset correlations are anyway notoriously variable over time, and tend to have a fairly small effect on indicated weights. Against equities the correlation estimates run from rather below the levels seen historically, to those generated by extreme levels of historic desmoothing. Against gilts, expected correlations in the range 0.2 to 0.4 are toward the upper end of historic figures generated by extreme desmoothing. A tighter spread between property yields and gilts, higher levels of gearing and a more fluid capital market were all offered as explanations for an increased linkage of returns on property and those on gilts.

Table 22: Expected asset returns, risks and property correlations

	Average	Maximum	Minimum
Property			
Return	6.7	8.5	5.7
Standard deviation	13.4	16.0	10.0
Equities			
Return	7.9	9.0	7.0
Standard deviation	18.8	25.0	15.0
Correlation with property	0.32	0.40	0.15
Gilts			
Return	4.4	5.3	4.0
Standard deviation	7.8	10.0	6.0
Correlation with property	0.27	0.40	0.20

Finally, respondents were asked what allocations to property were indicated by their models and the general advice they gave to investment clients on appropriate property weights. The property weights respondents said came straight from their asset allocation models ran from 15% to 50% – an extremely wide span. Our own MVPT optimisation using the average figures shown in Table 22, in fact, suggests a property weight in moderate return-risk portfolios at 40% to 50%. The respondents giving much lower model-generated weights were the asset allocation specialists running optimisations across a larger number of asset classes, or more likely to use ALM modelling, which may account for the difference.

When asked about the advice to typical clients, the most common response was a range (depending on the type of client) from 10% to 15% weighting, with some putting the lower end of the range as low as 5%, and some the upper end at 20%. The answers were frequently accompanied by the comment that respondents were 'very comfortable' to offer that advice since it was often lower than indicated by pure model outputs and, at the same time, well above the actual current property weights of all but the largest institutional investors. There is, therefore, a comfort zone in which advisors feel confident in advising that a strategic allocation to property should be higher than current weights.

5.4 Summary

The survey of fund managers, asset allocators and advisors gathered opinions on the importance of desmoothing, use of desmoothing methods and the incorporation of property in multi-asset portfolios.

- Attitudes to index smoothing and property risk showed a high level of agreement on the importance of the issue, with a large majority agreeing that historic figures on risk shown by valuation indices should always be adjusted.
- Most respondents also felt that their own businesses had thoroughly researched the issue. Views were split on whether the industry should have a consensus view on true property risk, with many preferring to leave the degree of risk adjustment to individual views.
- In line with those sentiments, a majority of firms are using adjusted estimates of property risk based on their own research. There is a strong preference for simplicity in desmoothing methods, with only one respondent using anything more complex than Lag 1 autoregressive techniques.

There was also a strong consensus on the appropriate estimate of historical property risk:

- Across 11 respondents producing quantified estimates of historic risk, the historic standard deviation came out at an average of 13.8%, with only one setting an estimate outside the range 13% to 15%.
- This consensus estimate matches our own preferred estimate of moderate desmoothing which sets adjusted risk at 1.5 times the standard deviation shown by Index figures of 9% to 10%.

These estimates were also reflected in the forward assumptions used to support recommendations on current property weightings to investors.

- Assumptions on medium to long term risks and returns aligned strongly with the classic view that returns on risks on property will fall between those on equities and gilts, with expected property returns averaging just under 7% and expected standard deviation a little over 13%.
- There was also a general assumption that future correlations between property and other asset classes will be somewhat higher than those observed on the historic Index figures. The average expected correlation with equities was 0.32, and with gilts 0.27.

Even after upward adjustments to property risk and its correlations with other assets over those observed historically, quantitative modelling run by respondents still indicates a very high property weighting, which most adjust downward in their recommendations to clients:

- Run with expected asset return profiles, respondents found indicated property weights in the range 15% to 50%. On the expected return assumptions they used, our own calculations suggest property weights for moderately risk-averse investors of 40% to 50%.
- The typical advice to clients offered by respondents was, however, a recommended property weight in the range 10% to 15%. This was often supported by the observation that this put recommendations in a comfort zone, in favour of weights well above those currently held by most clients, while below those indicated by purely quantitative models.

6. FINDINGS AND CONCLUSIONS

The study has aimed to set out in full the issues of methods and data surrounding the adjustment of property risk indicated by UK valuation indices. Its objective has been to distil from the range of possible methods and calibrations a robust estimate of adjusted property risk. This, we hope, will contribute to a wider understanding of the implications of varying views on property risk, and provide the basis for an industry consensus, or central estimate, of true property risk. This final section offers a brief summary of each stage in the analysis, and draws the implications together into a set of broad conclusions.

The argument that property risks measured by valuation indices should be adjusted upward is, in our view, conclusive. It may not be the case that any one piece of evidence on index smoothing is clinching on its own. But the consistency of theoretical and empirical evidence from different perspectives all points in the same direction.

Thus it is reasonable to infer from the nature of the process that valuations introduce a degree of smoothing. And that inference is supported by behavioural studies of valuers' judgements. It is also highly plausible that, because individual property valuations react to market signals with varying lags, the compilation of indices from individual valuations also introduces smoothing of market variations. Whatever the source of smoothing effects (which we have not sought to identify), the hypothesis that results are smoothed gains powerful statistical support from the very high serial correlation in high frequency indices, even if the purely statistical evidence of smoothing in the UK Annual Index is close to marginal.

The degree of smoothing in valuation indices would, however, remain an issue of no more than technical interest if it did not lead to glaringly anomalous results from the comparison of property with other asset classes. Given the fundamental nature of its income streams, and its delivery of an excess return over gilts, a recorded property risk below that on gilts runs against standard financial theory. The extremely high weights accorded to property by portfolio optimisers when run with unadjusted figures – from 31% to 77% depending on the time period used – is the final indicator of a fundamental problem with valuation indices. The failure of property to fit into widely used portfolio models has been a significant barrier to the acceptance of property investment by asset allocators, which has finally been overcome only by the exceptional property returns of recent years.

Over the close to 20 years since the anomalies in the risk recorded by valuation indices were first identified, there has been no shortage of proposed solutions. There has, unfortunately, been no clear convergence in the academic literature on the subject toward a standard risk adjustment method, or toward a consensus on the extent to which risk should be adjusted. The lack of agreement has resulted from the application of varying techniques to data sets over different time periods, and calculated at different frequencies. This study set out to contribute to the resolution of that disagreement by demonstrating the property risk estimates generated by a choice of techniques, time periods and index frequencies. We have arrived at our own preferred method and estimate of risk as a central estimate, which is most robust over the set of time periods and index frequencies likely to be used in practice. And we have left that choice open to further investigation by providing all the data and techniques used in the IPF Desmoothing Project Spreadsheet available alongside this report.

In terms of method, we favour the most basic and longest established technique of desmoothing through a Lag 1 autoregressive filter. It offers the advantages of simplicity against more elaborate methods which are less consistent when run over varying time periods, and generally demand more judgemental inputs by the researcher. Adjusted estimates of property risk are, however, as sensitive to the choice of period over which they are calibrated as to the choice of method. We take the history from 1971 onward as the best indication of fundamental returns characteristics. Longer runs of data are compromised by breaks in construction methods; shorter runs are biased by the exceptional peak and trough of the late 1980s and early 1990s.

Our preferred, or central, estimate of the appropriate adjusted property risk has been taken from the range of desmoothing techniques, length of return histories, and target characteristics of the desmoothed returns (such as tolerance for remaining serial correlation). There is no single factor on which the best estimate of adjusted property risk can be based. Rather, the preferred estimate rests on a combination of characteristics such as consistency over varying periods, index frequencies and calibration criteria. Taking these factors together, we identify a central tendency toward estimates of adjusted risk which, in terms of standard deviation, fall in the range 13% to 15% per year, or 1.3 to 1.5 times the standard deviation seen in the original Index. These figures form our best estimate of the range in adjusted property risk.

Outside of the technical aspects of the desmoothing process, this estimate of adjusted property risk is to some extent supported by other approaches to the problem, and by comparison with other asset classes. Preliminary results from a transactions based, rather than valuation based, UK index estimate risk at the lower end of our preferred range at 12.5%; the volatility in property share values suggests (after taking account of leveraging) a volatility of 15%, at the upper end of the range. And a standard deviation of 13% to 15% puts property risk back in the expected range between gilts and equities.

A final criterion on which an adjusted estimate of property risk can be assessed is the extent to which revisions to risk give more realistic results from portfolio optimisation techniques. Desmoothing, besides increasing the risk of property, also dilutes some of the diversification benefits of property in the multi-asset portfolio, increasing its correlation with gilts and equities, although decreasing its correlation with cash. Even at extreme levels of desmoothing, however, property's correlations with gilts and equities tend toward an upper limit, so substantial diversification benefits are retained.

For these reasons, while desmoothing modifies the case for property in a mixed-asset portfolio, it falls a long way short of destroying that case, or even of justifying the low weightings of property held by institutional investors over the last decade. Using mean variance portfolio optimisation techniques (MVPT), the property weight in optimal portfolios falls below 10% only if extreme desmoothing assumptions – more than doubling property standard deviation – are applied. With desmoothing at our preferred estimate, the property weights in the portfolios providing the maximum Sharpe ratio run from 23% over the last 25 years up to 58% over the last 55 years. Though these weightings are 15% to 20% below those indicated if original Index figures are used, they remain far above the weights actually held by investors over any of those periods.

The alternative portfolio optimising approach of Asset Liability Matching (ALM) produces lower indicated property weights, but still weights well above the average for institutional investors. Apart from the most extreme risk-averse portfolios, applying desmoothing assumptions in our preferred range indicates an optimal property weighting in the range 12% to 20% with varying forms of liability definition and levels of risk tolerance.

On these results desmoothing techniques, unless they are pushed to the extreme end of a plausible range, look like a partial rather than a complete solution to the property asset allocation problem. MVPT methods leave indicated property weights above 20%, even when calibrated over the most unfavourable periods of property's performance relative to other assets.

Optimal portfolios calculated on historical results are a strong influence on the perceptions of investors, but current investment decisions reflect judgements about future performance. Our survey of industry opinion collected views on property desmoothing, use of desmoothing methods, and the forward looking assumptions driving advice on asset allocation.

6. FINDINGS AND CONCLUSIONS

The survey was intentionally centred on large and leading firms, and therefore represents the most technically sophisticated and informed sector of the industry. Among this group, there was a general recognition that index smoothing was an important issue for property, and there was an almost universal use of desmoothing techniques. There is a strong preference for simplicity in desmoothing methods, with only one respondent using anything more complex than Lag 1 autoregressive techniques.

There was also a strong consensus on the appropriate estimate of historical property risk, which matched the results of our own analysis. The consensus on the true historic standard deviation of property came out at an average of 13.8%, with a typical range of 13% to 15%. Assumptions on medium to long term risks and returns aligned strongly with the classic view that returns and risks on property will fall between those on equities and gilts, with expected property returns averaging just under 7%, and expected standard deviation a little over 13%. On top of higher property risk than observed in the historic index results, there was also a general assumption that correlations between property and other asset classes should be taken as higher than the historic figures.

Even after these adjustments, the quantitative allocation models run by respondents still indicate a high property weighting, which most adjust downward in their recommendations to clients. Run with expected asset return profiles, respondents found indicated property weights in the range 15% to 50%. The typical advice to clients offered by respondents was, however, a recommended property weight in the range 10% to 15%. This was often supported by the observation that this put recommendations in a comfort zone, in favour of weights well above those currently held by most clients, while below those indicated by purely quantitative models.

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APPENDIX A: HIGHER FREQUENCY INDICES: MONTHLY AND QUARTERLY RESULTS

Most discussion of returns and volatility in UK property rest on annual Index results, because of the IPD Annual Index. Indices at higher frequency, however, cast more light on the smoothing process because both theory and the evidence of serial correlation suggest that smoothing effects are much stronger. From 2006, IPD's publication of a Quarterly Index with a much larger coverage of the market than its current Monthly Index may lead to the quarterly series becoming the Index of record. At present, the Quarterly Index itself has a history starting in 2000, to short to be used for quantitative analysis of smoothing.

We have therefore repeated the investigation of alternative desmoothing methods and desmoothing strategies applied using data from the IPD Monthly Index at both monthly and quarterly intervals. The latter is taken as the best available proxy for the return characteristics of the new Quarterly Index. For completeness, we also briefly examine the results of applying desmoothing methods to the other standard indices of UK property performance apart from IPD's – those from Jones Lang LaSalle (JLLS), and CBRE.

A1. IPD Monthly and Quarterly Indices

Although the Monthly Index is based on a sub-set of the properties covered by the Annual Index (7% by value at the inception of the Monthly Index in 1987, rising to 26% by 2005) there is a close correspondence in the annual results from the two Indices. From 1987 to 2005 the Monthly Index shows a mean annual return of 11.6% and standard deviation of 8.5%, compared with the Annual Index figures of 11.7% return and standard deviation of 9.6%. The standard deviation in the Monthly Index is not statistically different from that in the Annual Index at the 10% level.

At both Monthly and Quarterly frequencies, the Monthly Index shows very high serial correlation at Lag 1 – close to 0.90 in both cases – decaying to around 0.20 after 12 lags on the monthly results, or four lags on the quarterly results. In series without variation in serial correlation over different periods – ie pure random walk series – the standard deviations of n periods is that over one period times the square root of the number of periods. So annual standard deviation would be monthly standard deviation times Sqrt(12), or quarterly standard deviation times Sqrt(4). But because of the very strong correlation between successive monthly and quarterly IPD figures, the standard deviation observed at those frequencies is much lower that the standard deviation observed at an annual frequency. The observed monthly standard deviation from 1987 to 2005 of 0.78 would therefore imply an annual standard deviation of only 2.7% in an uncorrelated series, random walk, and the observed quarterly standard deviation would imply an annual standard deviation of only 4.6%.

So long as serial correlation varies at different lags in the results, therefore, there is no simple arithmetic relationship between standard deviation observed at one frequency and any other frequency. This means that the interpretation of desmoothed outputs for monthly and quarterly frequencies in terms of their implications for annual standard deviation is not straightforward. For example, a desmoothing procedure which doubled the observed standard deviation in monthly returns but at the same time reduced their serial correlation would imply less than a doubling in the standard deviation in annual returns.

Higher frequency indices also pose more problems in the calibration of desmoothing methods than are found in annual data. The extremely high Lag 1 correlations, and mix of positive and negative correlations at other lags, make it far more difficult to target specific values of residual serial correlation in desmoothed results without introducing other implausible characteristics such as major differences in the mean return from those in the original Index.

Table A1 gives a summary of results for varying desmoothing methods and strategies for monthly returns from 1990 to 2005. The first three years of the Monthly Index are not used since they are the calibration period for the

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Time Varying method. The impacts of desmoothing are shown in terms of both the change in monthly standard deviations and standard deviation in the desmoothed Monthly Index measured at a calendar year frequency since, at noted above, the desmoothing impacts are not the same at the two frequencies. It proved impossible to find calibrations for the Market States method at a monthly frequency which yielded results within a feasible range of standard deviations and mean returns, so the method is not shown.

Table A1: IPD Monthly returns - desmoothing methods and strategies

	IPD actual	Lag 1 method	Lags 1-n method	Equity Volatility	Time Varying
Monthly volatility					
Neutral desmoothing (Coefficients set by Index correlations)					
Monthly standard deviation	0.71	2.62	**	2.22	2.72
Ratio desmoothed:Index	1.00	3.68	**	3.12	3.82
Strong desmoothing (Coefficients set to serial correlation = 0)					
Monthly standard deviation	0.71	1.49	**	2.21	1.38
Ratio desmoothed:Index	1.00	2.09	**	3.10	1.95
Moderate desmoothing (Coefficients set to serial correlation = 0.25)					
Monthlystandard deviation	0.71	1.07	2.02	2.19	1.03
Ratio desmoothed:Index	1.00	1.50	2.83	3.07	1.45
Weak desmoothing (Coefficients set to insignificant serial correlation)					
Monthly standard deviation	0.71	1.24	2.02	2.20	1.18
Ratio desmoothed:Index	1.00	1.74	2.83	3.09	1.65
Annual volatility					
Neutral desmoothing (Coefficients set by Index correlations)					
Annual standard deviation	7.38	13.73	**	11.42	13.56
Ratio desmoothed:Index	1.00	1.86	**	1.55	1.84
Strong desmoothing (Coefficients set to serial correlation = 0)					
Annual standard deviation	7.38	9.57	**	14.74	8.96
Ratio desmoothed:Index	1.00	1.30	**	2.00	1.21
Moderate desmoothing (Coefficients set to serial correlation = 0.25)					
Annual standard deviation	7.38	8.29	16.22	18.30	8.01
Ratio desmoothed:Index	1.00	1.12	2.20	2.48	1.08
Weak desmoothing (Coefficients set to insignificant serial correlation)					
Annual standard deviation	7.38	8.78	16.22	16.53	8.37
Ratio desmoothed:Index	1.00	1.19	2.20	2.24	1.13

Source: own calculations from IPD data

APPENDIX A: HIGHER FREQUENCY INDICES: MONTHLY AND QUARTERLY RESULTS

The Lag 1-n method was set up using lags at month 1 and month 3 – the two periods in which joint serial correlation coefficients at all lags from 1 to 12 were statistically significant at the 5% level. The observed correlation coefficients at these lags are 0.63 and 0.36 which, since they sum to 1, produces unstable results in the neutral and strong desmoothing strategies, which have not been shown. Although this method seems an intuitively plausible way of dealing with monthly serial correlations distributed over several lags, the correlation coefficients on different lags appear to be highly unstable over different sub-periods. A calibration based on averages over the whole series tends, therefore, to produce desmoothed mean returns which depart explosively from the Index values at some point.

Even the simplest desmoothing methods are not easy to handle at the monthly frequency. A neutral calibration of the Lag 1 and Time Varying methods, for example, yield desmoothed returns with a strong negative Lag 1 serial correlation, which looks like an over-correction. Setting residual serial correlation to 0.25 – a very low level if it is taken to represent market frictions from one month to the next – produces only small increases from the observed standard deviation. Although, on these assumptions, monthly standard deviation is increased by around 1.5 times the Index values, for the reasons noted above this translates into a much smaller, and statistically insignificant, 1.1 times increase in annual standard deviation.

Overall, therefore, it is difficult to pick out a set of desmoothed figures which look both reasonable in terms of the characteristics of the desmoothed series and fairly consistent in their implied increase in standard deviation. A simple average of the quite widely spread estimates in Table A1 would indicate a standard deviation in monthly returns of 1.83% (2.57 times that seen in the Index), and a standard deviation in annual calendar year returns of 12.34% (1.67 times that seen in the Index) – an estimate which in terms of standard deviation falls at the lower end of the range produced by desmoothing on annual series.

The quarterly data series – created as the quarterly return from the IPD Monthly Index – is even more resistant to desmoothing methodology. Analyses run over the full period available – from 1992 to 2005, allowing 20 quarters for the calibration of the Time Varying desmoothing parameter – showed that, for many combinations of desmoothing method and desmoothing strategy, there were no values of the desmoothing coefficients which satisfied the required serial correlation conditions. Even on the simplest Lag 1 method, for example, no values of k can be found which produce serial correlation in the desmoothed index of 0 or 0.25.

This problem points to changes in the behaviour of the Index over time which are particularly acute in the quarterly series, although they are also apparent in the analysis at annual and monthly frequencies. The first seven years of the series (1987 to 1994), saw a strong boom and slump, through which there were several successive quarters of high or low returns generating strong serial correlation. Since 1994, returns have run closer to the mean, with larger quarter on quarter variation even through the run of strong annual returns in the last two years. There is, therefore, no fixed smoothing parameter which can produce a pre-specified level of serial correlation in the series over the whole of the period. In principle, the Time Varying method should work around this problem. In practice, however, a time varying parameter calibrated over 20 previous quarters (as we have done) picks up a high value in a period of sustained boom and slump like 1987 to 1994, and then applies it to a period in which serial correlation is actually much weaker, such as 1995 to 2005. The Time Varying method, therefore, does not deal well with abrupt changes in the nature of the serial correlation process.

Because quarterly analysis over the full period of the Monthly Index produces a small number of usable results, Table A2 shows a set of combination of desmoothing method and strategy only for the period 1996 to 2005 – the last 10 years. For those combinations of method and strategy which work over both time periods, the indicated changes to Index standard deviation are very similar except in the case of the Lag 1 method, which produces a smaller increase in standard deviation on desmoothing.

Table A2: IPD Quarterly returns - desmoothing methods and strategies

	IPD actual	Lag 1 method	Lags 1-n method	Equity Volatility	Market States	Time Varying
Quarterly volatility						
Neutral desmoothing (Coefficients set by Index correlations)						
Quarterly standard deviation	1.2	2.4	1.9	2.7	2.3	3.1
Ratio desmoothed:Index	1.00	1.97	1.59	2.18	1.9	2.53
Strong desmoothing (Coefficients set to serial correlation = 0)						
Quarterly standard deviation	1.2	2.1	2.1	2.6	2.5	2.1
Ratio desmoothed:Index	1.00	1.68	1.71	2.14	2.0	1.69
Moderate desmoothing (Coefficients set to serial correlation = 0.25)						
Quarterly standard deviation	1.2	1.6	1.6	2.5	1.7	1.6
Ratio desmoothed:Index	1.00	1.27	1.33	2.03	1.4	1.27
Weak desmoothing (Coefficients set to insignificant serial correlation)						
Quarterly standard deviation	1.2	1.5	1.6	2.5	1.7	1.5
Ratio desmoothed:Index	1.00	1.26	1.31	2.02	1.3	1.26
Annual volatility						
Neutral desmoothing (Coefficients set by Index correlations)						
Annual standard deviation	4.0	6.3	5.1	7.0	6.2	8.0
Ratio desmoothed:Index	1.00	1.60	1.29	1.78	1.6	2.03
Strong desmoothing (Coefficients set to serial correlation = 0)						
Annual standard deviation	4.0	5.6	5.4	7.3	6.6	5.7
Ratio desmoothed:Index	1.00	1.41	1.36	1.84	1.7	1.43
Moderate desmoothing (Coefficients set to serial correlation = 0.25)						
Annual standard deviation	4.0	4.6	4.5	7.7	4.9	4.6
Ratio desmoothed:Index	1.00	1.16	1.14	1.95	1.2	1.16
Weak desmoothing (Coefficients set to insignificant serial correlation)						
Annual standard deviation	4.0	4.6	4.5	7.7	4.8	4.6
Ratio desmoothed:Index	1.00	1.15	1.13	1.96	1.2	1.15

Source: own calculations from IPD data

Over this period, the Market States method yields erratic results, indicating either extremely high volatility or extremely low volatility on all apart from the neutral desmoothing strategy. All other methods and strategies produce volatility figures within a plausible range, all with differences from the Index standard deviation which are statistically significant at the 10% level, and mean returns which are not significantly different from the Index. At an annual frequency, the small number of observations means that the increases in desmoothed standard deviations over the Index are mostly not statistically significant at the 10% level.

Leaving aside the erratic results from the Market States method on all strategies except neutral desmoothing, a simple average of all other results shown in Table A2 gives desmoothed standard deviations at a quarterly frequency of 2.1% against the Index 1.2% (a factor of 1.7). At an annual frequency, desmoothed standard deviation is 5.7% against the Index 4.0% (a desmoothing factor of 1.4). Though standard deviation over this period is low, measured by the desmoothing factor this estimate again falls within the range of the results found in the annual analysis.

A2 Comparison of indices

The core of the analysis has worked with IPD indices, which are taken as the industry standard. This section provides a comparison of returns characteristics and desmoothing returns across the other UK indices – the CBRE Monthly Index and Jones Lang LaSalle (JLLS) Quarterly index. This has been done mainly for completeness, to include all available sources. Because all three Indices are based on similar sets of properties, differing only in sample size, and apply the same basic methods of index construction, using non-IPD series does not alter the general conclusions, and the discussion below is limited to the key points.

Table A3: Alternative indices and desmoothing

	Annual returns 1981-2005	Quarterly returns 1987-2005	Monthly returns 1987-2005
Index results			
Mean rate of return			
IPD	11.2	2.74	0.90
JLLS	11.5	2.83	..
CBRE	..	2.73	0.90
Standard deviation in returns			
IPD	8.4	2.28	0.78
JLLS	8.3	2.53	..
CBRE	..	2.69	0.94
Lag 1 serial correlation in returns			
IPD	0.42	0.85	0.87
JLLS	0.34	0.73	..
CBRE	..	0.78	0.81
Desmoothed results (Lag 1 method, neutral desmoothing)			
Standard deviation in annual return			
IPD	13.2	23.9	15.2
JLLS	11.8	18.1	..
CBRE	..	19.2	11.7
Desmoothed:Index ratio			
IPD	1.6	2.8	1.8
JLLS	1.4	2.0	..
CBRE	..	2.0	1.2

Source: IPD, CBRE, JLLS

At annual and monthly frequencies, all available indices show levels of standard deviation from (in round terms) 12% to 15%, similar to results from the IPD indices alone. Analysis at the quarterly frequency on all three indices, run in this instance over the full length of the IPD Monthly Index from 1987 to 2005, produces much higher estimates, due to the strong influence of the late 1980s to early 1990s boom and slump on the calibration of the desmoothing coefficient. As discussed in the last section, these estimates may be taken as outliers if such major cycles are regarded as low-frequency events.

APPENDIX B: SURVEY RESPONDENTS

Name	Business
Andrew Smith	Arlington
Peter Damesick	CBRE
Desmond Jarrett	Henderson
Carl Bennet	Hermes
Guy Morrell	HSBC
Malcolm Frodsham	Legal & General
Adrian Jarvis	Morley
Paul Clark	PMA
Anonymous	Property Fund Management
Martin Cumberworth	Prudential
Bill Hughes	RREEF
Russell Chaplin	UBS
Andrew Walker	Watson Wyatt

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