The Causes and Effects of Depreciation in Office Buildings: a Ten Year Update

Andrew Baum** and Anita McElhinney

Department of Land Management and Development
University of Reading
Whiteknights
Reading RG6 6AW
England

** corresponding author

Tel: 0118 931 6419
Fax: 0118 931 8172
E-mail: A.E.Baum@reading.ac.uk

The Causes and Effects of Depreciation in Office Buildings: a Ten Year Update

Andrew Baum and Anita McElhinney

There are good reasons for expecting that depreciation, defined as a real loss in the existing use value of property, in rental or capital terms, has recently become more important as a driver of property investment performance. The pace of technological change and lower land values each suggest that the contribution of the building component of property value is likely to decline as a proportion of property value at a more rapid rate. This would damage the capital return on real estate investment. Unless real rental growth or inflation is high, this depreciation damage will become more transparent.

A 1986 study, published in full in Baum (1991), established a data set, a methodology for the measurement of depreciation (and its contributing causes), and a set of results for the City of London office market as it entered a phase of rapid rental growth. An updated but similar dataset and the same methodology has now been used to re-estimate (in mid-1996) the incidence of depreciation in what has been a lower growth, lower inflation environment.

This paper publishes the results of the 1996 study, which repeats a cross-section analysis of around 125 City of London office buildings, and examines the longitudinal data contributed by a sample of 56 unrefurbished properties common to the 1986 and 1996 City of London datasets. An estimate of the average rate of rental and capital value depreciation is made; the effect of age is shown not to be straight-line; and the causes if depreciation are measured. The results are compared with the 1986 City of London findings.

A hedonic model is used to estimate the impact on value, and hence on the depreciation in value, of a set of quality variables and changes in those variables. This holds more explanatory power than age alone.

Further, it is suggested that the empirical evidence supports the intuitive suggestion that as buildings age the contribution of building value to property value tends to zero and depreciation thereby disappears. Finally, it is suggested that the pricing of City of London offices may fail to recognise this effect.

1. Introduction

In this paper, which is concerned with measuring the impact and causes of depreciation in office buildings, two objectives are pursued.

The first is to draw a general conclusion about the rate at which office buildings in the City of London have depreciated over the period 1986 to 1996. To achieve this, cross sectional and time series information is expressed through an indexing method to produce a broad general estimate of the rate at which the rental value and capital value of office buildings have declined, with age as the explanatory variable.

To measure depreciation rates is not a new challenge. Hotelling, for example, pondered the accuracy of methods of measuring depreciation rates for machinery as long ago as 1925 (Hotelling, 1925). However, its importance in property investment has not been recognised until very recently. Relevant work has been concentrated in the UK (see Baum, 1993) .

The second objective is to explain rental values - and therefore rates of depreciation - as functions of a set of quality variables and of changes in those quality variables.

Recently, several papers have been published which discuss the use of regression models or hedonic price models in estimating or analysing property values. These include Webb, Miles and Guilkey (1992); Glascock, Kim and Sirmans (1993); Liu, Grissom and Hartzell (1995); Lockwood and Rutherford (1996); and Crosson, Dannis and Thibodeau (1997). A similar hedonic model used for rent and capital value estimation was originally used in the 1986 study and has been updated in the 1996 analysis.

In 1996, the authors undertook a study of office depreciation in the City of London. This study is based on and developed from the original survey of the City office market undertaken by Baum in 1986. This was published in the UK in full in 1991 (Baum, 1991) and in 1993 in the USA (Baum 1993). The following section summarises essential parts of the introduction to the latter of these.

2. What Is Depreciation?

Buildings, unlike many other forms of investment, suffer from deterioration and obsolescence. As they age, they become less valuable than equivalent new buildings as a result of wear and tear and changes in technology.

Depreciation itself is a loss in the existing use value of the property. It can be caused by physical deterioration or by functional or aesthetic obsolescence. While obsolescence is one cause of depreciation, such a decline in utility is not directly related to physical usage or the passage of time (Baum, 1991).

This study attempts to measure the effects of both physical deterioration and obsolescence over time and as a function of selected building qualites. It examines the impact of depreciation as manifested in its impact on rental values, yields and (as a product) and capital values. It begins by establishing a model which allows for the impact of depreciation in property pricing.

3. The Importance Of Depreciation In Investment

In a low inflation, low growth environment depreciation is a crucial factor in property investment. It is fundamental because it forms a basic input for any pricing or valuation model.

Depreciation estimates are required for two purposes. Assuming a DCF model is used for valuation over a finite holding period, an estimate of market rental values is needed for the purpose of estimating cash flows, and the long term expected depreciation rate must also feed into exit capitalisation rates.

The basis of a valuation model and exit capitalisation rate computation lies in simple equations developed by Fisher (Fisher, 1930) and Gordon (Gordon, 1962). These have been adapted and simplified (Baum, 1988; Baum and MacGregor, 1992) in a form which sets out to explain respectively the total return required on an investment and the relationship between total required return and initial return, as follows:

$$\mathbf{RFR + r = k + g - d}$$

where RFR is a risk free rate, r is a risk premium, k is the initial yield on the asset, g is expected income growth for new buildings, and d is the annual depreciation rate.

In simple terms, the required return on a property is a function of the risk free rate and the required risk premium for the property; the expected return is a function of the initial yield, the expected income growth and expected depreciation into perpetuity.

Note that the model requires the estimation of expected income growth. For equities, the estimation of expected dividend growth across the market is driven largely by expectations of economic growth, profit generation and profit share. For property the estimation of expected rental growth across the market is also driven by expectations of economic growth; but the effect is not as direct. Buildings age and become less valuable purely as a result of the passage of time. This is not true of companies, which (partly because depreciation charges in profit and loss accounts reduce profits) are encouraged to re-generate themselves. Buildings depreciate through physical deterioration and obsolescence. Expected growth in income is calculated gross of this (usually by econometric modelling or extrapolation of undepreciated rent indices), so depreciation needs to be taken into account explicitly.

3.4 Correct yields

The 'correct yield' for a property may be estimated based on the market correctly discounting long term market expectations of real rental growth, depreciation and inflation. For this purpose, it is important to calculate the average rate of depreciation into perpetuity.

$$RFR + r = k + g - d$$

So:

$$k = RFR + r - g + d$$

If depreciation rates vary with age, the long term depreciation expectation will rise and fall as a building ages: in this case the correct yield will be age-dependent. Yields are generally expected to rise with age: this clearly need not be the case if depreciation rates do not also rise with age.

4. Methodology

4.1 Sources

In this paper, we set out to draw a general conclusion about the rate at which the rental value and capital value of City of London office buildings have declined, using age as the explanatory variable. We also attempt to explain rental values - and therefore rates of depreciation - as functions of a set of quality variables.

Liu, Grissom and Hartzell (1995) describe how the hedonic price model relates the price of a property to its physical, legal and environmental attributes, utilising consumption (rather than investment) theory, which posits that consumers derive utility from the characteristics associated with a good rather than the good itself. Two deficiencies of the hedonic price model in this context are identified. First, the attributes used need to be chosen subjectively. In our paper, we accept that this is problematic, but simply repeat the classification of qualities fully explained and developed in Baum (1991). These were: building configuration, internal specification, external appearance and physical deterioration.

Second, the choice of market is also subjective. How can the analyst be sure that the sub-market studied is a coherent one? The office market of the City of London is widely accepted as coherent and spatially highly constrained (it is known as ‘the square mile’, yet it contains around 80 million square feet of office space).

Webb, Miles and Guilkey (1992) describe how hedonic models normally use cross-sectional differences in the assets being modelled to explain changes in price. While their paper does not develop a pure hedonic model, it relies upon a subjective measurement of ‘functionality’ and location, each measured by local property managers on a scale of 1 to 10, to explain changes in property prices and returns. In our paper a pure, albeit simple, hedonic model is used to relate qualities (using a scale of 1 to 5, again subjectively assessed by property managers) to both rental value and capital value. Given the availability of two cross-sections 10 years apart, it is also possible to observe changes in the relationships between price and qualities.

Glascock, Kim and Sirmans (1993) set out to test the homogeneity of the relationship between rent levels and relevant explanatory variables in different time periods and in various submarkets. We also explore the impact across different sub-markets by adding a 125-property study of the office market in the West End of London (not discussed here: see HRES (1997). Additionally, the 1996 update of the 1986 data allows a comparison of UK results with the Glascock et al results, namely that shifts in the impact of different quality variables differ over time.

Crosson, Dannis and Thibodeau (1997) illustrate the use of a regression-based model to explain price which expands the hedonic model to take account of exogenous factors such as market vacancy rates, not therefore using a strict hedonic model. Of interest in this paper is the use of age as a quality variable; while it is not significant in the Crosson et al data for multi-family housing, it is expected to be very significant in the City of London office market.

Lockwood and Rutherford (1996) point out other deficiencies of regression modelling, including multicollinearity between independent variables, and develop a more complex model (factor-analytic linear structural relations, or LISREL) to explain determinants of industrial property values. Consistency of methodology determined that regression was our chosen model, but multicollinearity is accepted as a problem in this work and damages the significance of apparent changes in the impact of qualities. This challenges, but is not wholly damging to, the findings of this paper.

4.2 The 1986 study

The 1986 project studied the City office market and an industrial estate west of London. The latter results have not been updated. The results were published in various formats (Baum, 1988, 1989, 1991 and 1993).

The most convincing work was achieved with the City office sample. This work was of the greater general interest, if only because offices comprised and comprise more than 45 per cent of the UK commercial property market (IPD, 1997) while industrials cover only slightly more than 10 per cent.

For various reasons of data quality, it was decided that a cross-section studies was to be used as the major research method in the identification of the contribution of building obsolescence (and its causes) to depreciation. This necessitates the comparative examination of values of buildings of different ages and types at one point in time. Hence at one point in time (July 1986) a slice of the City office market was sampled, and variations between buildings, rather than within buildings over time, were used to measure the impact of different factors on value.

Data was collected to furnish a cross-section analysis of rental value, yield (capitalisation rate) and capital value in terms of building age and building quality.

Differences in site value are likely to complicate such a comparative examination to an unacceptable degree. It is therefore highly advantageous in constructing a data sample of actual properties to exclude the effect of site value variations between properties of similar size and type. The requirements of a statistically significant data set are a constraint upon this. Very few opportunities exist within the UK to collect an acceptable quantity of data within a sufficiently homogeneous (in terms of site values) location, particularly bearing in mind current requirements of confidentiality of data within the UK property market. The requirements of the sample (to minimise differences in locational value while maintaining as large a potential data set as possible) were ideally met by the office market of the central part of the City of London, the area within a maximum radius of around one-third of a mile from the Bank of England.

The database comprised 125 office buildings, largely selected on the basis of familiarity to a leading firm of City property managers and/or inclusion in the RICS/Actuaries Rent Index (now defunct). This skewed the sample towards larger, more valuable and more prominent properties. Despite this, the properties include examples of both refurbishments and original (that is non-refurbished) buildings, air-conditioned and non air-conditioned offices and a wide range of ages and styles.

In order to ensure that a useful and (to a limited extent) representative sample of City offices was the result of this method of data assembly, initial analyses of the data were carried out to identify inconsistencies and the study area was, as a result, re-defined from the original. Inconsistencies were defined as very high or very low rental values per square foot in comparison to measured averages in the sample. Property managers were questioned about outliers of this type. If there were good reasons for such inconsistencies, the data was dropped. This happened in the case of a small number of low rental value buildings, all of which were currently the subject of renovation or refurbishment and whose current rental values were therefore artificially low.

Further more formal tests were carried out (see Baum, 1991). It was also necessary to control the effect of varying locations within the study area, in order:

i to ensure that wide variations in locational value did not exist; and
ii to smooth away any remaining minor variations.

A full description of the data preparation process is provided in Baum (1991).

4.3. The 1986 Results

The main findings of the 1986 City office research were as follows. For all City office properties in the sample, the annual rate of depreciation in rental value over the first 35 years of life averaged 1.1 per cent. The period of greatest depreciation in rental values was years 17 to 26, where the annual rate of depreciation reached 1.8 per cent. The annual rate of depreciation in capital values averaged 1.6 per cent. The period of greatest depreciation in capital values was years 20 to 29, where the annual rate of depreciation reached 2.1 per cent.

Building quality, defined as a combination of obsolescence-related factors (configuration, internal specification and external appearance) and physical deterioration, was found to be a better explanation of rental value (and depreciation in rental value) than simple age.

The most significant and important determinant of depreciation in rental value was found to be configuration, followed by internal specification. Physical deterioration was found to be least important. For explaining depreciation in capital value, internal specification and external appearance were most important; deterioration was again least important.

6. The 1996 Survey: The Background

6.1 Selection of the dataset: City

The collection exercise began with a commercial database which holds details of of 536 buildings, generally the more prominent office properties in the City. This was to be reduced to a target size of 125 by a process which had the following objectives in mind:

(i) to update the sample, in order that it included new properties of size and importance and thereby retained a sample truly representative of the prime end of the City office market;

(ii) to maintain a lower size limit of 10,000 square feet;

(iii) to attain a representative sample by age band since construction or major refurbishment;

(iv) to structure the sample by size band;

(v) to avoid excessive locational clustering of the sample; and

(vi) to emphasise those properties best known to the property managers who were to take part in the survey.

While the data assembly was a fresh exercise independent of the 1986 dataset, it was hoped that the new dataset would include a significant sample of properties from the original sample in order that a simple longitudinal test of depreciation (a comparison of values at 1986 and 1996 for a constant sample of properties) might be made. The final 1996 dataset comprised 128 office buildings. Of these, 82 were in the 1986 survey. If those 82, 26 had been rebuilt or had been the subject of major refurbishments with in the previous ten years and could not, therefore, be retained in the constant sample. This leaves 56 properties which were in the 1986 survey and the 1996 survey without obvious evidence of major expenditure in the interim period.

However, to claim too much for the quality of a longitudinal analysis would be misleading. No attempt has yet been made to trace the detailed history of these properties over the intervening period: any expenditure other than the cost of a major refurbishment would not be taken into account. This would mean that the assessed depreciation rate would not be accurate. More specifically, while it may provide interesting comparative data describing the value of properties on which no refurbishment expenditure has been applied, it would tend to under-estimate any decline in value over time because it is likely that some expenditure outside the tenant's normal responsibilities will have been made on some properties.

6.2 Data collection

Further data to be collected included (i) the scoring of building qualities for the sample properties and (ii) estimations of the yield and rental value for each property. This data was collected in two one-day sessions from a team of three property managers.

Scoring was on a scale of 1 to 5, where 5 indicates highest quality. The qualities scored are the same as in 1986. These are:

(I) external appearance, including the impact of the entrance hall;

(ii) internal specification, including the quality of services;

(iii) configuration, including floor to ceiling height and plan layout; and

(iv) deterioration, both internal and external.

6.3 Data smoothing/preparation

6.3.1 Location

The property managers interviewed thought that location (the area of the City within which the property was located, for example West and East, or postal area EC3 against EC2) would have a significant impact on rents. However, as in 1986, the analysis showed low correlation between wider location factors and rental value. Variations in site quality, on the other hand, were important: the street, the immediate neighbours and so on had an effect on rent with a correlation coefficient of 43 per cent. However, the correlation in 1986 had been *81 per cent*: this suggests a weakening of the importance of micro-location, probably with a corresponding increase in importance of building quality. This would suggest the possibility that depreciation rates will be higher in the new survey than in the 1986 research.

Given the inconclusive nature of the result, rental data was analysed twice, with the rents smoothed for the site effect, and on an unsmoothed basis. The smoothed results are reported for the purpose of comparison with the 1986 analysis.

6.3.2 Lot size

In 1986 the yield (capitalisation rate) data had been adjusted to account for lot size variations. High lot sizes sold on lower yields in 1986: the correlation was (minus) 59 per cent. In the 1996 survey, it was expected that there would again be a premium (capitalisation rate discount) for large lot sizes, but this did not turn out to be the case. The correlation between lot size and yield was positive, and very small. Unlike 1986, therefore, no smoothing of the yield data was necessary for the 1996 sample.

6.3.3 Refurbished and original buildings

The 1986 survey had distinguished between original and refurbished buildings. A chow test suggested that the results for these sub-sets were not significantly different. The 1996 research produced the same result.

The maximum age of an unrefurbished building was imposed as 35 years. This affected a small number of properties with reported ages greater than this since a major refurbishment, the veracity of which is highly doubtful.

7. The 1996 Results

The main findings of the 1996 research were as follows.

7.1 Age and rental value means

The average age of the 1986 office sample was 9.6 years; the 1996 equivalent was 14.9 years, a large increase. Given an expectation of no change in the long run, one must speculate about the fundamental difference in the study date in terms of the development cycle. The City office stock clearly appears to have aged in the 1986 to 1996 period.

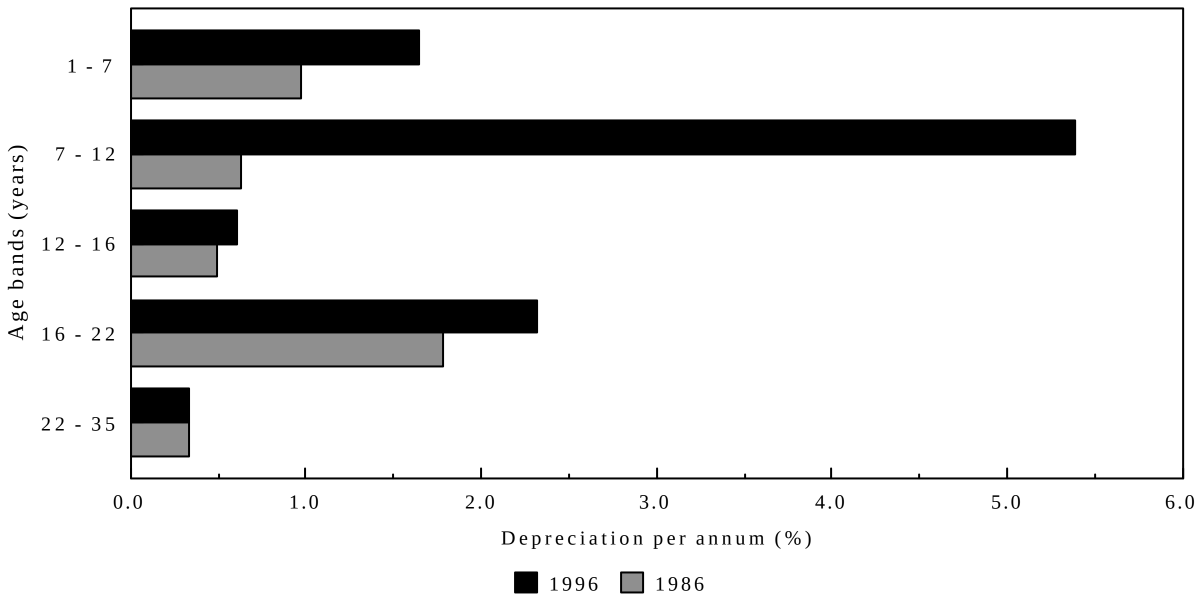
The mean City rent fell from the 1986 sample mean of £32.33 to the 1996 sample mean of £22.66; yet inflation over the period would have taken £32.33 to £50.36. This inflation-adjusted rent ignores depreciation, sample ageing and changes in the real market value and can only at best be attributed to one, two or all of these factors: see below.

7.2 The relationship of rental value and age

For all City office properties in the sample, rents fell from an average of £31.21 for properties with an average age of 1 year to an average of £15.18 for properties with an average age of 34 years. the annual rate of depreciation in rental value over (approximately) the first 35 years of life averaged 2.2 per cent. This was a doubling of the 1986 value of 1.1 per cent.

The period of greatest depreciation in rental values, previously years 17 to 26, was now much earlier (years 7 to 12) where the annual rate of depreciation reached 5.4 per cent. In brief, the incidence of depreciation in rent now appears more severe and affects the second review period by far the most.

Figure 1: Depreciation in smoothed ERV and age band: 1986 and 1996

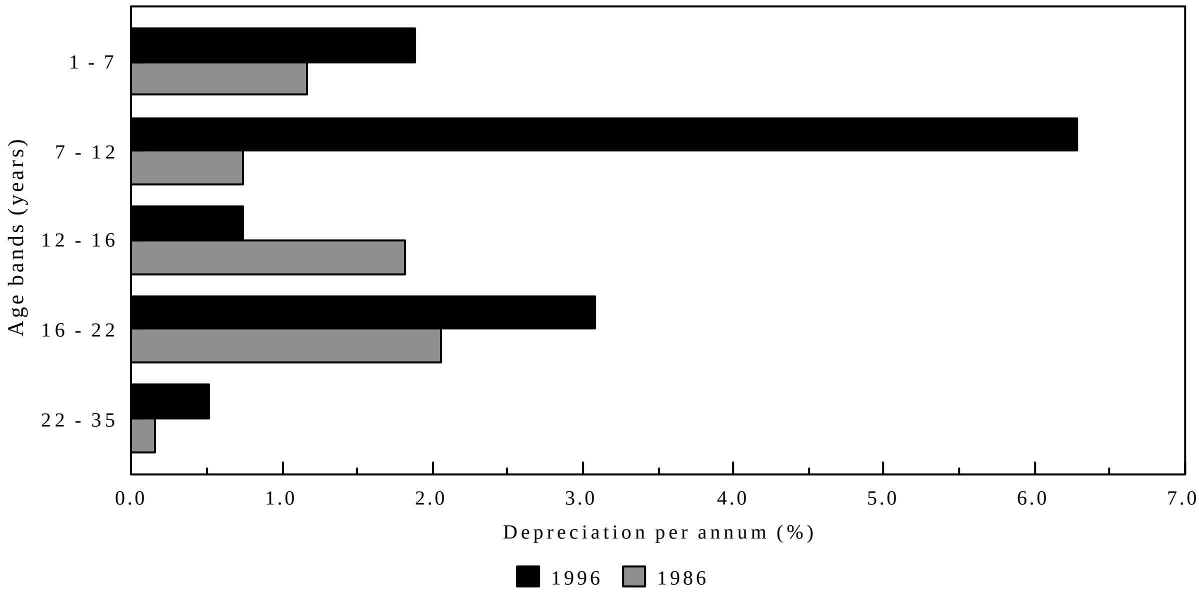


Source: Baum, HRES, LSH

7.3 Capital value and age

The annual rate of depreciation in capital values averaged 2.9 per cent (1986: 1.6 per cent), half as much again than before. The period of greatest depreciation in capital values was again years 7 to 12 (1986: years 20 to 29), where the annual rate of depreciation reached 6.3 per cent, more than three times its maximum 1986 value.

Figure 2: Depreciation in smoothed CV and age band: 1986 and 1996



Source: Baum, HRES, LSH

7.4 The impact of building quality

Building quality, defined as a combination of obsolescence-related factors (configuration, internal specification and external appearance) and physical deterioration, was once more found to be a better explanation of rental value (and depreciation in rental value) than simple age. The difference in coefficients of determination was 68 per cent less 29 per cent; in 1986 this had been 73 against 39 per cent.

The results should be qualified by the fact that all building quality factors are positively correlated with each other, which damages the clarity of the rankings.

The most significant and important determinant of depreciation in rental value was found, by a clear distance, to be internal specification (1986: configuration), followed by physical deterioration (1986: internal specification) which, in 1986, had been least important. Least important in 1996 was external appearance. For explaining depreciation in capital value, the same results are clearly obtained.

The results probably indicate a major change in the demands of space users in the City. Configuration in 1986 was all-important, driven by the effect of Big Bang and the needs of financial services occupiers for clear areas of dealing space and underfloor space for cabling. In 1996 configuration of space had become less important, and the need was for high specification buildings, particularly in services, as traditional (non-dealing floor) users of space appear to have more influence on market prices.

8. Longitudinal analysis: 1986-1996

8.1 Introduction

Of the 128 properties in the 1996 survey, 82 were also in the 1986 dataset. Our enquiries showed that 26 of these properties were the subject of serious refurbishment in the intervening period, leaving a dataset of 56 properties common to the 1986 and 1996 surveys.

The average age of these properties in 1996 was 17 years (7 in 1986, of course), with a standard deviation of 8.4 years, a maximum age of 45 years and a minimum of 10 years. The average size was 62,000 sq ft (maximum 305,000, minimum 10,000). The average (smoothed) rental value in 1996 was £18.96; in 1986, the same properties had an average (smoothed) rental value of £31.60. The correlation between the 1986 and 1996 rental values was 0.52: there was clearly a large range of subsequent performance.

It is possible to use this data to assess depreciation over time, both in rental value and capital value.

8.2 Rental value

The average rent for the July 1986 sample was £31.60; the average rent for the July 1996 sample was £18.96. This would suggest an average annual depreciation rate of *5.2 per cent*.

However, this incorporates the effect of movements in market value, including the demand for and supply of space. It is useful, therefore, to measure the differential movement in rents for the ageing 56 properties relative to the dynamic market.

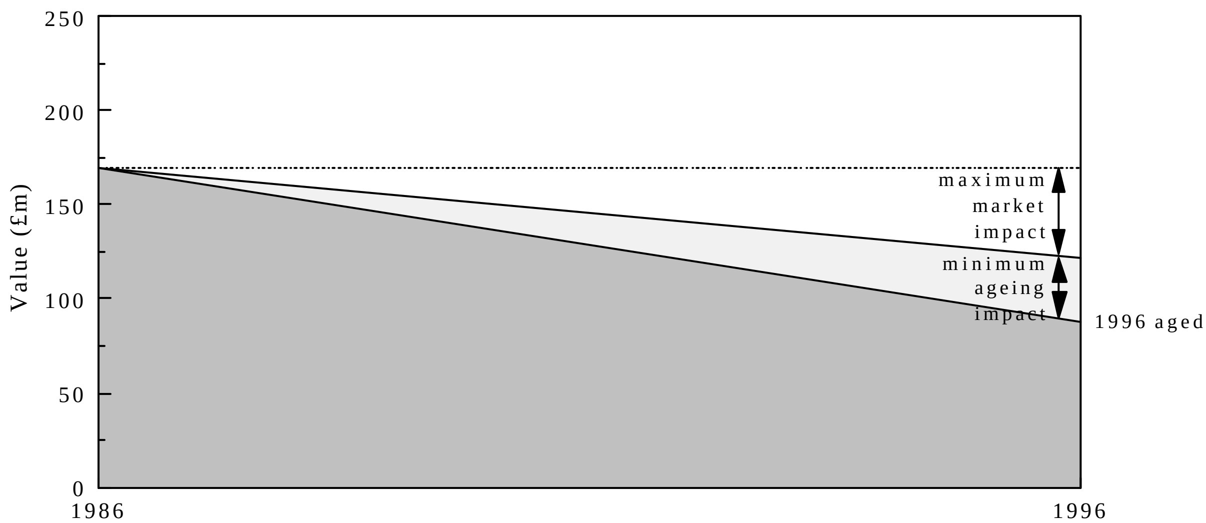
The top rent in the 1986 sample is identical to the top rent (£40) in the 1996 sample. This may suggest that market values had not changed over the ten years, but this may be misleading, for two reasons. First, in 1996 incentives were still common as a means of maintaining 'headline' rents (Baum, 1995). Rent free periods of 12-18 months were not uncommon for new lettings, and the rents collected from property managers in the 1996 survey were provided on a headline basis. This had not been the case in 1986. Hence the market had probably fallen in value, despite the maintenance of the headline rent.

Second, many would argue that in 1996 the market was less deep - in other words, that secondary properties were worth less as a proportion of prime values than would have been the case in 1986. So what was the average price movement in the City over the period?

IPD (IPD, 1997) measures year-end rental value and capital values for the City. In 1986, valuations of 361 properties produced an ERV index of 169; this had fallen to 122 on 287 properties in 1996. The capital value index had fallen from 146 to 126 over the same period. Bearing in mind that the average age of this sample had almost certainly increased (see above), it should be borne in mind that the data will tend to exaggerate the like-for-like decline in market value and therefore tend to understate depreciation. The results are therefore as follows. The rental value depreciation rate for the sample is 5.3 per cent. Of this, a maximum of 3.3 per cent can perhaps be attributed to declines in market value; a minimum of 2 per cent remains as ageing-related depreciation.

Hillier Parker provide a rent index and yield series for high quality property, disaggregated to the City office level. This provides a hypothetical rent and capital value series, and one which can be criticised for its lack of direct association with real property portfolios, but one which is unaffected by ageing of the sample. At May 1986 the rent index stood at 278, having risen to 296 by May 1996; the capitalisation rate (yield) level stood at 4.8 per cent in May 1986, and had risen to 5.3 per cent in 1996. This suggests a reduction in capital values for a hypothetical property of 0.36 per cent each year, leaving around 5 per cent as the implied depreciation rate in the City sample used in this research.

Figure 3: Market and age impacts: value over time, City



Source: Baum, HRES, LSH

This rate is much higher than the average rate produced by the 1996 cross-section study (2.2 per cent). There appears to have been more depreciation within the properties which formed part of the original sample than within the 1996 cross-section. This illustrates the methodological difficulties involved; it may also indicate that the apparent rate of depreciation is highly time-dependent due to differences in market conditions.

8.3 Capital value

The average (smoothed) capital value per square foot in 1996 was £278; in 1986, the same properties had an average (smoothed) capital value of £662 in 1986.

The capital value depreciation rate for the sample is 9.1 per cent. It is difficult, if not impossible, to attribute this to market value declines and the impact of age due to the impact of over-renting (Baum, 1995) and the distorting effect of this upon yields.

In the 1996 cross-section study, the period of greatest depreciation in capital values was again years 7 to 12, where the annual rate of depreciation reached 6.3 per cent, somewhat supporting the longitudinal result. Capital values in the City office market appear to have depreciated in value by around six per cent for each year of age in the recent past.

8.4 The impact of quality changes over time, 1986 to 1996

Following Webb, Miles and Guilkey (1992), we have been able to measure changes in the quality of the sample buildings and the impact of this upon performance.

The variation in subsequent performance in terms of rental and capital values is clearly not explained by age, as all properties are ten years older, but the correlation between rental and capital values for the two dates is as low as 52 per cent. This could be measurement error. More likely, the variation must be explained by variations in building quality, bearing in mind the smoothing of the locational effect.

This would be more likely if the correlation of 1986 building qualities with the 1996 scores were less than one. In all four cases, the correlation is between 0.4 and 0.5, with internal specification the least variable.

Changes in the average quality scores are instructive. Site scores were stable, averaging 3.6 and 3.7 in the two surveys. Configuration was, as expected, also stable at 2.9/2.8. Deterioration only fell from 3.4 to 3.2, suggesting continuing maintenance efforts by owners and perhaps occupiers, while internal specification (partly an obsolescence factor, and thereby incurable) fell from 3.2 to 2.7. The decline in external appearance quality (an obsolescence factor which is at least partly incurable) was greatest, from 3.5 to 2.2.

It is possible to hypothesise a simple relationship between change in rental value and change in quality scores. The suggested relationship is as follows:

change in rental value =

constant +

change in external appearance +

change in internal specification +

change in configuration +

change in deterioration

The relationship is not powerful: only 27 per cent of rent change is explained by these variables.

Within the measured factors, declines in rental value are explained best by changes in the internal specification score, confirming the importance of this factor, and by changes in the deterioration score, again following the cross-section result. Internal specification is significant at the 95 per cent level; deterioration is significant at the 90 per cent level.

Changes in configuration are insignificant. This may appear to be obvious, as the plan layout and floor to ceiling height will not normally change, but this finding may also be interpreted as suggesting that there are no major perceived changes in market notions of high configuration quality.

Changes in the external appearance score also fail to explain declines in rental value. The relationship is random, suggesting the taste of property managers is not reflected in the rents occupiers are prepared to pay.

For capital values, deterioration is the most significant factor explaining falls in value over the ten year period. Changes in the quality of external appearance and internal specification are also significant at the 90 per cent level.

9. Other Findings

9.1 Building lives

Capital values in the City office market appear to have depreciated in value by around 2.9 per cent for each year of age. Assuming site values of 50 per cent of prime value, the maximum life of a building would be around *25 years*. This is a surprising result. If building lives are considered to be longer - our survey suggested 40 years - site values would have to be as low as one-third of the total property value. At depreciation rates of 1.6 per cent each year, 40-45 years was the implied building life assuming 50 per cent site values in the 1986 research. Building lives in the City appear to be shorter than they were.

9.2 Depreciation is not forever

Depreciation for older property is lower than depreciation on new property. This is because properties are closer to the end of their building lives and therefore close to their site values. When depreciation rates are calculated into perpetuity depreciation rates for older property are therefore lower than for equivalent new buildings. In all 1996 results, depreciation rates tend towards zero as the building age approaches (say) 30 years.

9.3 Age and pricing

It is possible to make some generalised comment on the relationship between observed prices and hypothesised 'correct' prices. To do so we need to use a model for correct pricing (see section 2 above) and make some assumptions.

The simple perpetuity model is as follows.

$$RFR + r = k + g - d$$

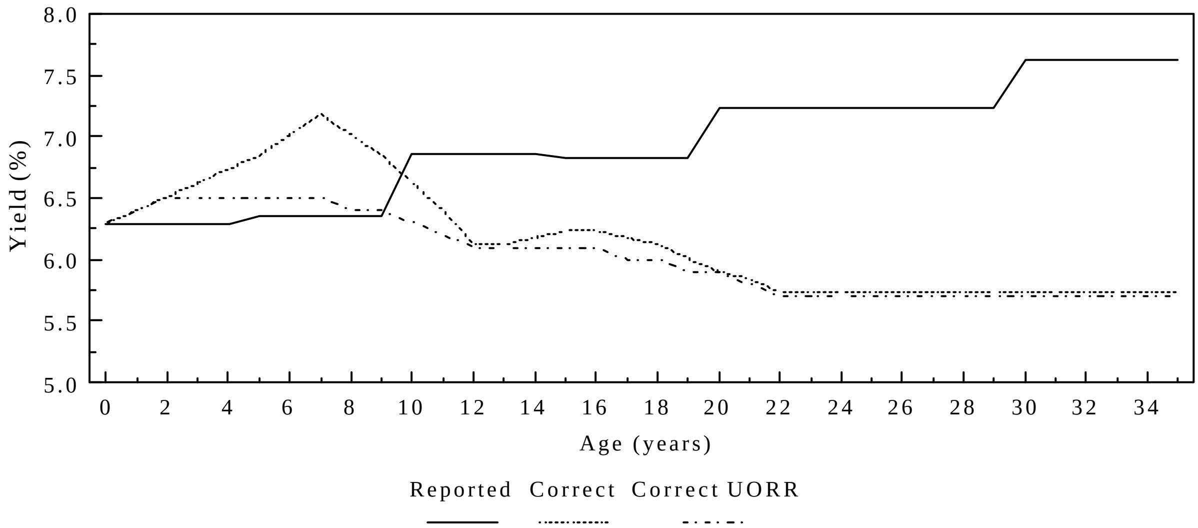
So that: $$k = RFR + r - g + d$$

If we can estimate the long term values of r, g and d and the risk free rate, adjusted marginally by the cash flow pattern of property and the inflation effect, we can then produce an estimate of the correct value of k.

The current average yield based on our sample, of new City properties is 6.3 per cent. Using a DCF expansion of Fisher/Gordon, this would be explained, for example, by a risk free rate derived from long-dated government bonds at 6.9 per cent, a risk premium for property over bonds of 2 per cent, long term inflation expectations at 4 per cent and real expected rental growth of one per cent.

A comparison of 'correct' yields and reported yields for different age bands suggests an anomaly. Reported yields rise as age increases, from 6.3 for new properties to 7.6 for older properties (assumed to be let at the current rental value on new 15 year leases with upward only rent reviews), as shown in Figure 4.

Figure 4: Reported and correct yields, City



Source: HRES

Correct yields, calculated on the same basis but with annual upward and downward rent reviews, do not rise with age. Instead, there is an initial rise followed by a fall. The data suggests the greatest pricing error at year 7, just before the period of high depreciation rates is suffered; and the best value at year 34, where the error is at its minimum.

This illustrates one or both of two conclusions: first, City investors are highly dependent on long leases with upward rent reviews to protect the value of depreciating assets; second, it is possible that they have been over-paying for new investments, as better value may be available in the older sector of the City market. In order for this conclusion to be incorrect, newer buildings have to demonstrate much higher average rental growth and/or investors have to be prepared to accept lower returns on new buildings.

10. Conclusions

The attraction of property compared to other assets is undermined by the effects of depreciation reducing value over time. It is essential that adequate provision for the effects of depreciation is made in any property investment analysis.

In 1986, rental values for City offices had been found to be been declining at just over 1 per cent per annum. Capital values had been falling at 1.6 per cent, as buildings aged. However, building qualities, not ages, were found to be better at explaining falls in value.

Configuration of space had been the most important building quality in 1986, about the time of Big Bang and explained incurable depreciation, while internal specification explained curable depreciation.

Since 1986, the City office stock has clearly aged and average rents have fallen. In the last ten years, City office market rental values have fallen by 1.5 per cent per annum: but ageing has led to further declines for our sample of properties of nearly 4 per cent. Rental value depreciation has increased from 1.1 to 2.2 per cent. with the impact concentrated over the second review period. Capital value depreciation has increased from 1.6 to 2.9 per cent with the impact on the second review period three times as great as it had been in 1986.

Internal specification is now more important than configuration and maintenance of the fabric has become more important; curable depreciation is now more important than incurable effects, because buildings are more flexible.

Building lives are getting shorter. But depreciation is not forever: depreciation for older property is lower than depreciation on new property. Better underlying value is available in older buildings.

Depreciation is now much more important as a driver of property investment performance. Even the City of London office market, arguably the best-researched sector of one of the world's most efficient property markets, offers the potential for serious damage - and also for serious profits, generated through wise investment in a mispriced market.

Bibliography and references

Baum, A (1988a), **Property Investment Depreciation and Obsolescence**, London, Hill Samuel and Richard Ellis

Baum, A (1988b), Depreciation and Property Investment Appraisal, in Nanthakumaran, K and MacLeary, A (eds), **Advances in Property Investment Theory**, London, E and F N Spon, pp 48 -69

Baum, A (1991), **Property Investment Depreciation and Obsolescence**, London, Routledge

Baum, A and MacGregor, B (1992), The Initial Yield Revealed: Explicit Valuations and the Future of Property Investment, **Journal of Property Valuation and Investment**, Vol X, No 4, pp 709-726

Baum, A (1993), Quality, Depreciation and Property Performance, **Journal of Real Estate Research** (USA), Volume 8 Number 4, Fall, pp 541-566.

Baum, A (1995), Can Foreign Real Estate Investment Be Successful?, **Real Estate Finance**, 12.1, Spring 1995, pp 81-89.

Brennan, T, Cannaday, R and Colwell, P (1984), **Office Rent in the Chicago CBD**, AREUEA Journal, 12:3, 243-60.

Crosson, S, Dannis, C and Thibodeau, T (1997), Regression Analysis: A Cost Effective Approach for the Valuation of Commercial Property Portfolios, **Real Estate Finance**, Vol 12 no 4 (Winter 1996), 20-28

Fisher, I. (1930) **The theory of interest**, Porcupine Press, Philadelphia

Glascock, J, Kim, M and Sirmans, C F, (1993), An Analysis of Office Market Rents: Parameter Constancy and Unobservable Variables, **Journal of Real Estate Research**, Vol 8, no 4 (Fall 1993), 625-638

Gordon, M.J. (1962) The Investment, Financing and Valuation of the Corporation**,** Irwin, New York, reported in Brigham, E. (1982**) Financial management: theory and practice**, (Fourth Edition), Dryden Press, Chicago

Hotelling, H (1925) A General Mathematical Theory of Depreciation, **Journal of the American Statistical Association**, 20, 340-353

Henderson Real Estate Strategy and Lambert Smith Hampton (1997), **Trophy or Tombstone? A Decade of Depreciation in the Central London Office Market**, London, Lambert Smith Hampton

Investment Property Databank (1997), **Annual Digest 1997**, London, IPD

Liu, C, Grisson, T and Hartzell, D (1995), Superior Real Estate Investment Performance: Enigma or Illusion? A Critical Review of the Literature, in Schwartz, A and Kapplin, S (eds.), **Alternative Ideas in Real Estate Investment**, Boston, ARES/Kluwer, pp 59-82

Lockwood, L, and Rutherford, R (1996), Determinants of Industrial Property Value, **Journal of the American Real Estate and Urban Economics Association**, Vol 24, no 2 (Summer 1996), 257-272

Webb, J , Miles, M, and Guilkey, D (1992), Transactions-driven Commercial Real Estate Returns: the Panacea to Asset Allocation Models**, Journal of the American Real Estate and Urban Economics Association**, Vol 20, no 2 (Summer 1992), 325-357

Acknowledgements

We would like to thank Mark Charlton of Lambert Smith Hampton, Paul Richards, formerly of Lambert Smith Hampton, and colleagues at HRES for their technical input. We would also like to thank the property managers at Lambert Smith Hampton who contributed their valuable time, effort and data to this research.