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Extending the Real Estate Pricing Model

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Report for Royal Institution of Chartered Surveyors

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Executive Summary

Investment theory dictates that capitalisation rates for freehold property should be determined by the risk free nominal rate of return plus the risk premium less the expected growth rate, with an allowance for depreciation. The capitalisation rate will therefore vary depending on capital markets and a range of locational and physical characteristics, as well as leasing structures and tenant quality.

The purpose of this micro-level study is to examine the pricing of commercial property investments focusing on the determination of capitalisation rates and the property attributes that influence the risk premium. In reality, capitalisation rates within market valuations are often determined by reference to direct comparison with other similar property investments, especially in mature, transparent markets with a depth of transactions. However, this process still requires some reconciliation of imperfect comparables. This study seeks to aid that process by identifying the attributes that drive the differences in capitalisation rates.

In order to achieve these aims, this paper develops a risk framework that ranges from macro economic influences to micro property-specific attributes. The framework is used to identify appropriate explanatory variables that are analysed within a spatially robust multi-level model. This model is estimated to attempt to disaggregate the capitalisation rates observed for office properties, distinguishing between the macro economic factors, property market influences and property specific attributes.

The cross-sectional inter-temporal analysis employs a dataset of 497 property transactions that occurred in the London office sector over a two and half year period during 2010, 2011 and 2012 and that contains property specific information, including the new CoStar building quality rating launched in 2013.

The findings of the research are that, as expected, the major influences on the variation in capitalisation rates across the London office markets are at the micro property-specific end of the risk scale, rather than the more macro economic and property market factors. For example, submarket influences explain only 15% of the variation in capitalisation rates in the London office market. Increases in the risk free rate, as measured by 10 year Government bonds, introduce a decrease in capitalisation rates; which suggests that over the period 2010 to 2012 they were related to both a change in the risk premium and in expected growth caused by changes in inflation expectations. In addition, the timing of the transaction has little influence on capitalisation rates as the study was undertaken in a time of stable yield levels.

Specifying rental growth expectations within a modelling framework has proved problematic within other studies. Here, following our conceptualisation of the capitalisation rate and its components, we identify a range of factors that, together with growth expectations, indicate investor concern for market quality. We adopt a submarket location rental change variable to identify the quality of the location that will ultimately drive rental growth. The analysis suggests better performing submarket locations are being recognised by investors through reduced capitalisation rates. However, actual rental growth, when measured as an absolute instead of relative historic growth rate, appears to have no impact.

Property specific influences on capitalisation rates include the existence of mixed use offices with retail (lower capitalisation rates) or residential (higher capitalisation rates) and higher tenant covenant strength (lower capitalisation rates). We also explore the influence of transaction type, to include freehold or long leasehold tenure (freeholds have lower capitalisation rates). All these findings are as expected.

Property specific attributes that, surprisingly, fail to significantly impact on capitalisation rates include unexpired term to lease expiry. Results for building quality are inconclusive although, when vacancy levels are high, some types of poorer quality buildings attract higher yields.

Other insignificant property-specific factors include single or multi letting, properties located on corner plots and sales of mixed ownership properties. However, some aspects of ownership are significant, principally those purchasing with international investment experience, whether from overseas or the UK, buy at lower capitalisation rates than UK investors with no international experience.

This project has added further evidence of the drivers of capitalisation rates and therefore investors' risk preferences and should help to develop a better understanding of how investors perceive individual property attributes. This is important to practice and academia, not least because it employs a revealed preference method and a transaction based dataset that have not been used before to examine the pricing of commercial property investments.

Keywords: *Property pricing; London office market; Capitalisation rates; Risk premia; Revealed preferences*

1.0 Introduction

The nature and behaviour of commercial investors have radically altered in the wake of globalisation and the liberalisation of capital and investment markets which has taken place during the second half of the 20th Century and the first few years of the 21st. A consequence of these changes has been that the ownership of the larger, more valuable stock in the UK has shifted from small local entrepreneurs to major property companies, financial institutions and funds, both national and international, with banks acting as a major source of finance for much of this change. Subsequently, commercial investment property pricing has developed within an increasingly sophisticated, analytical and global environment.

However, the relative lack of transaction volumes, and the fact that many transactions are not in the public domain, has restricted the analysis of property markets at the micro level and increased the importance of valuations in commercial property investment analysis as well as in the acquisition and sale process, in performance measurement and in bank lending decision-making. This study seeks to redress this imbalance by using transactions rather than valuations to carry out a micro level analysis of prices in the central London office market.

This paper is part of an ongoing exploratory study that examines commercial property investment decisions and the perceived risk attached to specific property attributes in the determination of prices. The level of prices in the market place for investment property is represented by capitalisation rates; formed by dividing the transaction price into the current rent/rental value. There have been very few empirical studies that have attempted to measure the importance of attributes in the pricing process. Most studies have investigated the determination of capitalisation rates using aggregated data and no published study in the UK has examined variation in the determination of capitalisation rates on a cross-sectional basis (for example, Nourse, 1987; Ambrose and Nourse, 1993; McGough and Tsolacos, 2001). Hence, the aim of this study is to develop a theoretical and consequential modelling framework that will enable the relative importance of individual investment attributes in the determination of capitalisation rates to be explored. In order to do this, a database of central London office transactions has been developed.

2.0 Previous Research

Previous studies that have investigated property yields have tended to adopt one of three broad approaches. The first focuses on estimating capitalisation rates as a function of macroeconomic and capital market variables, for example Froland (1987), Evans (1990) and Chandrasekaran and Young (2000). Froland explained 86-95% of the variation in US cap rates between 1970 and 1986, although attracted criticism for his lack of theoretical foundations (Judd and Winkler, 1995) and for not allowing for property sector differences or for the effects of time (Chandrasekaran and Young, 2000). Evans (1990) and Chandrasekaran and Young (2000) examine capitalisation rates for residential/commercial real estate, concluding that real estate investors are slower to adjust their expectations than stock market investors in response to changes in the macro-economy, isolating the real estate market from the capital markets.

The second approach is dominated by the US Band of Investment framework. Initially, Ambrose and Norse (1993) modelled average capitalisation rates as a fixed effects panel model. In this simple two-level hierarchical model, they derive a function of location and market factors and debt and equity components, as defined by the band of investment approach, to explain sector based capitalisation rates. They conclude that a cross-section/time series panel approach provides parameters that are most consistent with a priori expectations of the band of investment model. However, they find that most of the variation is explained by property type, captured by the intercept terms, and argue for the need to account for the variation in yields by allowing for property specific characteristics.

Judd and Winkler (1995) extend the work of Ambrose and Norse by developing a model of property capitalisation rates that compliments traditional finance theory, drawing on WACC and CAPM theories. They model capitalisation rates as debt and equity spreads using contemporaneous and lagged spread variables and find that capital markets appear to drive the required returns on property. They also find that significant lag adjustments exist and that the structure of these depends on the property type and local areas.

Each of these first two approaches produces useful empirical evidence at a high level of aggregation but lacks the full theoretical conceptualisation needed to advance understanding of the determination of capitalisation rates at the stock level, albeit the Band of Investment framework lays clear foundations. Thus, the third approach draws on and extends the work of Fisher (1930) and Gordon (1959), focusing on the now well-established pricing model:

1 $k = \mathrm{RFR} + \mathrm{RP} - g + d$

where k = capitalisation rate, RFR = nominal risk free rate, RP = risk premium, g = growth and d = depreciation.

As shown, the model is extended here to include depreciation, important within the real estate sector. Breaking this down into its component parts reveals that some elements are well understood and represent little measurement difficulty. However, by contrast, others are less well researched or established, both in terms of the underlying determinants and the empirical estimation of the importance of each.

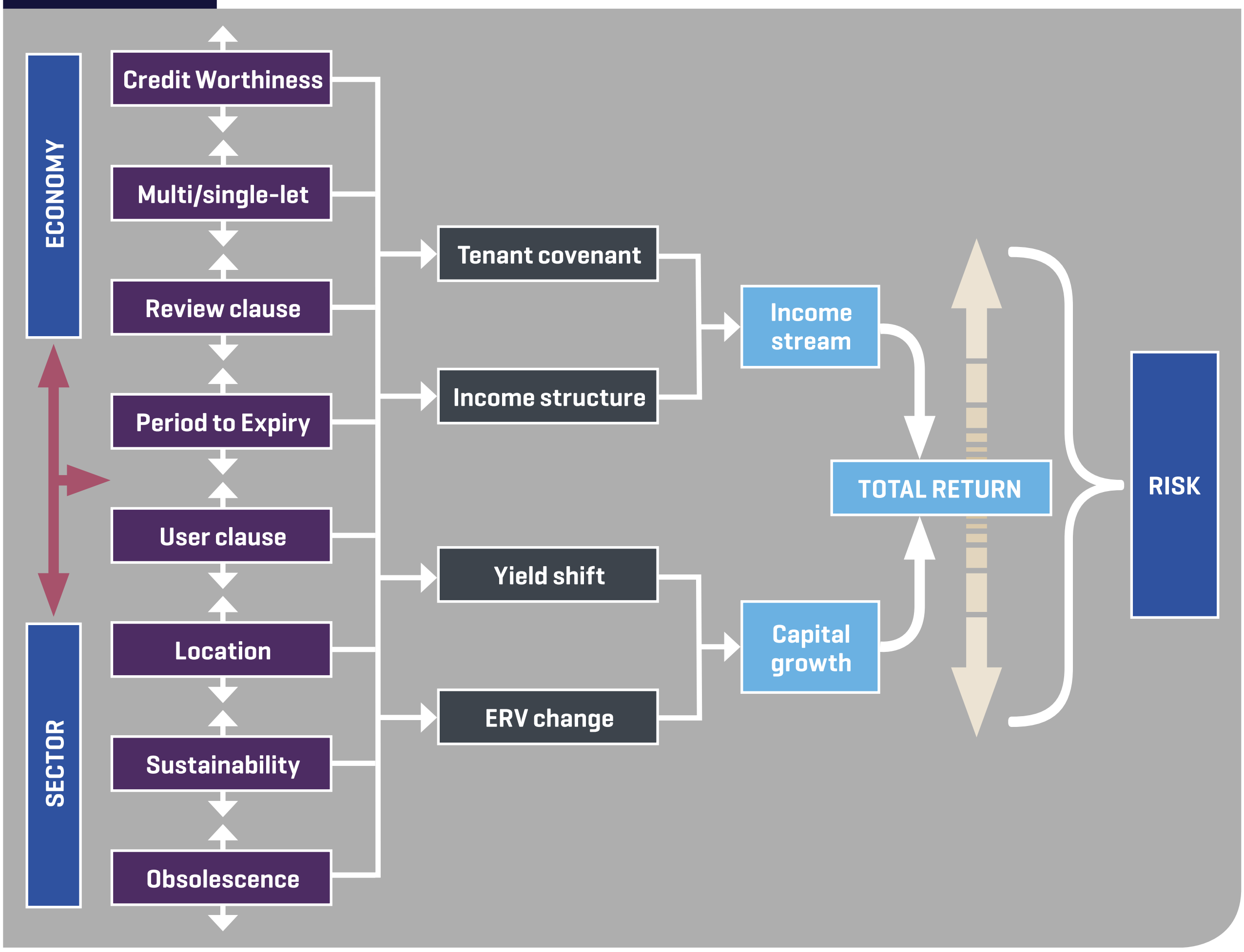
Returns on individual stock vary in response to numerous factors across what could be termed a broad risk scale, determined by macro to micro levels of influence. Beginning at the macro end of the scale, as money searches for the best returns, the minimum that should satisfy is that available from a risk-free asset (RFR). Thus, drawing on Fisher (1930), Baum and Crosby (2008) set out that the RFR represents return to compensate the investor for expected inflation and time preference/impatience. This, then, provides the benchmark against which alternative (riskier) assets are assessed and returns considered. Baum and Crosby discuss that the redemption yield on government bonds, matched to the term of the investment, provides an appropriate guide. Hutchison et al. (2012) suggest that while this is a reasonable measure for the loss of liquidity and anticipated inflation, relationships between real returns and expected inflation have appeared to break down in the aftermath of the financial crisis and the flight to safety, with real returns close to zero for bonds (Dimson et al., 2013). The debate on whether these new levels are temporary or are part of a changing dynamic in investment markets is important to understanding the level of target rates and risk premia. In this paper we accept the traditional view of risk free rates but acknowledge the uncertainty surrounding the basis of the risk free rate choice. Baum and Hartzell (2012) go on to explain that, to avoid time-specific bias during unusual market periods, longer run averages may be used.

Moving along the risk scale to the property market exposes the investor to risk (and growth and depreciation) and a risk premium (RP) is required by investors in compensation. Blundell (2009) considers this at the national level and that it will reflect a range of factors, such as illiquidity, expected earnings growth, default probability and so on. Baum and Crosby (2008) break this down and discuss how this risk can be conceptualised and its sources disaggregated within the overarching RP. They set out three alternatives to help assess the appropriate level of the RP, but conclude that, at the individual stock level and due to definitional and data constraints, the two options provided by CAPM and WACC are of little use. They therefore focus on what they term the ‘intuitive approach’, drawing from Baum (2002). Thus, Baum and Crosby (2008) and Baum (2009) set out that the RP can be disaggregated into various components to include property market, sector, location and stock-specific factors, and each, in turn, can be seen as representing an increasingly micro level influence. The property market premium is stated to represent the differential risk associated with property compared to equivalent equity risk and, in addition, an amount to represent the sensitivity of the cash flow to economic shocks, especially in terms of rental growth and depreciation expectations; illiquidity; and a catch-all group of other factors, stated to include factors such as the impact on portfolio risk and the lease pattern. Conceptually, this is a little problematic given possible overlaps with other categories of drivers at more micro spatial scales and, therefore, more detailed specifications are sought within the conceptualisation and, of course, when operationalising this pricing model.

The sector and location components of the RP are given little attention in the literature and thus it seems sensible to continue with the idea of moving through the spectrum of spatial scales to guide conceptualisation. Thus, for example, factors such as vacancy rates and growth potential at the sector level may be considered, while Baum and Crosby (2008) encourage investors to consider, within the location component, the local market and the local economic structure and catchment (and local competition) as relevant, especially in their contribution to market quality and, therefore, a sound and liquid investment opportunity at this sector/location scale.

The final component of the RP, the stock/asset premium, is disaggregated further by Baum and Crosby (2008), drawing on Baum (2002), to comprise tenant risk, lease risk, location risk and building risk – factors that underpin specific risk, each contributing to the risk and growth potential of individual stock. Jackson and Orr (2011) provide a review of studies of these stock-specific factors underpinning variation in return and risk levels, finding general consensus of the categories provided by Baum and Crosby. Drawing on these studies (for example, Wofford and Preddy, 1978; Dixon et al., 1999; IPD, 2000; Devaney and Lizieri, 2005; Blundell et al., 2005; Adair and Hutchison, 2005; Byrne and Lee, 2006), Jackson and Orr set out a conceptual model unravelling the chain of causal effects linking tenant/lease/location/building risk to asset returns and risk (Figure 1). In operationalising their model, they set out specific definitions of different levels of these factors for investors to consider.

Figure 1 **Real Estate Attributes, Return and Risk**



Source: Jackson and Orr (2011)

The extended Gordon pricing model set out in Equation 1 above explicitly shows adjustments to the capitalisation rate to reflect expected future growth, further influenced by depreciation. Factors underpinning growth may be seen across the risk scale, such as the impact of the economy on the property market overall and variation in this across sectors and submarkets. Likewise, Crosby et al. (2013)'s findings on UK depreciation measurement and rates suggest that rental depreciation rates are also affected by factors across the risk scale; i.e. market state and ratio of site value to developed values, as well as specific property attributes such as building quality. However, the major drivers were specific property attributes.

Most previous work does not disaggregate the components of the capitalisation rate to the level of addressing the measurement of growth and/or depreciation across the risk scale. However, Jackson and Orr's (2011) conceptual model set out in Figure 1 traces the causes of variation in returns at the stock level back to the underlying attributes. This is important here – it is proposed that growth and depreciation expectations at the stock level are a function of the stock attributes and these attributes therefore capture investor expectations.

Table 1 provides a summary and conceptualisation of the complexities of the property pricing model. Crucially, it attempts to locate distinct elements along a risk scale. The table shows a disaggregation of the components of the capitalisation rate and identifies the causes of risks at distinct spatial scales. The final column sets out variables to enable the operationalisation of the model.

A few studies have sought to undertake a disaggregated level of analysis, raising important and useful findings, but they have not taken the disaggregation to the extent presented here which necessitates the detailed conceptualisation proposed. For instance, Sivitanidou and Sivitanides (1999) modelled local level (metropolitan) office capitalisation rates in the US using local-fixed and time-variant components within a simple equilibrium adjustment framework, with time series/cross sectional versions. They include local and time variant variables to explain investors' required returns and income growth expectations. They found the local and time variant components to be significant and to explain more of the variation than the national factors (expected inflation and stock returns). A follow on study by Sivitanides et al. (2001) refines the approach and confirms that fixed market characteristics

Table 1 **The Capitalisation Rate and Risk Scale**

<table>
<tr><th colspan="2">Spatial Scale of Influence</th><th>Returns to Reflect</th><th>Drivers</th><th>Variables</th></tr>
<tr><td rowspan="8">Macro
Micro</td><td>Investment and Capital Markets</td><td>RFR</td><td>Expected inflation, time preference</td><td>National level measures such as Treasury Bill rates, Gross Redemption Yields on government bonds, and actual and expected inflation rates</td></tr>
<tr><td>Property Market</td><td rowspan="7">Risk and growth expectations</td><td>Performance and volatility of property relative to other assets</td><td rowspan="3">Macro-economic and industry estimates of income and capital returns and key drivers in asset markets at national, local and submarket levels</td></tr>
<tr><td>Sector</td><td rowspan="2">Market specific factors, economic/ catchment profile</td></tr>
<tr><td>Location</td></tr>
<tr><td rowspan="4">Stock/Asset</td><td>Tenant</td><td>Credit worthiness</td></tr>
<tr><td>Lease</td><td>Multi/single-let, Review/user clause, Period to expiry/review</td></tr>
<tr><td>Location</td><td>Micro location/ accessibility</td></tr>
<tr><td>Building</td><td>Sustainability rating, Obsolescence</td></tr>
</table>

create persistence differences in capitalisation rates across markets but that national macroeconomic forces account for some of the variation.

Hendershott and MacGregor (2005) present one of the few property level UK studies using privately held data. They apply an error correction framework to appraisal capitalisation rates in prime UK locations and demonstrate that office and retail yields are inversely related to real expected rental growth and positively related (but insignificantly) to real dividend growth. Dunse et al. (2007) examine the determination of initial yields in nine provincial office markets in the UK relative to the City of London. They adopt the basic pricing framework and set it within an error correction panel model which covers a period of more than 20 years. They use the gross redemption yield on 15 year bonds to measure the nominal risk free rate of return, and split the risk premium into two variables, one measuring the return on alternative investments (measured as the dividend yield on the FTSE 100) and the other capturing investors' perceptions of local market conditions, measured by the real value of financial institution regional transactions. They also measure the expected growth rate as the real rental growth derived from the net annual average rents achieved by properties held in the IPD portfolio and assume depreciation is constant across the cities. A further two variables, following the work of Hendershott and MacGregor (2005), are added to the error correction model to capture the deviations of rent and stock market dividend yield variables from the equilibrium.

Plazzi et al. (2008) and Plazzi et al. (2010) use transaction data for US Metropolitan Areas and build a set of simultaneous equations, derived from an extended Gordon framework, to examine the cross-sectional dispersion of rental growth and expected returns (in their 2008 paper) and time variation in expected returns, rental growth and capitalisation rates at the area level (in their 2010 paper). They find that office capitalisation rates cannot be used to forecast expected returns and call for further work on identifying the determinants of property capitalisation rates.

Looking at previous empirical estimates of the RP overall, figures vary to include around 2% (Fraser, 1993, for prime property); 3% (Hoesli and MacGregor, 2000); an average of around 4% in the pre-crash period of 2002-06 (DTZ, annual); or, surprisingly lower at around 3.5% in the post-crash period since 2008 (IPF, quarterly, for the required return above RFR). Blundell (2009) estimated that the risk premium in past returns on property over the period 1981-2008 as 3.1%. His estimate includes the risk-free rate (as measured by the gross redemption yield on government bonds over the period) at 7.3%, 6.4% for the property initial yield, 6.3% for net rental growth and 2.3% for depreciation. Hutchison et al. (2012) attempt to advance this work by modelling commercial risk premia within a time varying framework, reflecting market dynamics and cyclicality in returns. Their Markov regime switching model suggests that regime shifts are less important in the property market than in other investment and commodity markets. They found no evidence of structural breaks in office risk premia, unlike other sectors, although warn that the aggregation of data may be masking structural changes, implying the need to examine risk premia at a more disaggregated level.

3.0 Developing the Pricing Framework into a Multi-Level Model

The literature review set out above highlights the importance of distinguishing between the influences on expected commercial property investment performance and therefore prices. The review highlights the importance of influences at different spatial scales on the performance of property. These spatial influences on the performance of property assets should give rise to spatial variation in the capitalisation rate achieved by investors in investment transactions. However, the spatial disparities in capitalisation rates can be masked by a range of property and transaction specific factors that operate across several spatial levels, and give rise to spatial autocorrelation. This argument was made by Orford (1993) and Leishman (2009) to explain their use of multi-level analyses to explicitly allow houses to be nested hierarchically when modelling local house prices. A similar nested hierarchy exists within the commercial property market. Figure 2 shows how investment transactions can conceptually be represented as a simple two level nested structure, where transactions are clustered within submarkets and that there may be shared influences from particular submarkets on transactions within those submarkets.

A multi-level model, similar to the approach taken by Sivitanidou and Sivitanides (1999), will allow an exploration of the spatial variations in capitalisation rates that are driven by submarket effects, while also measuring the variation generated by the characteristics of the property, its tenants, its purchaser and how wider macroeconomic factors influence the expectations of purchasers with regards to individual investments. This modelling framework is suitable here as it explicitly captures the hierarchical structure of investment transaction outcomes when transactions are clustered within submarkets. Other statistical techniques, such as multiple regression, that ignore the effects of clustering, give biased standard errors which can result in random variation being mistaken for real effects.

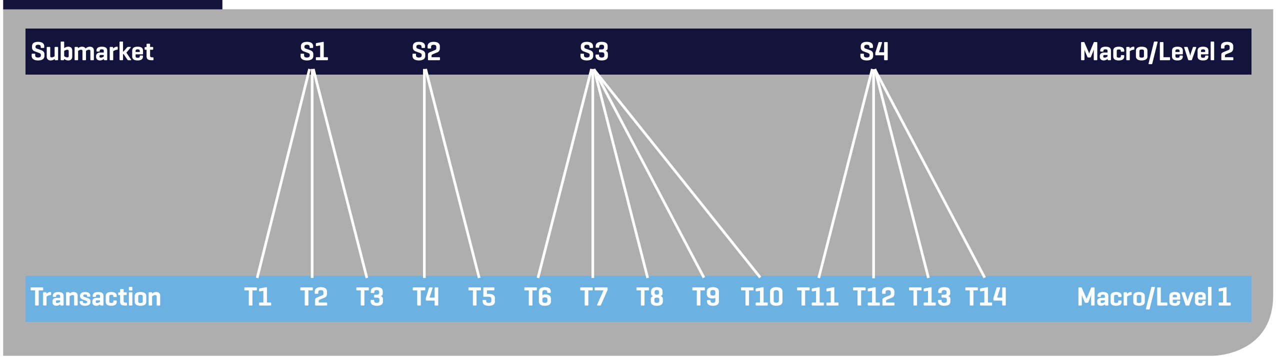
Initially, a micro-level model is specified to capture the impact of attributes specific to the transacted property in the determination of property capitalisation rates achieved in each investment transaction. This gives the level 1 model:

2 $$k_{ij} = \beta_{0j} + \sum \beta_{lj} \beta_{lij} + e_{ij}$$

where k_{ij} is the capitalisation rate achieved in transaction i nested in submarket j and e_{ij} represents the variation in yields that cannot be explained by the property and transaction characteristics. This model is extended from a regression model where β_{0j} accommodates the possibility of j intercepts as these can vary across sub-markets.

The explanatory variables and parameters are represented by β_{lij} and β_{lj}, respectively. In theory there could be any number of explanatory variables but the sigma sign (Σ) is used to give a concise expression for the sum of the variables that determine the capitalisation rate in transaction i nested in submarket j and l represents the index of summation. These explanatory variables capture the property and transaction specific variables expected to influence the return a buyer expects on a transaction. An assumption underpinning this model is that the residual term (e_{ij}) follows a normal distribution with variance equal to σ_e^2.

Figure 2 **A Unit Diagram for a Two Level Nested Hierarchy**



With reference to the conceptual framework in Table 1, investors' expectations about the performance of investments over their holding periods are a function of macro/micro factors, beginning with conditions in the national capital markets and moving to local office submarkets. Level 2 specifically captures the clustering of transactions within submarkets, and the influence of the structural traits of the submarket, such as size, composition and quality of the market, which influence investors' risk perceptions. These effects should be common to all transactions in the same submarket so it is necessary to add an area-level error term that allows for variation between areas. Equation 3 allows for this by taking the intercept of Equation 2 (β_{0j}) and specifying it as:

3 $\beta_{0j} = \gamma_{00} + \sum \gamma_{l1} A_{lj} + \mu_{0j}$

This represents the macro-level equation. This equation assumes that a submarket's intercept varies around an overall average capitalisation rate (γ_{00}) when all the predictors (A_{lj}) are equal to zero. ΣA captures the submarket-level explanatory variables and μ_{0j} represents the deviation of submarket j from this average. This is also termed the submarket-specific effect. The combination of Equations 2 and 3 forms a simple two-level hierarchical model that models the determination of capitalisation rates as a transaction process nested within submarkets:

4 $k_{ij} = \gamma_{00} + \sum \gamma_{l1} A_{lj} + \mu_{0j} + \sum \beta_{lj} \beta_{lij} + e_{ij}$

This type of multi-level model is termed a "fixed effect model" and allows for two sources of random variation, at level 1 of the transaction process (e_{ij}) and at level 2 of submarkets (μ_{0j}). In keeping with analysis of variance models, the two variance components ($\text{var}(e_{ij}) = \sigma_e^2$ and $\text{var}(\mu_{0j}) = \sigma_\mu^2$) need to be estimated along with the other parameters in the model. The total variance is $\sigma_e^2 + \sigma_\mu^2$ and the proportion of the total variance attributed to submarkets can be estimated as $\sigma_\mu^2/(\sigma_e^2 + \sigma_\mu^2)$ whereas the transaction specific variance can be estimated as $1-(\sigma_\mu^2/(\sigma_e^2 + \sigma_\mu^2))$. The clustering of transactions into submarkets induces a correlation between the capitalisation rates of pairs of transactions ($\text{cov}(R_{er_{ij}} R_{er_{ij}}) = \sigma_\mu^2$) which are located within the same submarket and the size of this correlation, also referred to as the variance partitioning coefficient, should be the same as $\sigma_\mu^2/(\sigma_e^2 + \sigma_\mu^2)$. In ordinary least square regression there should be zero correlations between the residual terms in the model.

In Equation 4, submarket variation in capitalisation rates is allowed for by the inclusion of fixed effects in the theoretical linear model. This can be conceptualised as a series of submarket curves, each having different intercepts for each submarket but being similar in slope due to the same micro-level drivers having the same effects on the transaction process across all submarkets. However, it is possible that the effect of any micro-level covariate that determines capitalisation rates will vary between submarkets, and Bailey *et al.* (2012) highlight the benefit of hierarchical models in that they allow for the existence of more complex patterns of variance to be investigated. This can be achieved by specifying an additional macro-model as:

5 $\beta_{nj} = \gamma_{n0} + \mu_{nj}$

Equation 5 now allows for variation in the slopes of the submarket curves where the common slope β_{nj} is replaced by another random effect. From this a random-intercept and random-slope model, including level-2 variables and cross-level interactions, is derived by substituting Equation 5 into 4 to give Equation 6.

6 $k_{ij} = \gamma_{00} + \sum\gamma_{l1} A_{lj} + \gamma_{n0}B_{nij} + \sum\beta_{(l\text{-}n)j} B_{(l\text{-}n)ij} + \mu_{0j} + \mu_{nj} B_{n1ij} + e_{ij}$

This is our theoretical mixed effect model of capitalisation rates. Within the model $\gamma_{00} + \sum\gamma_{l1} A_{lj} + \gamma_{n0}B_{nij} + \sum\beta_{(l\text{-}n)j} B_{(l\text{-}n)ij}$ represents fixed effects and $\mu_{0j} + \mu_{nj} B_{n1ij} + e_{ij}$ represents random effects which have two random effects at the submarket level. In a stepwise estimation process, each of these stages in the model's development will be operationalised and examined to see how effective the inclusion of the fixed and random effects are in explaining capitalisation rates.

4.0 Transaction Data

4.1 Data sources and transformation

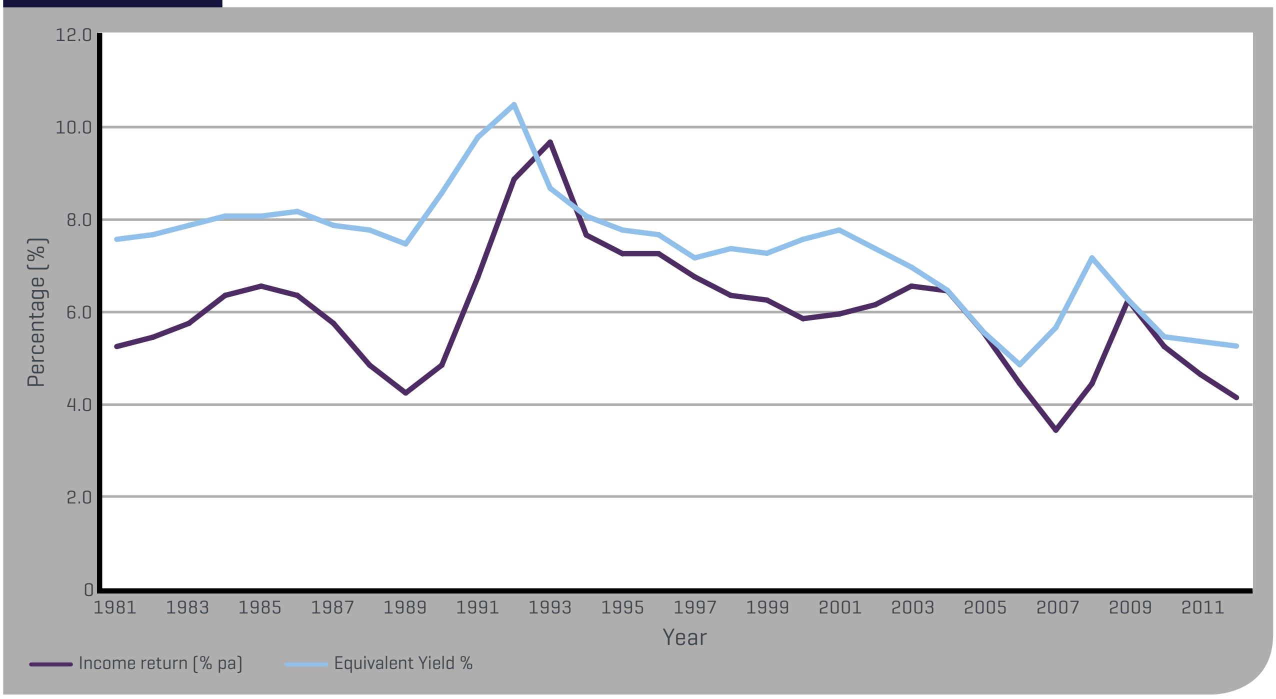
The analysis of capitalisation rates presented here explores transactions in the central London office market over the period 2010Q2-2012Q3. The data for the project are primarily provided by CoStar and comprise information on individual transactions relating to the characteristics of the buildings, leases, occupation and ownership. Beginning in the period explored here, CoStar also collects building quality data. Additional data are collated from CoStar and other sources such as EGi for tenant covenant scores; these additional data sources are used to also confirm and supplement the individual property data from CoStar. The new building quality data from CoStar represent the first opportunity to fully explore the pricing of property attributes and that has driven the timescale of the analysis.

The dataset may be the most comprehensive available but it has its limitations. Much of the data are provided by agents, owners and tenants and cannot be verified as being perfectly accurate although the data collectors do try and verify the information. There are a number of observations that are available from multiple sources, for instance floorspace, and there were some discrepancies between sources, not always minor. The research team spent a considerable amount of time attempting to reconcile different information while amalgamating data from different sources.

The team also investigated outliers in some detail to eliminate those that come from potentially inaccurate data provision or recording. The results have been considered cautiously given these data difficulties.

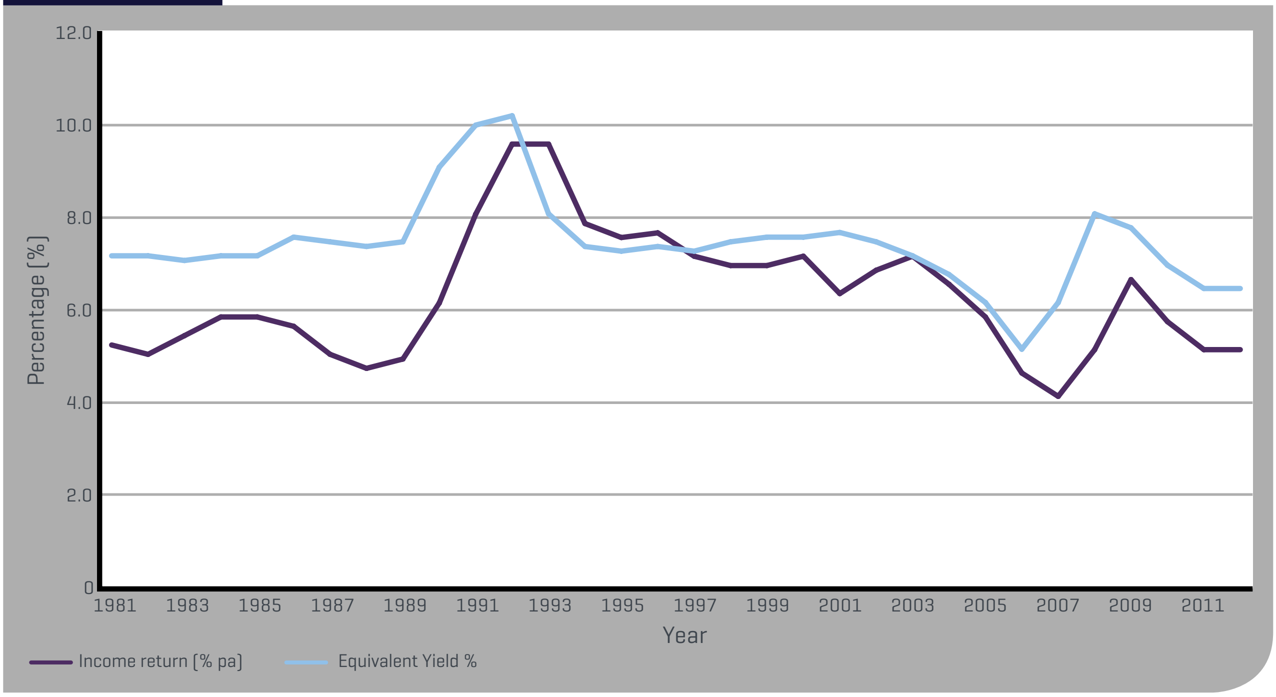
The dataset only provides initial yields for each transaction, necessitating calculation of the equivalent yield required for the study. The equivalent yield is the preferred measure in the UK context as it takes into account not only the level of the initial rent, but also the reversion to a market rent (assuming current market levels) and the scheduled date for this change in income stream (i.e. at review or lease expiry). It is common in the UK that there can be 3-5 years between changes in rental levels due to review clauses in the lease. Thus, the equivalent yield more fully reflects both current and expected future returns and is therefore the measure used in all UK performance measurement systems (for example, IPD, 2012; CBRE, Quarterly). Figures 3 and 4 indicate the discrepancies between the two measures of initial and equivalent yield. Figure 3 illustrates the London West End office market between 1981 and 2012 and shows that, apart from one year in the early 1990s, equivalent yields were higher than initial yields, indicating positive reversionary potential. Figure 4 illustrates the same data for the City office market, showing that the post 1990 downturn created a longer period of over-renting in the City than it did in the West End.

Figure 3 IPD Equivalent and Initial Yields – London West End Offices 1981 to 2012



Source: IPD (2013)

Figure 4 IPD Equivalent and Initial Yields – London City Offices 1981 to 2012



Source: IPD (2013)

Estimation of the equivalent yield requires some additional data, these being the market rent and the unexpired term to the next rent change.

Market rents have been determined by comparison to lettings within the same building. Where these lettings are not contemporaneous with the transaction date, they have been updated using data from the CBRE Rent and Yield Monitor (CBRE, quarterly). The actual rent point valuations through time were given to the project confidentially and these were matched with the individual transactions within the transaction database.

The unexpired term to the next rent change was identified from the lease data collected for each transaction at the transaction date. Where a property was multi-tenanted, a weighted (by rent) average unexpired term was used. Not all lease expiry and rent revision dates were known for all leases within a transaction. Where they were not known across all leases in a property, a default of 2.42 years was used. This was the average across the entire sample based on those transactions where the next rent change was known. Where the majority of lease details were known for a multi-let property, the weighted average across the known leases within the property was extrapolated for the unknown leases.

Table 2 presents the summary descriptive statistics for the estimated capitalisation rates in the form of equivalent yields over 13 contiguous submarkets as defined by market agents (those with very small sample sizes are merged into the neighbouring, most relevant, submarket). The skewness and kurtosis statistics above +2 or below -2 and additional distribution plots imply that the data do not fit with the normal distribution assumption and require transformation, using natural logarithms, to give a normal distribution for this, the dependent variable.

Table 2 Descriptive Statistics for Equivalent Yields Imputed for the Sample of Transactions Across Submarkets

Central London Submarket	Sample Size	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
						Statistic	Std error	Statistic	Std error
Bloomsbury	21	1.88%	12.34%	5.09%	.0236	1.492	.501	3.613	.972
City Centre	137	2.36%	28.15%	6.86%	.0347	3.175	.207	13.767	.411
City Fringe	62	0.84%	14.35%	6.50%	.0209	.770	.304	3.229	.599
Clerkenwell	24	1.57%	11.48%	6.10%	.0224	.068	.472	.392	.918
Covent Garden	38	1.15%	12.78%	5.48%	.0223	.813	.383	2.157	.750
Holborn	37	3.45%	8.69%	5.98%	.0113	.455	.388	.660	.759
Knightsbridge & Victoria	20	3.15%	15.18%	5.96%	.0313	1.981	.512	3.745	.992
Marylebone & Paddington	23	1.73%	7.43%	4.68%	.0130	-.241	.481	.206	.935
Mayfair	48	1.00%	10.01%	3.77%	.0198	1.434	.343	2.482	.674
Noho	28	2.55%	12.77%	5.13%	.0215	1.668	.441	4.705	.858
Soho	25	2.58%	10.40%	5.25%	.0223	.928	.464	.263	.902
St James	21	1.50%	10.92%	4.92%	.0218	.774	.501	1.434	.972
Westminster	13	1.46%	12.88%	6.88%	.0335	.360	.616	-.659	1.191
Total Sample	**497**	**0.84%**	**28.15%**	**5.84%**	**.0274**	**2.434**	**.110**	**13.060**	**.219**

4.2 Data Issues for Consideration

Analyses using data such as presented here inevitably lead to various data and modelling issues. Rental growth expectations are explicitly shown in the Gordon model and are arguably determined by the market and are therefore endogenous. Dunse et al. (2007) built this endogenous variable into their model, using change in current rental growth to be an indicator of market expectations. If the modelling approach was to employ a standard regression model we could measure using an instrument/proxy, say office employment figures or business service GDP (ideally at London level), or inflation which are exogenous. Other ways to handle rental growth include:

- using a structural model would be to treat *g* as an unobservable latent variable or provide as a lagged variable and assume exogenously determined.
- including the variables as lagged, thereby making it exogenous with the system (i.e. determined in previous period).

In this instance, we use a broader measure of market quality, reflecting the literature and the conceptualisation in Table 1, to capture factors identified as important, such as local economic structure and catchment, as well as growth expectations. A differential rental measure is used to indicate market quality; specifically, lagged rents are used, adjusted for inflation through the time frame of the project and centring around the average rent (grand mean) across all the submarkets included in the study. This allows us to interpret changes in this variable as a percentage adjustment to the average capitalisation rate.

Another important consideration in a transaction based pricing model is the extent to which depreciation and obsolescence influence the return expected by real estate investors. As set out in Table 1, expected depreciation at the individual stock level is a function of location and building characteristics. These building and locational characteristics are captured by the measure of building quality within the CoStar data as set out in detail in Table 3. This building quality rating is a categorical variable that measures the condition of the building through a grading of its specification, quality of maintenance, architectural quality, energy performance and prominence of its location. Thus, the use of this variable captures depreciation through locational, physical and functional obsolescence for each stock, while avoiding the need for many variables which could result in multicollinearity. This approach and conceptualisation therefore advances previous studies that have either ignored depreciation at the stock level, or assumed it away as a constant.

Table 3 CoStar Building Classification for Offices

Building Rating	Definition	Percentage in Sample
1 Star	A very poor quality building with no tenant and little prospect of attracting a tenant because it is in very poor condition with substantial physical and structural defects and does not offer viable accommodation.	0.0%
2 Star	An older building, typically more than 20 years old, with the majority of the accommodation cellular. Poor quality reception areas with no lifts or old, poorly maintained lifts and generally poor maintenance with physical or structural defects. Rents will be substantially lower than for 3 Star buildings and close to the lowest levels achieved locally.	1.2%
3 Star	This is an older building that offers basic open plan accommodation and has been partly renovated but the interior has not been completely refurbished. Plant and other servicing likely to be outdated and inferior with some functional limitations although still reasonably well maintained.	39.2%
4 Star	A modern building, completed or renovated in the last 10 years, which offers good quality modern open plan space which is well maintained and managed. Externally less architecturally impressive than a 5 Star building and provides accommodation with raised floors, some form of air cooling system and adequate passenger lifts but is of a more basic design than a five star building.	47.6%
5 Star	A landmark building, either new built or extensively renovated within the last 5 years, providing top specification accommodation and typically have a BREEAM rating of VERY GOOD, EXCELLENT or OUTSTANDING. If the building is older then the interior will be completely reconstructed with only the historical façade or structural frame remaining, and maintained and managed to the highest standard. Commands rents at or close to the top achievable rents in the local market.	12.0%

Source: CoStar (2013)

Table 4 Exploring the Determinants of Office Capitalisation Rates: variables and data

Spatial Scale of Influence	Variable Group	Variable Name	Variable Definition	Data Source
	Dependent variable	Ln(EY)	Capitalisation rate (Equivalent yield) net of purchasers' costs and in logs	Derived from transaction data on deals in Central London between Q2 2010 and Q3 2012
Macro	**Systematic Risks**			
Investment and Capital markets	Cross-submarket Drivers	LnNGRY	Risk free rate (Rrf)	Quarterly average Gross Redemption Yields on 10 Years Gilts in logs (Source BoE).
		LnSPP1	Anticipated inflation	Services Producer price Index, lagged one quarter and in logs (Source NSO).
Property Market		LnDivYield	Return on alternative investments	Quarterly average dividend yields on FTSE-100 index (Source Datastream).
Sector	Submarket Specific Drivers	SubInVac1	Submarket vacancy rate	Average submarket vacancy rate from Costar; lagged one quarter.
Location		SubLnRRent1_GC	Submarket quality	Real average rent in submarket, lagged one quarter, in logs and grand mean centred
	Specific risks			
Stock/Asset	Tenant	Aver_TS	Weighted average tenant covenant strength	Measured as weighted average of covenant strength of tenants in the building; weighted by floorspace occupied. Tenant strength classified using Experian credit scores with 0=undisclosed/unknown, 1 = very low risk or government agency, 2 = below risk, 3 = normal risk, 4 = above risk; 5 high/maximum risk.
	Lease	Multi	More than 1 tenant at the time of sale.	Categorical variable 0=single or vacant; 1 = multi let
		Aver_Expiry	Weighted average term to lease expiry	Measured as weighted term to lease expiry in CoStar transactions in years, weighted by floorspace occupied.
		Vacant	Vacant at the time of sale	Categorical variable 0=not vacant; 1 = vacant
	Location	CornerPosition	Property occupies a prominent corner site	Categorical variable 0= not on a corner; 1 = on a corner site
	Building	BuildRating	Quality of building, including extent of depreciation and obsolescence	Costar's building quality rating, which is a five point system that varies between 1 and 5. Lowest quality = 1 where as highest equals 5.
		NoResidential	Existence of a residential element in building	Categorical variable 0= residential use of part of building; 1= no residential use.
Micro		NoRetail	Existence of a retail element in building	Categorical variable 0 = retail use of part of building; 1 = no retail use

continued

continued

Spatial Scale of Influence	Variable Group	Variable Name	Variable Definition	Data Source
	Dependent variable	Ln(EY)	Capitalisation rate (Equivalent yield) net of purchasers' costs and in logs	Derived from transaction data on deals in Central London between Q2 2010 and Q3 2012
Transaction/Purchaser/Time variables				
	Transaction Traits	Type	Type of investment transaction	Categorical variable 0= long leasehold transaction; 1 =freehold.
		PortSale	Property sold as part of a portfolio	Categorical variable 0=individual property sale; 1= part of a portfolio deal.
		Partial	Proportional share of property sold.	Categorical variable 0=100% deal; 1= proportional share in property.
	Purchaser Traits	IntExp	International experience of the buyer	Categorical variable 0=undisclosed purchaser; 1= purchaser appears to be UK and has no international property or experience of investing internationally; 2 = owner is either from abroad or has international property investment experience.
		BuyReg	Continental region origin of buyer	Categorical variable 0 = undisclosed purchaser; 1 = buyer is either based or has major office in the UK; 2 = buyer located elsewhere in Europe; 3 = buyer located in Asia Pacific; 4 = buyer located in Middle East; 5 = buyer located in Africa; 6 = buyer located in Americas; 7 = offshore buyer.
		BuyType	Type of buyer	Categorical variable 0 = unknown; 1= fund either based or has major office in the UK; 2 = fund from outside the UK; 3 = offshore fund; 4 = private (identify not revealed).
	Time	Time	Transaction period	Categorical variable to capture transaction year and quarter. 1 =2010 Q2; 2=2010 Q3; 3=2010 Q4; 4=2011 Q1; 5=2011 Q2; 6=2011 Q3; 7=2011 Q4; 8=2012 Q1; 9=2012 Q2; 10=2012 Q3

5.0 Findings and Discussion

The results of the multilevel models for capitalisation rates, estimated using a Restricted Maximum Likelihood (REML) method, are given in Tables 5 and 6. The Tables also show significance levels: parameters with '***' indicate that the fixed and random effects being tested are significant at the 1% confidence level, '**' are significant at the 5% confidence level and '*' are significant at the 10% confidence level.

The analysis begins by testing the basic two-level model, expressed previously as Equation 3 but without any explanatory variables. This is the same as $k_{ij} = \gamma_{00} + \mu_{0j} + e_{0j}$ where the intercept (γ_{00}) in the empty model (shown in Table 5 as Model 1) represents the overall average capitalisation rate. It is shown in natural logs (-2.9800) to create a normal, non-skewed data series and, when transformed back into percentage, gives an average capitalisation rate of 5.08%[1]. Starting at this point in the analysis is useful as it allows us to see how capitalisation rates differ from the overall average and then attribute these differences separately to submarket effects and transaction effects. It also is useful as it serves as a baseline for comparison against more complex models.

The intra-submarket correlation for the sample over the study period captures a significant proportion (85.45%) of the variation in capitalisation rates around the estimated mean[2]. This conforms with *a priori* expectations as previous studies show that specific risks contribute a large proportion of the investment risk attached to an asset and that default and void risks are primarily driven by the characteristics of the tenants, lease terms and property, as set out in the model by Jackson and Orr (2011).

It is noteworthy that the variance between transactions is 5.9 times larger than the variance between submarkets (see estimate of covariance parameters near bottom of Table 5). However, a not-insignificant 14.5%[3] of the differences in capitalisation rates in the sample can be traced to submarket differences. Thus, both stock and submarket variables need to be investigated to fully explain capitalisation rates. The relatively small size of the submarket-specific influence may surprise some analysts, but this could reflect the fact that many buyers are overseas and are seeking to buy in London as a perceived politically and financially stable international market, rather than very specific parts of London. Given the gap between capitalisation rates in London and the rest of the UK (CBRE, quarterly), this London effect would be expected to be more noticeable if submarkets outside London had been included. The impact of overseas purchasers on capitalisation rates is one of the factors being tested in later models.

The next stage of the analysis explores the influence of adding submarket variables as fixed effects into the empty model to give Model 2. Here, we add the level-2 submarket variable SublnRRent1_GC to capture market quality. This mean-centred variable measures the change in the difference between average rental values across the central London area and in each submarket location. As set out in Table 5, while the average capitalisation rate across all submarket locations remains at 5.08% (transformed from -2.9801 in natural logs), there is a clear improvement in the explanatory power of the model. The model indicates that investors purchase at lower capitalisation rates for better submarket quality – for every 1% the submarket location rental value rises above the change in average Central London rental value, the capitalisation rate falls by 0.36% (transformed from 0.3159)[4]. This is statistically significant and, thus, the unexplained variance between submarkets falls by 36.49%. The reduction in the Akaike's Information Criterion (AIC); Hurvich and Tsai's Criterion (AICC); Bozdogan's Criterion (CAIC) and Schwarz's Bayesian Criterion (BIC) also suggest an improvement in model fit. However, looking at the covariance parameters, the Wald Z statistics for the variance components suggest that unexplained transaction variation still exists in the model at the 1% confidence level. Although such tests can be unreliable (Snijders and Bosker, 1994), the fall in the Wald Z statistics to 1.786 for the unexplained submarket variation suggests (but only at the 10% confidence level) that a little variation exists between submarkets and the inclusion of the level 2 predictor does not remove all the submarket specific variation present in capitalisation rates.[5]

1 This average is the common average across all the submarkets allowing for between and within submarket variation and the bias generated by between submarket variations.
2 This is estimated as 1-(0.0285/(0.0285+0.1672)).
3 Calculated as (0.0285/(0.0285+0.1672)).
4 For example, if the rent in a submarket is £20 per square foot above the average central London rental value and that difference grows by 10% to £22, assuming all else remains unchanged, the capitalisation rate will fall by 3.6%; i.e. from 5.08% to 4.9%.
5 The influence of other submarket measures (absolute and grand mean centred submarket vacancy rates and actual rental growth, adjusted for inflation) in explaining capitalisation rates were examined. None of these results are reported in the paper as they were insignificant and failed to improve the explanatory power of the model.

Table 5 **Multi-level Model Results**

Fixed Effects	Model 1		Model 2		Model 3		Model 4		Model 5	
Intercept	-2.9800	***	-2.9801	***	-2.9026	***	-2.9556	***	-2.9798	***
SublnRRent1_GC			-.3159	*	-.4638	**	-0.5465	***	-0.3402	*
TIME=1					-.0935					
TIME=2					-.1189					
TIME=3					-.0658					
TIME=4					-.1005					
TIME=5					-.1567	**				
TIME=6					-.1643	**				
TIME=7					-.0122					
TIME=8					.0451					
TIME=9					-.0901					
Estimates of Covariance Parameters										
Residual	.1672	***	.1680	***	.1676	***	0.1723	***	0.1674	***
Intercept [subject = Submarket_id] Variance	.0285	**	.0181	*	.0158	*			0.0176	*
TIME [subject = Submarket_id] Variance							0.0143	**	0.0009	
Model Fit Statistics										
-2 Restricted Log Likelihood	548.73		547.72		568.20		575.88		547.49	
Akaike's Information Criterion (AIC)	552.73		551.72		572.20		579.88		553.49	
Hurvich and Tsai's Criterion (AICC)	552.75		551.74		572.23		579.90		553.54	
Bozdogan's Criterion (CAIC)	563.14		562.13		582.57		590.29		569.10	
Schwarz's Bayesian Criterion (BIC)	561.14		560.13		580.57		588.29		566.10	

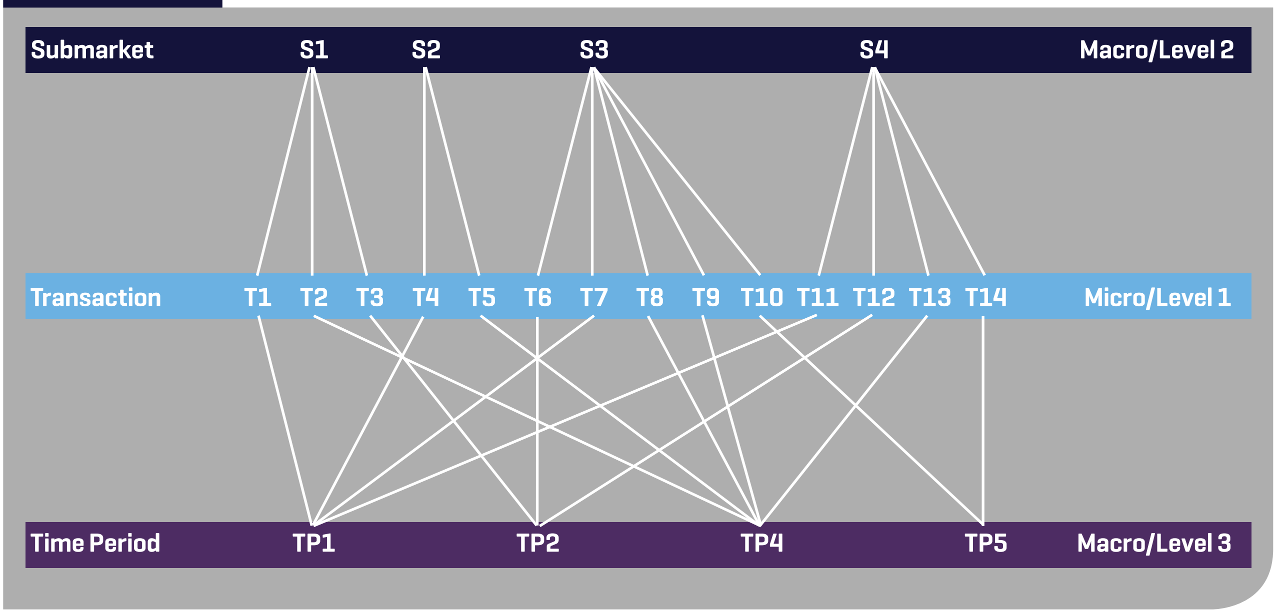
Movements in the level of capitalisation rates associated with the timing of the transaction are tested in Model 3[6]. With only two exceptions (Q2 and Q3 in 2011) the model shows no significant differences over the study period, possibly implying that yield movements were very static over the period of analysis. Market evidence supports this finding, with CBRE (various) indicating that prime yields in central London offices remained largely static for most of this analysis period. Statistically, the addition of the time variables fails to improve the model fit. When retested with time specified as random effects (Model 4) this results in higher information criteria than the baseline model suggesting the fit of the model has been negatively affected by the inclusion of a time random effect. Time does not help explain the variation in capitalisation rates[7].

The last model in Table 5 checks for the possibility for time to be a third level of spatial influence where it affects multiple transactions over more than one submarket (as illustrated in Figure 5). This can be captured as a non-nested third level model and presented as Model 5 in the findings. The level 2 and 3 random effects in Model 5 have been included as single identities[8]. A comparison of AIC and BIC statistics implies that the simpler 2 level hierarchical models (such as Models 1 and 2) are a more relevant structure to adopt.

Table 6 presents the analysis when property, buyer and transaction (level 1) explanatory variables are included in variations of the model. These include those at the macro end of the risk scale: investor's expectation regarding the risk free rate of return, return on alternative investments and anticipated inflation; and, at the micro end of the risk scale: variables capturing the location, tenant and property specific attributes of the asset, as detailed in Table 4. The rate of return expected on a risk free asset, the weighted average term to expiry and the weighted average of the tenants' credit scores are measured as continuous variables, with the remaining attributes captured through categorical variables. The intercept is removed from these models to allow them to differentiate the mean capitalisation rate by type of transaction with 0 denoting the purchase of a long leasehold and 1 representing a freehold.

Model 6 presents a range of possible predictors as fixed effects but not all the fixed effects are significant. These are removed in Model 7. This represents a more parsimonious fixed effects model[9] which yields AIC and BIC statistics lower than the full model and nearly all the fixed effects are significant at the 90% confidence level.

Figure 5 A Unit Diagram for a Two Level Nested Hierarchy and Non-Nested Third Level



6 These relatively more complex models are referred as growth models

7 Other random effects tested in our mixed effects model as random slope effects were absolute and grand mean centred submarket vacancy rates and actual rental growth, adjusted for inflation and grand centred submarket rents, adjusted for inflation. The addition of these variables as random effects did not improved the explanatory power of the model. The results are not reported in this paper.

8 More complex covariance structures were investigated but they failed to significantly improve the explanatory power of the model

9 This model was derived in a stepwise process from Model 2, retaining the key risk drivers that influence capitalisation rates as specified in the conceptual framework

The exceptions are average weighted tenants' credit score (Aver_TS), average weighted expiry term (Aver_Expiry), some building quality ratings (BuildRating), and the category for international experience that represents when this buyer information is unknown (IntExp=0). The average capitalisation rates for a long leasehold is 3.98% (transformed from -3.2244) and freehold is 3.64% (exponent of -3.3137). These averages are based on the sample of transactions where the buildings being transacted are rated as 5 star, top quality stock and bought by buyers with international experience.

At the macro end of the risk scale, Model 7 shows that, the fixed effect for contemporaneous nominal risk free rates suggests that higher Gross Redemption Yields lower yields. This is the same result even when lagged rates or alternative measures such as the Treasury Bill rate are used. Either real estate investors are slow to react to changes in the capital markets or rising bond yields encourage investors to shift towards growth assets, especially if rising bond yields are a product of expected increases in inflation that may impact on equity income flows. Moving along the risk scale, Model 7 shows that mixed use within properties impacts on capitalisation rates. Where there is a residential component in the building, the model suggests that investors are pricing this as a risk and raising capitalisation rates. In contrast, where offices have a retail component, this is perceived to lower risk and therefore lower capitalisation rates. The level of international experience of the buyer is also significant, with the model indicating that investors with no overseas experience price risk higher than those with international experience. The origin of buyers has been removed from Model 7 as the inclusion of this variable failed to improve the fit of model and multicollinearity appeared to exist between this variable and the definition used to categorise the international investment experience of buyers. Yet when included, the results (see back to Model 6) confirm with the finding that buyers' investment experience influences capitalisation rates, suggesting that buyers from the UK, Asia-Pacific and the Americas transacted at lower capitalisation rates than other regional buyers.

Table 6 **Results of Multi-Level Models Containing Property, Buyer and Transaction Variables**

Fixed Effects	Model 6	Model 7	Model 8
SubInRRent1_GC	-.0098 **	-.5892 ***	-.4882 **
Type=0	-2.8833 ***	-3.2244 ***	-3.4109 ***
Type=1	-2.9438 ***	-3.3127 ***	-3.4984 ***
PortSale=0	-.0062		
Partial=0	-.0186		
BuildRating=2	-.2023	-.3329 *	-.7927
BuildRating=3	-.1546 **	-.2105 ***	-.4490 **
BuildRating=4	-.0619	-.1049 *	-.0641
Vacant=0	.0327		
Multi=0	-.0345		
CornerPosition=0	-.0176		
NoResidential=0	.2334 ***	.1807 **	.2246 **
NoRetail=0	-.1007 **	-.1004 **	-.1060 **
IntExp=0	.0023	-.0592	-.0297
IntExp=1	.0971 **	.1355 ***	.1127 **
BuyReg=1	-.5683 *		
BuyReg=2	-.4402		
BuyReg=3	-.5132 *		
BuyReg=4	-.4569		
BuyReg=6	-.6556 **		
BuyType=0	.1567		

continued

continued

Fixed Effects	Model 6	Model 7	Model 8
BuyType=1	-.0051		
BuyType=2	-.4054		
Aver_TS	-.0052	.0017	.0732 *
Aver_Expiry	.0008	.0001	-.0005
LnNGRY	-.2294 **	-.1315 *	-.1512 **
LnSPP1	-.1041		
LnDivYield	-.5645 *		
Aver_TS * SubInVac1			-1.0906 *
Build_Rating=2 * SubInVac1			9.5509
Build_Rating=3 * SubInVac1			5.2467 ***
Build_Rating=4 * SubInVac1			.7985
Build_Rating=5]* SubInVac1			1.0599
Estimates of Covariance Parameters			
Residual	.1605 ***	.1651 ***	.1576 ***
Intercept [subject = Submarket_id] Variance	.0114	.0106 *	.0139 *
Model Fit Statistics			
-2 Restricted Log Likelihood	597.32	587.09	532.52
Akaike's Information Criterion (AIC)	601.32	591.09	536.52
Hurvich and Tsai's Criterion (AICC)	601.35	591.12	536.55
Bozdogan's Criterion (CAIC)	611.62	601.46	546.87
Schwarz's Bayesian Criterion (BIC)	609.62	599.46	544.87

Model 8 specifies cross-level interactions (as specified in Equation 6) to capture the possibility that our submarket measure of market quality may be linked to the quality of buildings. It also allows for the influence of historic vacancy rates in the submarket on investors' perceptions of void risk and how these are influenced by lease expiry terms. This yields a model with a base capitalisation rate of 3.30% for investors with experience in international markets buying long leaseholds with no retail or residential component in a top quality building (transformed from -3.4109). For a comparable freehold, the base capitalisation rate is 3.02% (transformed from -3.4984). Key changes in the results given by Model 8 include that the effect of tenant covenant strength now has a significant role in explaining capitalisation rates, with rates increasing with increased covenant risk. The effect of building quality in explaining the differences in capitalisation rates is inconclusive (even contradictory to expectations) although the positive and significant cross interaction figures suggest that, in times of higher vacancy rates, capitalisation rates are higher for buildings of poorer 3 star ratings than for buildings with higher ratings.

The significant variables in this model driving transaction capitalisation rates (in logs) are the risk free rate, type of property interest, existence of retail and residential space in the building, and tenants' covenant strength. Investment experience has a significant influence, with experience in only UK markets resulting in upwards shifts in capitalisation rates of 0.36% for freeholds and 0.39% for long leaseholds. The lower AIC and BIC tests suggest Model 8 is the better model which is also confirmed by a Likelihood Ratio Test which describes the difference in deviance between Models 7 and 8, Models 1 and 8, and Models 2 and 8 and suggests Model 8 fits the data better.[10]

10 Tests show on the Level 1 residuals appear to follow a normal distribution. The residual histogram fits a normal distribution reasonably with Skewness statistic of 0.321 although the Kurtosis statistic is a little high at 2.279.

6.0 Conclusions and considerations

The purpose of this study is to examine the pricing of investment property, focusing on the determination of capitalisation rates and the property attributes that determine the risk premium. A spatially robust multi-level model has been developed to attempt to disaggregate observed capitalisation rates for office properties to examine the complex array of factors that influence it and the risk premia within.

The cross-sectional inter-temporal analysis employs a dataset composed of property transactions that occurred in the central London office sector over a two and a half year period and contains property specific information not previously released by CoStar. This dataset was released to the research team prior to general release in 2013. The data have been enhanced and verified as much as possible from other public domain or subscription based sources such as EGi but there are limitations with this dataset. These limitations have been fully acknowledged in the text and a significant amount of work has been carried out to address the data difficulties. The data have also had to be transformed, mainly by the addition of reversionary rents and hence equivalent yields calculated by the research team, to represent more accurately investors' pricing, than the initial yields reported within these datasets. The final dataset included 497 transactions within the time period Q2 2010 to Q3 2012.

The framework for the analysis of the capitalisation rates is a central part of this work and builds from the previous work of Jackson and Orr (2011); initially funded by the RICS Education Trust. This framework is based on a risk scale that explains capitalisation rates (k) in the form of:

$$k = \mathrm{RFR} + \mathrm{RP} - g + d$$

where RFR = nominal risk free rate, RP = risk premium, g = expected growth and d = depreciation.

The spatial scale of the framework drives the inputs into the explanatory model and starts at the macro level. It explains the RFR in terms of macro-economic variables such as the real time preference of money and expected inflation. The property risk premium is a complex agglomeration of market and specific property attributes at an increasingly micro level. At the market level it includes the relative performance and volatility of property relative to other sectors (a significant research question in its own right) and sector/location specific issues such as market quality and underlying local economic influences and indicators such as vacancy rates. At the micro property specific level, the risk premium and capitalisation rate will be influenced by building attributes coupled with lease structures, tenant quality and micro location factors.

The unbiased average capitalisation rate/equivalent yield across all transactions is just over 5%. The analysis period constitutes a period of relatively stable yields in the central London office market and therefore the finding that time generally is not influencing the level of capitalisation rate variation is not surprising.

The more interesting finding is that the level of capitalisation rate is influenced by changes in the risk free rate as measured by the 10 year bond yield, but in the opposite direction than would be implied in the Gordon growth model. A rise in the RFR would lead to a rise in k if all other inputs remain stable. However, the opposite happens and this suggests that either the risk premium falls by more than the increase in the bond yield or that g and d increase/decrease by more than the bond yield. A rational expectation is that if bond yields are rising, especially in the wake of a flight to safety, risk premiums may be falling as investors start to contemplate taking more risk. As risk free rates are nominal, bond yields include inflation expectations so it may also be that nominal growth expectations are rising on the back of expected inflation increases. But this would lead to a positive relationship between RFR and g and no effect on k. The fact that an increase in RFR leads to a decrease in k suggests that both effects are present, a reduction in RP and an increase in expected g.

At the property market level of the risk scale, the influence of submarkets has been tested. Using the CoStar submarket divisions, the analysis has been undertaken across 13 contiguous submarket groupings and the findings are as expected; that specific property risks explain much more of the variation between equivalent yields than locational differences across submarkets. Around 15% of the explained variation in the capitalisation rates is explained by the submarkets, against 85% by the property-specific attributes. Within that, submarket location quality has a significant effect on the variation in submarket capitalisation rates.

Property specific characteristics figure prominently in the model. There are differences in capitalisation rates for mixed use properties: offices mixed with residential have higher capitalisation rates, while offices mixed with retail tend to have lower capitalisation rates. This mirrors historic relationships between retail and office yields with some commentators suggesting that the increased depreciation rates for office properties has kept their yields higher than high street retail. Higher tenant covenant strength also leads to lower capitalisation rates. All these findings are as expected.

Property specific attributes that fail to significantly impact on capitalisation rates included unexpired term to lease expiry. This is probably the most unusual finding, especially in a time of post financial crisis where the flight to safety and the search for “core” investments appears to have been a key driver of investor behaviour. It may be that this aspect is picked up in other measures. The other major surprise is the lack of influence on capitalisation rates of building quality; here the analysis is inconclusive at best. However, in times of high vacancy, poorer CoStar rated 3 star buildings have higher capitalisation rates than higher quality 4 and 5 star buildings. Other non-significant factors include single or multi letting, corner properties and sales of mixed ownership properties.

Finally the research investigated aspects of the transaction including the purchaser and the type of transaction. The principal finding is that buyers from the UK (and from overseas) with international investment experience appear to purchase at lower capitalisation rates than UK investors with no international operations. In terms of transaction type, capitalisation rates for freeholds are found to be lower than for those with long leasehold tenure.

This project has added further evidence of the drivers of capitalisation rates and therefore investors’ risk preferences and should help to develop a better understanding of how investors perceive individual property attributes. This is important to practice and academia, not least because it employs a revealed preference method and a transaction based dataset that have not been used before to examine the pricing of commercial property investments.

7.0 Acknowledgements

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