The University of Reading Business School
Department of Real Estate & Planning

Working Papers in Real Estate & Planning 08/06

The University of Reading

Capturing UK Real Estate Volatility

A paper presented at the 13th Annual European Real Estate Society (ERES) Conference Weimar, Germany June 2006

Robert Fourt
Gerald Eve Chartered Surveyors and Property Consultants
7 Vere Street, London, W1G 0JB
Tel: +44 (020) 7333 6375, Fax +44 (0)20 7333 6402
E-mail rfourt@geraldeve.com

George Matysiak
Professor of Real Estate Investment
The University of Reading Business School
Dept of Real Estate & Planning
Whiteknights, Reading RG6 6AW, UK
Tel: +44 (0)118 378 6588 Fax: +44 (0)118 378 8172
E-mail g.a.matysiak@reading.ac.uk

Alan Gardner
Gerald Eve Chartered Surveyors and Property Consultants
7 Vere Street, London, W1G 0JB
Tel: +44 (020) 7333 6322, Fax +44 (0)20 7333 6412
E-mail agardner@geraldeve.com

Abstract

Volatility, or the variability of the underlying asset, is one of the key fundamental components of property derivative pricing and in the application of real option models in development analysis. There has been relatively little work on volatility in real terms of its application to property derivatives and the real options analysis. Most research on volatility stems from investment performance (Nathakumaran & Newell (1995), Brown & Matysiak 2000, Booth & Matysiak 2001). Historic standard deviation is often used as a proxy for volatility and there has been a reliance on indices, which are subject to valuation smoothing effects. Transaction prices are considered to be more volatile than the traditional standard deviations of appraisal based indices. This could lead, arguably, to inefficiencies and mis-pricing, particularly if it is also accepted that changes evolve randomly over time and where future volatility and not an ex-post measure is the key (Sing 1998). If history does not repeat, or provides an unreliable measure, then estimating model based (implied) volatility is an alternative approach (Patel & Sing 2000).

This paper is the first of two that employ alternative approaches to calculating and capturing volatility in UK real estate for the purposes of applying the measure to derivative pricing and real option models. It draws on a uniquely constructed IPD/Gerald Eve *transactions database*, containing over 21,000 properties over the period 1983-2005. In this first paper the magnitude of historic amplification associated with asset returns by sector and geographic spread is looked at. In the subsequent paper the focus will be upon model based (implied) volatility.

Key words: *historic actual volatility; derivatives; real options; transactions database;*

1. Introduction

Development of, and investment in real estate is a risky business. Arguably the former carries a greater variety of risk than the latter, which contributes to the underlying circumstances that are often involved in releasing the development contingent claim. Methods of understanding and measuring risk with real estate have progressed over the past 15 years or so. Today's practitioners have a pallet of tools at their disposal ranging from the deterministic (ratio, sensitivity and scenario analysis) through to stochastic (Monte Carlo, VaR and real options analysis). Whilst it is acknowledged in finance literature that the addition of randomness (stochastic) should lead to a better solution or understanding in assessing a particular project, the application of this approach in real estate practice has yet to be fully embraced.

Real estate carries a multitude of embedded options which again are acknowledged in practice but nonetheless rarely quantified, other than intuitively. Nevertheless, academic advances have provided frameworks such as real options analysis, in which optionality can be quantified and risk clarified. Real estate derivatives in the UK are still in their infancy. If the market is to grow in the way in which other derivative markets have evolved globally, then an understanding of underlying volatility will be key.

Notwithstanding some of the computational issues associated with stochastic applications such as real optional analysis, the practitioner will also seek comfort in the robustness of one of the fundamental inputs in such analysis: volatility, ie the variability of the underlying asset. Whilst volatility has been acknowledged as an important research topic, there is only a limited amount of work on its measurement and alternative views on methodology, on how this can be applied. The practitioner is, therefore, reliant upon a relatively small pool of empirical analysis to support the calculation and production of data to be inputted into the appraisal model. In addition, the practitioner will be concerned that the data utilised is a true proxy that captures real estate volatility in respect of the particular circumstances being appraised. Otherwise it could lead, arguably, to inefficiencies and mis-pricing, particularly if it is also accepted that changes evolve randomly over time and future volatility (which the practitioner is seeking to anticipate) and not an ex-post measure.

This paper is written from a practitioner’s perspective in seeking to understand and capture UK real estate volatility historically. A second paper will consider the factors necessary to develop and apply a model to capture implied volatility. Both approaches will be reviewed for the purposes of application in either derivative pricing or real options models.

2. Objectives

Volatility, in simple terms, can be defined as the risk associated with the variability of an asset. In financial markets it has also become the proxy for pricing, as it contains information that changes as the market adjusts, allowing market makers to identify mis-pricing and arbitrage opportunities as well as hedging strategies.

So far as the UK real estate market is concerned direct volatility can, be measured in several ways:-

- (i) the standard deviations of an historical data series (ex-post);
- (ii) a model based implied volatility, again from an historical data series (ex-ante); and
- (iii) the analysis of traded property derivatives.

The third of these requires an active and transparent market which, at least for the time being, does not exist in the UK. Property derivatives, if the market, as expected, does evolve could in the future provide a wealth of data which will assist in formulating views upon volatility.

Both (i) and (ii) rely upon an historical data series. In the UK, several indices are produced by leading firms as well as the Investment Property Databank (IPD). Whilst some of these indices are transaction based, the majority including the IPD index are valuation based. Inherent within valuation based indexes is the so called smoothing effect and whilst various methods have been applied to de-smooth (Booth & Matysiak 2001) there must be concern as to the degree of market variance is captured.

In addition, the indices cannot be sub-divided to provide an estimate of individual property risk. Therefore estimates of risk that have been published to date focus upon these indices or at portfolio level. Therefore specific property risk is unlikely to be fully captured as a result of a combination of both valuation based appraisals and aggregation.

Transactional based data and analysis at individual property level prior to aggregation would seek to overcome these concerns. This is addressed in the Gerald Eve/IPD data base which we describe below.

A further fundamental issue arises in respect of the volatility deriving from the two approaches ie ex-post (standard deviation); and ex-ante (implied volatility model): what is the better in terms of proxy and reliability measure for inputting into property derivative and real option models? Ex-post measures in the financial markets are not considered suitable measures of volatility, on their own, as they are constant whereas the market changes randomly. This initially led to the use of the Black-Scholes model to derive implied volatility. Subsequently it led to stochastic and time varying volatility models.

Any shortcomings of ex-post measures not being a good proxy for future volatility in property derivative or real option models must at present be a subject of some conjecture given our comments above on producing figure which accurately captures the market. On the same basis it is also possible to question the efficiency to date of ex-ante measures which can produce inconsistent and inexplicable results.

"Excess volatility" is defined as the difference between model implied volatility and historic standard deviations. If real estate variance is relatively constant given such matters as liquidity, transaction costs, and its heterogeneous nature, historic standard deviation could be an appropriate proxy. This is assuming the standard deviation of past pricing data fully captures market volatility. In the financial markets both actual (historic standard deviation) and implied volatility are utilised with the different between the two being the profit on a derivative.

Part 1 of our research into capturing UK real estate volatility therefore looks at historic variance (ex-post) via a unique database that has been established. Part 2, a forthcoming paper will develop an implied volatility model and again apply this to the database we have created. The results will be compared, contrasted and "excess volatility" identified.

3. Literature Review

In undertaking variance (volatility) analysis, various authors have commented that it is important to understand why and where it is being used in terms of option pricing, ie the nature of the model to which volatility is the input. Merton (1973) states in his analysis of the Black-Scholes formula (Black & Scholes1973) that "the Option price does not depend upon the expected return on the common stock, risk preferences of investors, or the aggregate supplies of assets. It does depend on the rate of interest (an "observable") and the *total* variance of the return on the common stock which is often a stable number and hence accurate estimates are possible from time series data". Merton adds that the Black-Scholes formula "does not depend upon the betas (covariances with the market) or other assets' characteristics" and therefore CAPM despite Black-Scholes claim may not be as central to the formula as they assumed.

Merton acknowledged that the Black-Scholes formula could be reversed and option prices and the model used to deduce implied variance rates as estimates for the future volatility of stock.

In producing an alternative derivation of the Black-Scholes Model, Merton (1973) considered investor preferences and expectations. He stated that 'a necessary condition for a rational option pricing theory is that the option be price such that it is neither a dominant nor a dominated security". As such no conditions are necessary about investor preferences other than that they satisfy this assumption. Merton adds:-

> "This assumption is much more acceptable than the usual homogenous expectations. It is quite reasonable to expect that investors may have quite different estimates for current (and future) expected returns due to the different levels of information, techniques of analysis, etc. However, most analysts calculate estimates of variances and covariences in the same way; namely, by using previous price data. Since all have access to the same price history, it is reasonable to assume that their variance – covariance estimates may be the same."

Patel et al (2005) identified a number of challenges in applying real options analysis to real estate. Two areas they identify comprise the public availability of property data in a suitable form; and "the escalation and volatility pattern of the eventual property value and cost volatilities need to be identified from (as close as possible to) market data, using other than "smoothed" appraisal price data.

Nanthakumaran & Newell (1995) carried out a detailed empirical evaluation for a range of UK property indices. They conclude that the choice of an appropriate and reliable benchmark is of crucial importance for effective property performance evaluation. One of the key findings was that of the indices examined, each significantly underestimated property risk which was largely attributable to appraisal smoothing resulting from the use of valuations instead of market transactions.

Miles et all (1991) examined the possibility of creating a transactions based index and concluded constraints exists in most of the world's markets and that professional will be forced to work with less than ideal real estate proxies.

Lee & Ward (1999) presented a simple method of estimating the average risk of returns within a property portfolio together with average correlation between individual properties. They concluded that the average risk for retail property was about 20%. They estimated that average risk for property (both UK and overseas) and suggested that it is likely to lie in the region of 15% to 30% per annum. There were a number of caveats to these results and the authors suggested further research at individual property level within retail as well as other sectors.

Sing (1998) commented extensively upon volatility inputs for real option models and in particular the use of ex-post and ex-ante measures. So far as the former was concerned, inherent valuation biases and sampling errors in the indices created the serious problem of the underestimation of market risk. In a subsequent paper Patel & Sing (2000) presented the research contained in Sing (1998) for computing implied volatility on a stochastic contingent claim valuation model. This involved over 20,000 property transactions between 1984 and 1997. Implied volatility modeling is considered further in a forthcoming paper. In Patel & Sing (2001) this work was extended in an examination of irreversibility in the UK market and the correlation between volatility and the release of a contingent claim for development. Bulan et al (2002) also look at the effect of volatility on development irreversibility and explore different approaches to measuring actual historic volatility, while controlling the predictability of returns. They conclude that increased volatility leads to delay in development, but also show there is interplay between volatility, exposure to market risk and competition.

Bond & Hwang (2001) looked at the common volatility factor between securitised and unsecuritised UK real estate market. They stated a preference for multivariate models incorporating information from both the returns on valuation-based series and returns from securitised series rather than a single series, which could mask underlying asset volatility.

Wu & Guo (2004) highlight the role of information asymmetry on trading volume by focusing on the structure of rational beliefs and how the heterogeneity of belief structures affect equilibrium prices and price volatility. They state that a positive relationship exists between trading volume and the directions of price changes. As equilibrium prices increase price volatility decreases, and where short selling leads to equilibrium price falls, price volatility increase.

4. Database

The research presented in this paper (and the one that follows) is based upon a unique database created for Gerald Eve by IPD within the strict confidentiality rules in which they operate. This was as a result of a major research project into the holding periods for commercial UK property initiated in late 2003 utilising data of actual individual property assets within the IPD UK database. The project has been led by the Gerald Eve Research Team with input from the University of Reading Business School and in close consultation and assistance from IPD. As a result research was undertaken at an individual property level into performance, based on actual transaction prices (purchase and sales prices) to enable a more accurate assessment of UK commercial property in both absolute and relative terms. This avoids reliance on valuations and so called "smoothing bias" which in turn as indicated in the previous research above understates the volatility of property.

IPD in accordance with a specification provided by Gerald Eve Research and University of Reading Business School initially created a database of office, retail and industrial properties purchased between 1983 and 2004. This extended to only properties which had been acquired, thereby restricting the database to active trades. This eliminated any legacy assets retained in portfolios. In addition the following properties were also removed:-

- those where data was incomplete over the period between purchase and sale;
- properties held for six months or less not representative of "ordinary" transactions;
- "extreme" properties in the 1st and 99th percentiles of the raw sample which may have been affected by incomplete data or illogical chain linked measures; and
- any remaining properties recording an annualised return between purchase and sale exceeding 200%.

The Gerald Eve IPD database combines property records held in both the December and March IPD databases. The Gerald Eve IPD database is updated each year and the figures presented in this paper and therefore from 1983 to 2005 comprise a total of 21,038 which are broken down as follows:-

Sector	Gerald Eve IPD Database 1983 - 2005					
	Total %		Sold %		Held %	
Offices	5,839	27.8	3,691	28.6	2,148	26.4
Retail						
Shops	*7,634*		*5,584*		*2,050*	
Shopping Centre	*518*		*244*		*274*	
Retail Warehouses	*2,047*		*1,015*		*1,032*	
sub total	10,199	48.4	6,843	53.0	3,356	41.3
Industrial	5,000	23.8	2,372	18.4	2,628	32.3
Total	**21,038**	**100%**	**12,906**	**100%**	**8,132**	**100%**

In total the Gerald Eve IPD database after filtering contains over 1.45m observations. The database is separated into descriptive (spot) and performance (chain linked) measures with the former including acquisition and disposal prices, initial yields and equivalent yields and the later total return, capital growth, rental growth etc. The data is analysed used the Stata^R programme to enable regional market, and sub sector analysis.

In the earlier holding period analysis (Gardner & Matysiak 2005, Fourt et al 2005) equivalent investment performances were calculated for all property sub sectors at individual property level between purchase and sale. The raw performance measures were indexed to calculate returns between purchase and sale and this was divided by the derived holding period to give a comparable holding period measure of average annual performance for each property. As a result several observations were apparent:-

- for properties traded within the first four years of purchase there is significantly higher median total return;

- beyond the median holding period of 4.9 years, annualised total returns stabilise; and

- there is a far greater range of investment returns for properties traded in the early years after purchase demonstrating a large degree of volatility.

5. Data Analysis

Utilising the Gerald Eve IPD database for the period 1983 to 2005, there were a number of components which could be examined at individual property level for the purposes of ascertaining actual volatility estimates. The key, as already indicated above, was to identify which data within the database when measured at individual property level and subsequently aggregated, would best capture historic UK commercial property volatility which could then be applied to individual projects and to assist property derivative pricing.

For example when applying real options analysis to say development scenarios, the return on the scheme is derived from a number of individual inputs. The dominant factor being value. Value in turn is derived from a number of components including yield and rental levels but also have regard to timing. Scheme returns are project specific ignoring market cycles and relative performance. The proxy input volatility should therefore in our view be derived from being able to gauge the full investment performance of an asset relative to a benchmark for a defined period of time.

Property derivatives are essentially hedging instruments, which are more concerned with specific rather than market risk. Again the volatility proxy should have regard to establishing pricing.

We have therefore created a data series having regard to the benchmark of all properties within the December valued IPD universe. This was broken down into the five major sub sectors (industrial, office, retail warehousing, shops and shopping centers). Benchmarks were calculated over matching holding periods (see below) for each individual property (calculating the annualised figure for the relevant period). This was then subtracted from the annualised holding period return of the property, thereby calculating an excess return (or "alpha") for each property.

Two methods for capturing volatility have been used in this paper. The first of these we believe has particular application real options analysis for development properties, whilst the second may be more appropriate to property derivative pricing as illustrated below. Both use the Gerald Eve/IPD database.

Method One: In order to represent the average development period ie the time from formulation of a scheme, through the planning process, implementation and completion, we initially chose a 3/4 year period. Whilst a developer can decide whether to implement a particular project or not, therefore releasing the contingent claim, the project in terms of its form and content is settled upon some time before this date. It therefore seemed appropriate that for a schemes input volatility this should have regard to the whole development process. The 3/4 year benchmark was also relevant given previous research by Fourt et al (2005) which indicated a wide distribution of excess returns across sectors within a 4 year period. Below, by way of contrast, 3 year and 2 year periods are also looked at.

As a result a data series of excess sector returns was created on the following basis:

- a period of 3 years was defined ie say 1998 to 2000 and properties that were bought during that period identified;
- from the time of purchase all those properties sold were identified, ie for a property bought in 1999 if it was traded at 4 years it would have sold in 2003;
- as properties purchased at the end of the period could have traded up to 4 years thereafter, the analysis or data point was 4 years from the end of the period ie for the period 1998 to 2000, the data analysis point would be 2004;
- excess returns were calculated in respect of each individual traded property;

- distribution and standard deviations of returns were calculated by sector and geographic area.

As a result of the above a volatility time series built up from individual traded assets can be established at sector, sub sector and geographic level.

Method Two: The second of the two approaches focuses on the volatility of excess returns for acquisitions and disposals within 2, 3 and 4 year periods. For each year between 1989 and 2005 individual properties are identified that were purchased and sold within these periods for each of the sub sector property types. Distributions and standard deviations of returns were then calculated.

The results of the two methods are analysed in the next section. It is however important to note that no preference is made in respect of one over the other for the reasons outlined above.

6. Empirical Results

This section is set out under the following headings:

i. Overall sector volatility 1989 to 2005 for traded observations under 4 years;
ii. Sub 4, 3 and 2 year traded sector volatility 1989 to 2005;
iii. Geographic/sector volatility 1989 to 2005 for traded observations under 4 years; and
iv. Illustrative ex-post hedging strategies 2001 to 2005

In each case comments are provided on the results. General conclusions are provided in the following section.

i. Overall sector volatility 1989 to 2005 for traded observations under 4 years

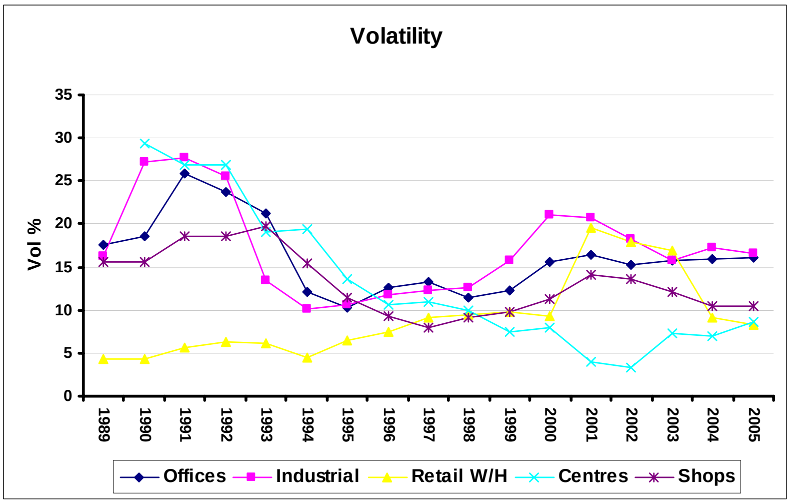
The table below sets out the number of observation and provides volatility results for the five major sub sectors. When considering the total number of observations in each period it should be noted that the same property may appear at different data points, as would be the case for traded properties. It follows that these should not be considered cumulative figures but simply as data that supports the volatility during any one period of time.

Sector		1989-2005									
		All Observations	Traded Observations <4 years					Standard Deviation			
		Acquired	Total Traded	% of Acquired	Av. pa	Min(yr)	Max(yr)	Av.%	Min%	Max%	Spread
Offices		12,132	3,510	28.93%	206	69	367	16.1	10.3	25.8	15.57
Retail											
	Shops	16,924	4,648	27.46%	273	84	455	13.1	7.9	19.8	11.90
	SC	859	151	17.58%	9	2	28	13.3	3.2	29.4	26.20
	Retail WH	3,814	1,053	27.61%	62	4	133	9.1	4.3	19.5	15.22
Industrial		8,624	2,242	26.00%	132	40	290	17.2	10.1	27.7	17.68
Total		42,353	11,604	27.40%	683	199	1,273				17.31

The total traded properties under 4 years as a percentage of all observations is just over 27%. Shopping Centres tend not to trade early and therefore the data is particularly thin with regard to this sector. Retail warehousing was an emerging sector in the early 1990's and therefore trading again was light, although observations had significantly increased by the mid to late 1990's.

The volatility for the sectors shows that industrials were on average, for the period, the most volatile sector at 17.2% followed closely by offices (16.1%) with retail warehousing being the least volatile at 9.1%. Ignoring shopping centers due to thin data, the spreads (i.e. between the lowest recorded volatility during the period and the highest of each sector) again show that industrials as the highest and perhaps surprisingly standard shops having the lowest spread. For all property the average spread was just over 17% during the period.

The graph below illustrates the changes in volatility for each of the sectors during the period:



With the exception of retail warehousing each sector showed higher volatility in the early 1990's than in subsequent years. This of course would be consistent with the poor or falling market where it would be expected to see increased levels of volatility. Lower levels of volatility are seen in the mid to late 1990's, again consistent with a recovering / rising market in most sectors. An upwards movement is observed in the early Y2K's.

ii. Sub 4, 3 and 2 year traded sector volatility 1989 to 2005;

Below a series of tables are presented showing for the five major sub sectors volatility changes for the period 1989 to 2005 for trades of sub 4, 3 and 2 years. This uses the method two approach outlined above. For comparison with the above the sub 4 year trades are shown in the table below:

Sector	**1989-2005**							
	Traded Observations <4 years				Standard Deviation			
	Trades	Av. pa	Min(yr)	Max(yr)	Av.%	Min%	Max%	Spread
Offices	1,274	75	29	123	16.8	10.3	25.8	15.5
Retail								
Shops	1,554	91	27	178	12.3	6.8	22.8	16.0
SC	68	4	-	19	8.0	0.0	23.5	23.5
Retail WH	437	26	2	52	9.2	2.0	22.9	20.9
Industrial	989	58	17	137	16.3	7.6	38.3	30.7
Total	4,322							21.31

This time the volatility for the sectors shows that offices were on just on average for the period the most volatile sector at 16.8% followed closely by industrials (16.3%). Again ignoring shopping centres due to thin data, retail warehousing was the least volatile at 9.2%. The spreads again show industrials as having a significantly high spread at 30.7% followed by standard shops and retail warehousing with spreads of 23.9% and 20.9% respectively. Offices have the lowest spread. For all property the average spread was just over 21% (compared with 17% above) during the period.

The sub 3-year trades for the period are as follows:

Sector		1989-2005							
		Traded Observations <3 years				Standard Deviation			
		Trades	Av. pa	Min(yr)	Max(yr)	Av.%	Min%	Max%	Spread
Offices		830	49	13	87	19.8	11.6	32.4	20.8
Retail									
	Shops	1,059	62	15	127	13.6	7.2	26.0	18.8
	SC	46	4	1	16	8.9	0.0	33.3	33.2
	Retail WH	293	17	2	39	10.0	2.0	26.1	24.1
Industrial		672	40	11	95	18.3	9.4	39.2	29.8
Total		2,900							25.34

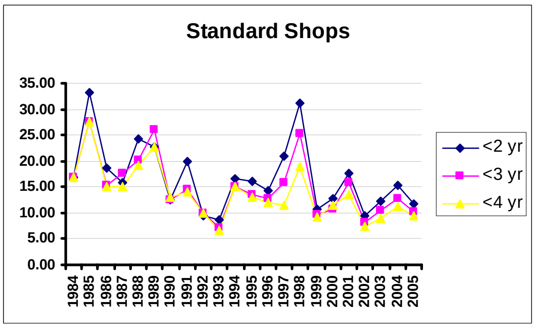
It is clear from the above in comparison with the previous table that volatility is in general increasing across all sectors with again offices being the highest at 19.8% and, ignoring shopping centres retail warehousing lowest at 10%. Spreads have also widened with the overall average over 25%.

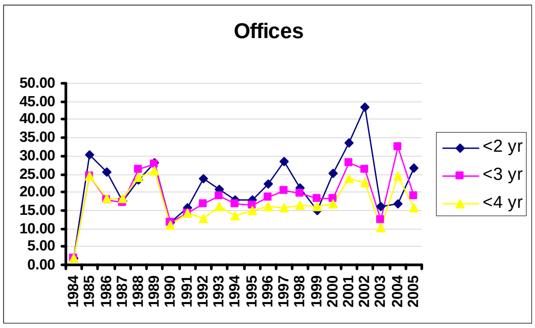
The sub 2-year trades for the period are as follows:

Sector		1989-2005							
		Traded Observations <2 years				Standard Deviation			
		Trades	Av. pa	Min(yr)	Max(yr)	Av.%	Min%	Max%	Spread
Offices		448	26	5	55	22.7	11.6	43.6	31.9
Retail									
	Shops	587	35	5	68	15.4	8.8	31.1	22.3
	SC	24	1	-	8	12.2	2.0	33.3	31.3
	Retail WH	159	9	-	26	10.2	4.3	16.2	11.9
Industrial		394	23	1	55	21.3	10.5	48.0	37.6
Total		1,612							26.98

Again volatility is increasing in general across all sectors with both offices and industrial being above 21% for the period. Retail warehouses are relatively static in comparison. Spreads have widened in the offices and industrial sectors significantly and to a lesser extent for standard shops. The retail warehouse spread has declined which may be due to data deficiencies during the period. The overall spread is just under 27%.

The relativity of the volatilities for the period 1984 to 2005 for trades of sub 4, 3 and 2 years are shown in the graphs below for standard shops and offices:

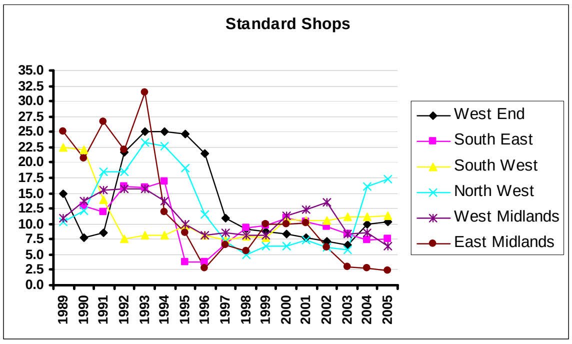


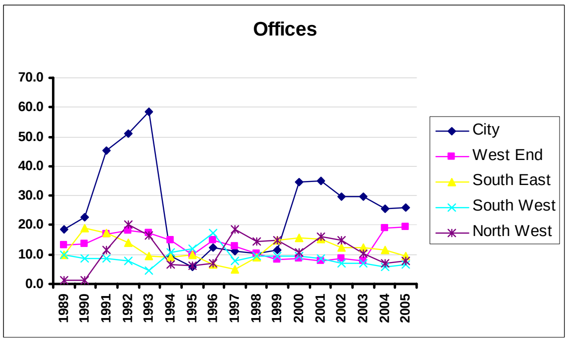


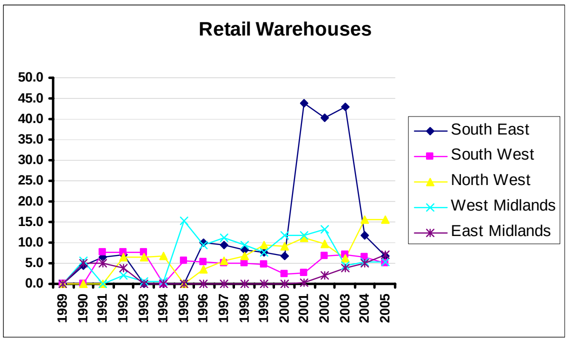
The general pattern is one of increasing volatility the shorter the trading cycle. This may be particularly of relevance for the emerging derivatives market where contracts are generally between 1 and 3 years.

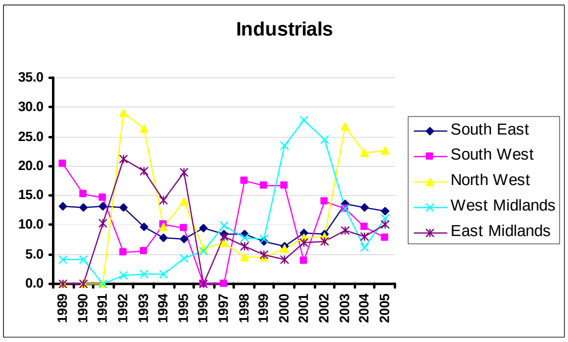
iii. Geographic/sector volatility 1989 to 2005 for traded observations under 4 years;

Whilst it is of interest to look at overall sector volatility this masks to some extent what is happening regionally. For the purposes of say appraising development schemes using real option models, the practitioner will be more interested in sector and geographical information. From the graphs below for standard shops, retail warehouses, industrials and offices, it is amply illustrated that geographic markets do not always follow national trends as previously indicated:





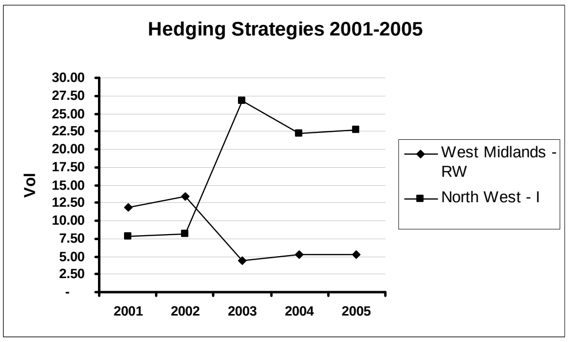


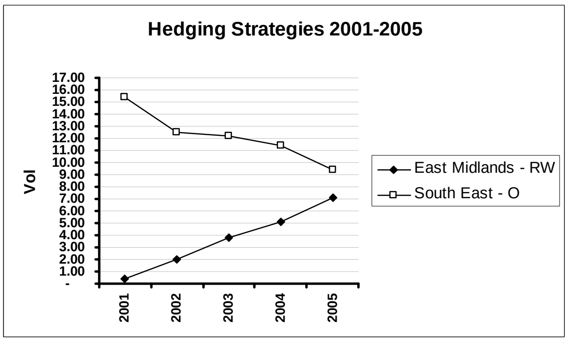


Data from individual sectors and geographic regions provide a mixed volatility picture when considered as a whole. Each graph may be indicating that individual property specific risk is far more in evidence particularly in highlighting local market trends for relevant sectors. We have not sought to compare the different sectors by region in this analysis, which may be of relevance particularly for mixed use schemes.

iv. Illustrative ex-post hedging strategies 2001 to 2005

Finally an analysis was undertaken utilizing the regional / sector data to see if volatility strategies could have been employed if a property volatility derivatives market had been in place. On a crude analysis looking at the period 2001 to 2005 negative correlations of 0.95 and above, several counter trades were evident. As an illustration two of these "volatility hedges" are shown in the graphs below for: west midland retail warehouses and north west industrial; and east midland retail warehouses and south east offices:





It is stressed this is a crude illustration and indeed to properly hedge for the period mixes of LIBOR may have to be introduced once more sophisticated pricing models are applied. In addition there would in practice be a need to re-hedge in a truly liquid volatility market. Assuming that five-year contracts were on offer (which is perhaps unlikely at present), it can be seen that it may be able to trade sector and geographic volatilities. The underlying transactional basis on the analysis may provide a more reliable basis for such contracts irrespective of the fact that the contracts themselves rely on indexes, which are valuation, based, thereby creating arbitrage opportunities.

7. Conclusions

Understanding risk in the context of real estate development and investment is a fundamental concern. Volatility is a key input into stochastic models for appraising risk. Whilst the UK property derivatives market is still in its infancy, its evolution will rely on a better understanding of underlying volatility.

Seeking to capture volatility and then apply this is critical to avoid mis-pricing and market inefficiencies.

This paper has looked at actual historic volatility of excess returns as an ex-post measure, using a specifically created transaction based data at individual property level.

The results from this paper will be compared with the results from forthcoming research using implied model based volatility (ex-ante) utilizing the same transactions based index. “Excess volatility” will also be identified.

Two methods have been applied to analyse historic volatility in this paper. It is stressed neither is preferred to the other as each could be applied dependent upon the specific circumstances from a practitioners perspective.

Excess returns were considered an appropriate basis from which to measure volatility given that specific risk rather than market risk is more relevant for applying to appraisals of individual projects on in derivative pricing.

Average volatilities and spreads in basis points, were identified having regard to both methods and trades from sub 2 to sub 4 years for the period 1989 to 2005. This can be summarized as follows:

Sector	Average volatility	Spreads (bp)
Offices	16% to 23%	1,500 to 3,200
Industrials	16% to 22%	1,700 to 3,800
Shops	13% to 15%	1,200 to 2,200
Retail warehousing	9% to 10%	1,100 to 2,400
Overall spread (average)		1,700 to 2,600

For shopping centers the data was considered to be unreliable given the scarcity of data, which is probably due to a lack of short term trading.

In general, the shorter the trading period the higher the volatility. This is of relevance to property derivative pricing which currently involves contracts of between 1 and 3 years in the main.

Geographic/ sector analysis provides a mixed volatility picture indicating that individual property specific risk and local trends are in evidence.

In crude terms, hedging strategies could have been employed based on directional volatility movements, assuming that a property derivative market for volatility had existed.

Finally the above results will be, tested and compared with model based implied volatility in a forthcoming paper.

References

Black F., Scholes M., (1973) “The Pricing of Options and Corporate Liabilities” *Journal of Political Economy* No 81 pp 637-654

Bond S., Hwang S., (2001) “A measurement of Fundamental Volatility in the Commercial Property Market” *Unpublished Working Paper, Department of Land Economy University of Cambridge.*

Booth P., Matysiak G., (2001) “Unsmoothing Real Estate returns: How should it Affect Pensions Plan Asset Allocation?” *2001 Cutting Edge Conference*

Brown G., Matysiak G., (2000) *Real Estate Investment, A Capital Market Approach*, Financial Times Prentice Hall

Bulan L., Mayer C., Somerville C (2002) ”Irreversible Investment, Real Options, and Competition: Evidence form Real estate Development *Unpublished Working Paper Brandies University, The Wharton School, and Ubiversity of British Columbia.*

Fourt R., Gardner A., Matysiak G., (2005) “Asset accumulation and replacement: Investment holding periods and performance costs of conventional active management” *Paper presented at the IPD/IPF Investment Conference, Brighton, UK October 2005*

Gardner A., Matysiak G., (2005) “Holding periods and investment performance: Analysing UK office returns 1983-2003” *Paper presented at the 12th Annual European Real estate Society (ERES) Conference, Dublin, Ireland June 2005*

Lee S., Ward C., (1999) “Estimating the Average Risk of UK Real Estate” *Unpublished Working Paper, Centre for Real Estate Research (CRER), The University of Reading.*

Merton R., (1973), “Theory of Rational Option Pricing” *Bell Journal of Economics* Vol. 4 No. 1 pp 141-183

Miles M., Hartzell D., Guilkey D., Shears D., (1991) “A transaction-based real estate index: is it possible?” *Journal of Property Research* Vol. 8 pp 203-217

Nanthakumaran N., Newell G., (1995) “An Empirical Evaluation of UK Property Performance Indices” *Proceedings of the “The Cutting Edge” Property Research Conference of the Royal Institution of Chartered Surveyors*, pp 75-92 RICS, Aberdeen, Scotland

Patel K., Sing T. (2000) “Implied Volatility in the UK Commercial Property Market: Empirical Evidence Based on Transaction Data”, *Journal of Real Estate Finance and Economics* Vol. 20 No.1 pp 5-24

Patel K, Paxson D, Sing T (2005) “A Review of the Practical Uses of Real Property Options”, *RICS Research Vol 5 No. 1*

Sing T., (1998),”Real Options in Real Estate: Irreversibility, Volatility and Option Premia in UK Commercial Property Market” Unpublished Doctoral Thesis, University of Cambridge, Department of Land Economy

Sing T., Patel K., (2001),"Evidence of Irreversibility in the UK Property Market" *The Quarterly Review of Economics and Finance* Vol. 41 pp 313-334

Wu H., Guo W., (2003) "Asset price volatility and trading volume with rational beliefs" *Economic Theory 23 pp 795-829*