Modelling Property

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Introduction

There are many reasons why insurance companies choose to invest in property. These include the desire to achieve the strong long term growth seen in this sector in recent history, diversification from equities in an asset class that provides real returns, obtaining an income stream from rental income and convenience (if the property is occupied by the company).

Investigating FSA returns from 31/12/02 showed that the large life insurance companies had an average of nearly 10% of the value of their Long Term Business Fund assets invested in property, much of this in with-profit funds. The range is significant, with some funds having property backing of up to 15% of the fund, and others as low as 5%. It is clear that the stochastic projection of property rental streams and values is going to be an important consideration when calculating Realistic Balance Sheets or Individual Capital Assessments.

However, there are many difficulties when modelling property stochastically, particularly when it is desirable that the projections are consistent with current market values. This paper highlights the issues and some possible solutions.

Data sources

The most commonly used source of property return data in the UK is the Investment Property Databank ("IPD"). The index incorporates property from the retail, office, industrial, farms, leisure and residential sectors throughout the UK. The main measure of performance is the total return i.e. incorporating rental and capital growth changes and expenditure on the property during the period. (Returns are split between income and capital growth.) The index is valuation-based, which means that the property values are estimated by surveyors (as opposed to being based on transaction prices or another method). Other indices that are available in the UK are the CB Hillier Parker index and Jones Lang LaSalle. Several residential indices are also available.

As noted by Booth and Marcato (2003) the method used for construction of the index is particularly important when it comes to interpretation of the data. All of the indices mentioned above are valuation based. As surveyors tend to consider the previous valuation price as part of the valuation process, this means that the data used in the indices will incorporate implicit smoothing. Removal of this implicit smoothing can impact the data significantly. For example, Booth and Marcato found that de-smoothing the IPD index over the period 1977 to 2002 increased the standard deviation from 9.3% to 16.7%. There are a number of ways that index data can be de-smoothed. The methods used usually involve making an assumption that successive capital values of property should be uncorrelated, and then adjusting the data to remove any correlation that is present. It is therefore important to consider whether the modelling of property returns should be based on transaction prices or valuation prices. If valuation prices are required then the data can be used in parameter estimation without alteration. If transaction prices are required then the data must be adjusted first to ensure that the volatility of property returns is not under-estimated.

Distribution of property prices over history

Total returns since 1947 were analysed based on valuation prices. Using the method of moments, a transformed Gamma distribution can be fitted to m - log(1 + r_t) where
r_t = total property return and
m = maximum observed value of log(1 + r_t).

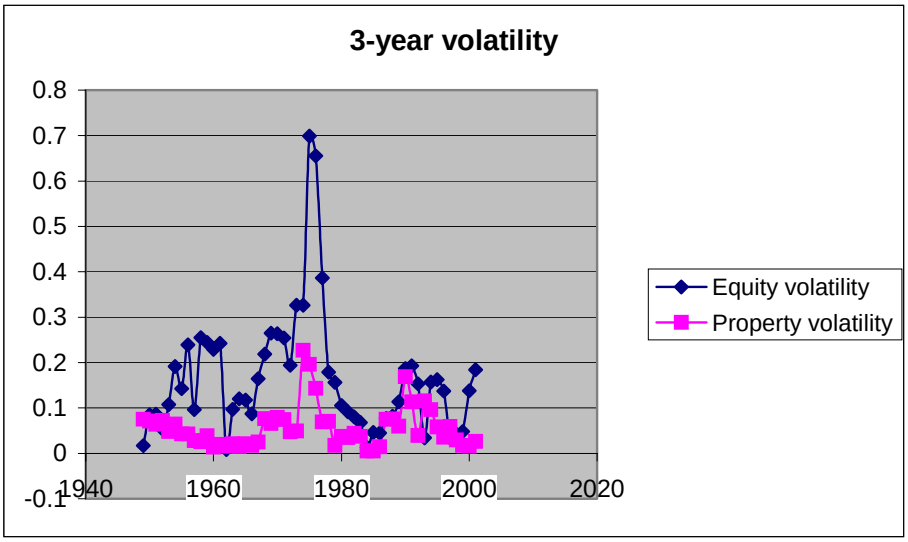
The characteristics are:

	Mean	Standard Deviation	Skew	Kurtosis
Observed	0.160592	0.082435	0.396603	3.421778
Fitted	0.160592	0.082435	0.396603	3.23594

The key findings are:

- the fit is reasonably good;
- the volatility of returns over rolling 10-year periods displayed negative correlation with equities until about 1974, and has displayed positive correlation since then until very recently. In the graph below, we show the standard deviations of annual total property and equity returns calculated over rolling 10 year periods.

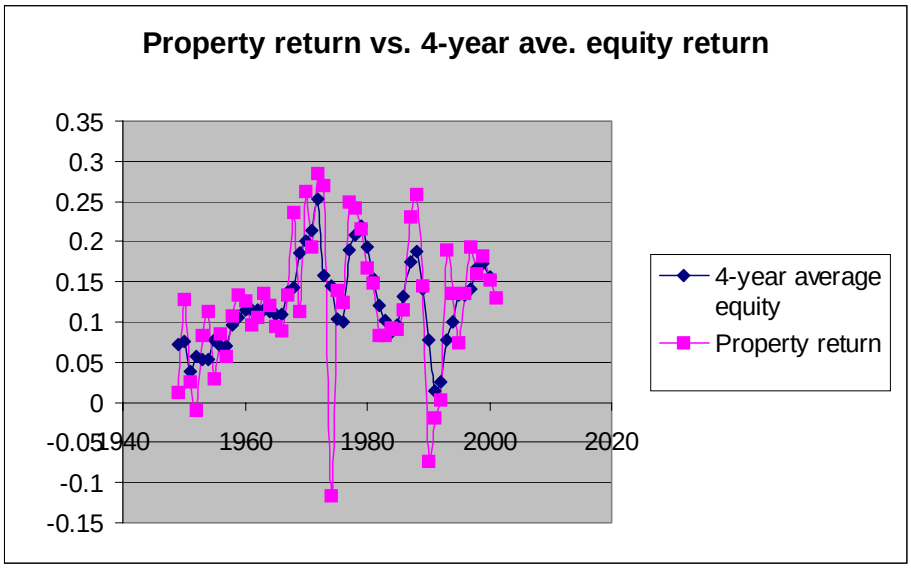
- It is noteworthy that the property volatility has been lower but by significantly varying amounts.
- The rolling 3-year volatility has similar characteristics.



Correlations

Property returns appear to be influenced by equity returns. In particular, the property return in a given year is strongly positively correlated to the average equity returns over the 4 years up to and including the year under consideration.

The correlation coefficient is 0.525.



Though both should be driven by economic growth, equities are indicative of property movement. This however may be a consequence of the smoothing of property valuations in the light of recent economic history.

There is also significant autocorrelation in observed property returns: the autocorrelation coefficient (with lag of 1 year) is 0.31644. For equities over the same period, the equivalent number is –0.08689. This again may be indicative of the smoothing of valuations.

Available models

Given the importance of the asset class it is no surprise that there has been significant work put into developing models to stochastically project property rentals and values. However, relatively few models have been published. Indeed, the only actuarial model in common use is that published by Daykin and Hey in 1990 and updated by Wilkie in 1995 (and variants thereof).

The Wilkie property model is based on an autoregressive time series approach, with yields and rental income modelled separately. Property values can then be derived using the formula Value = Rent / Yield. Both the yield and rental series incorporates correlations with inflation. The model has since been extended by Booth and Marcato (2003) to incorporate correlations with bond and equity yields.

This form of model is appealing to actuaries, as it uses a methodology that is explainable in the context of economics. However, it is generally not suitable for modelling where it is desirable to replicate market values due to the lack of a market consistent discounting methodology. It is also possible that arbitrage can exist, which could lead to misleading projection results if the model takes advantage of this.

Most of the proprietary models currently include property as an asset class. The approach often taken is to model property in a similar way to equity, but using different assumptions for correlations with other asset classes. In a similar way, it is also possible to allow for property

investment within the Black Scholes formulae for valuing guarantees. By making assumptions about the volatility of property and correlations with other asset classes, it is possible to develop a volatility assumption for the mixed asset class that underlies asset shares, and the formulae can then be applied using this parameter.

The problem with developing a market consistent model is that it is very difficult to obtain data on the market for property. There are no commonly traded options on the property market, making it very difficult to derive a suitable volatility assumption.

Market consistent valuation of property and approaches to hedging

The determination of a market consistent value of the options and guarantees in a with profits portfolio relies on the existence of a liquid market in options and other derivatives to which we can calibrate. No such market exists in property. This is for two principal reasons:

1. Property itself is not liquid:
    a. Typically transaction costs on a sale and repurchase would be 7.5%. Arbitrage-free pricing depends on the ability to create and continuously rebalance a replicating portfolio. Clearly, this cannot be done without incurring significant expenses.
    b. In the world of property investment, it appears that there is not the same requirement for the liquidity as there is in equity investment, and hence there is not the same demand for derivatives. Anecdotal evidence suggests that there is often market consensus on property investment, and presumably the illiquid nature of the assets is understood when they are purchased.
2. Properties are unique, so the creation of a replicating portfolio is itself problematical. We note the following table:

Capital Growth	UK property funds, 2001[1]
5th percentile	5.1%
Upper quartile	1.7%
Median	0.6%
Lower quartile	-1.4%
95th percentile	-6.3%

We note the spread of portfolio performance.

Pragmatic solutions and parameterisations

In the absence of a derivatives market, there has been little incentive to develop continuous models with Martingale properties. The models used by property analysts tend to be regression-based ‘real-world’ discrete-time models, at least conceptually similar to the Wilkie Model discussed above. Such a model would not be suitable for our purposes.

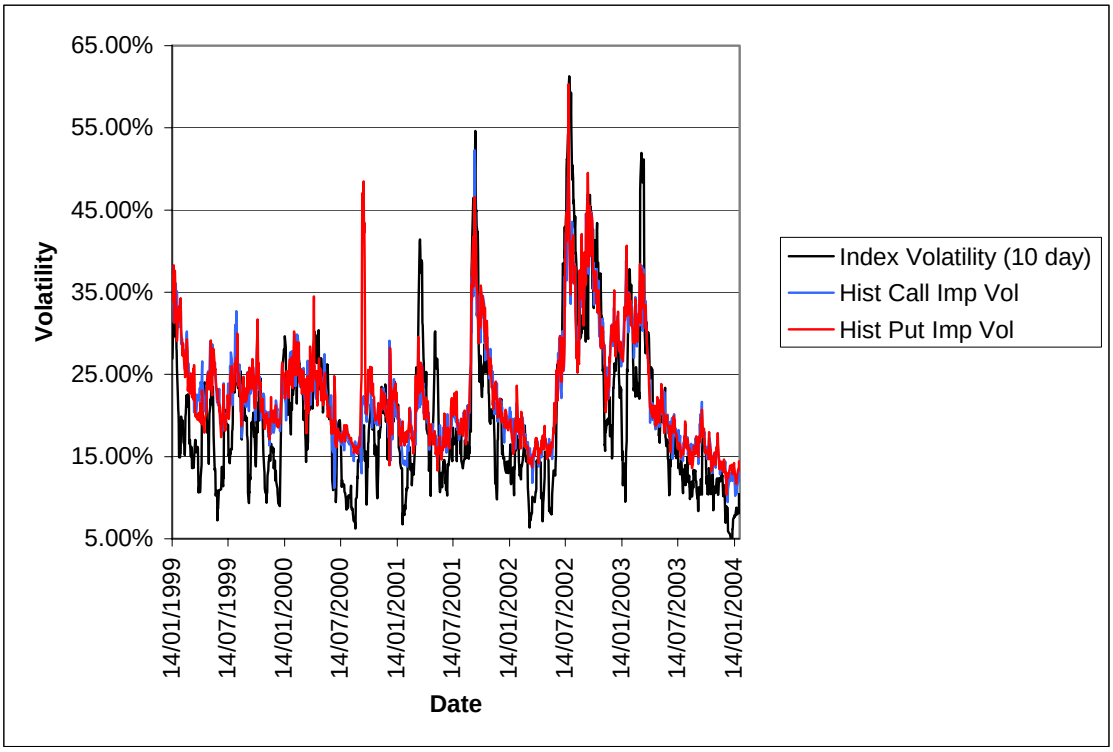
We must accept that in the absence of a derivatives market, our ‘market consistent value’ of guarantees and options will be somewhat curious, to say the least. A pragmatic solution requires us to estimate the prices that would charged for options, if they existed. To do this, we need:

1. to estimate the implied volatility of put options of duration and strike price that correspond to our liabilities;
2. to construct a property model that exhibits similar relations to equities (and gilts) to those we can observe in historical data.

[1] *IPD Property Funds Review, 2002: An analysis of differences in fund performance*

We have commented above on the salient features of the correlation between property and equities. For an estimate of the volatility, we may compare historical equity volatilities with implied volatilities, and make similar adjustments to the historical property volatility. We may assume that the adjustments reflect profit margins and trading expenses, and scale these to be appropriate to property rather than equity.

Unfortunately, the relationship between observed and implied volatilities of equities is not stable. The implied volatilities of short term put options on equities can approach twice the historical observed volatilities during times of crisis. At other times, the relationship is much closer.



Turning to the structure of the model, given the absence of suitable models in use by analysts, it would appear that a reparameterised market consistent equity model would be as valid a vehicle as any. In spite of objections to the conceptual validity and practical problems in parameterisation, it does not appear that any other recourse is available.

Transaction prices vs. Valuation prices

Given the lack of a liquid market for property, companies will usually base the value of property shown on the balance sheet on valuations by surveyors or other experts. However, as noted above, valuations tend to exhibit implicit smoothing over time. This raises a question of whether stochastic projections should be based on valuations or transaction prices.

The decision over whether to project transaction prices or estimated values will depend on the particular circumstances of the individual company and the purposes of the modelling. As asset shares will often be the basis for determining policyholder bonuses, the projection should be consistent with the methodology used for valuing property in the asset shares. For most companies, the value of property on the balance sheet and in asset share calculations will usually be based on a valuation rather than a transaction, and this suggests that in most cases it is valuation prices that should be projected. However, in cases where a company is closed to new business and liquidating its investment portfolio it may be more appropriate to project transaction prices. For calculation of ICAs, transaction prices may also provide more meaningful information.