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1. Introduction

In property investment it is generally accepted that the required return comprises two elements; a risk free rate (RF) and a risk premium (RP). The risk free rate compensates investors for the time value of money, while the risk premium reflects the risk associated with the cash flows (Geltner *et al* 2007). If nominal analysis is used, the nominal required return is;

$$R_N = RF_N + RP$$

As the required return is used to discount cash flows to the present day in order that investment decisions can be made, the selection of both components is important in property pricing. The use of an inappropriate discount rate could lead to the under or over pricing of property investments. It is recognised that the need for a risk free rate is common to all investments and that the amount of the risk premium varies between investments (Hoesli and MacGregor 2000). Much has been written on the selection of the risk premia, but surprisingly less on the behaviour of the UK gilt market in the context of property pricing and the selection of the appropriate risk free rate of return.

A 100% risk free rate of return does not exist in reality. Companies, banks and individuals all have the potential to default on their income and repayment components, and history has shown that even governments have not always been able to meet their repayment obligations, witness Argentina in 2001 and in June 2010 Greek government bond yields came under pressure following a downgrading of their credit rating by Moody's (FT.com). That said, it is generally considered that in mature democracies, government issued debt is as close to a risk free rate as it is possible to achieve, and thus the gross redemption yield on conventional government bonds or index linked government bonds is often suggested as the proxy for the risk free rate. However, there are a range of different maturities of gilts with significant differences both in their gross redemption yields and their investment characteristics, raising the question of which maturity of gilt is most appropriate to be used in property pricing. A better understanding of how the different maturities of gilts behave is a major motivation behind this paper.

In the period post the financial crisis in 2007/08, the gross redemption yield (GRY) on UK gilts fell sharply as investors fled to the safety of government issued stock. For example, the GRY on two year conventional gilts fell from 5.77% to 0.96%, from 29/06/2007 to 31/03/2010, while 10 year gilt yields fell from 5.46% to 3.9% over the same period - the lowest level for at least 30 years. Over the period 2007 to 2010, the yields on all maturities of gilts - short, medium and long - fell sharply but with different degrees of volatility, raising questions as to whether it was still appropriate to use the current GRY as the proxy for the risk free rate when the rates had fallen to such low levels. If the risk premium had remained static, this would have implied a reduction in the required return rate. In fact, the property market witnessed a sharp decline in value and the IPD All Property equivalent yield moved out around 300 basis points over this period. This might suggest that investors had either abandoned the direct link with current gilt rates, instead perhaps using an average rate, or applied a higher risk premium.

If the last 30 years has seen a gradual decline in the gilt yield, the same time period has witnessed some significant structural changes in the UK commercial market. For example, average lease length has fallen, holding periods have reduced and break clauses are now common, forcing investors to reconsider the benchmark rate to use.

With this background in mind, the aim of this paper is to investigate the behaviour of UK gilt yields and to consider the appropriate benchmark risk free rate suitable for pricing of property investments in the UK. In delivering the aim, four objectives of the research are outlined. These are first to consider from a theoretical perspective what risk free rate should be used, secondly, to analyse the changes to holding periods and income structure in the UK, thirdly to analyse the financial characteristics of both conventional gilts and index linked gilts with different maturities over the period 1980 to 2010, and fourthly to investigate how the property investment community selects the risk free rate.

In exploring these issues, Section 2 sets the study in a theoretical context by considering the literature on the appropriate risk free rate. Section 3 considers bond pricing and the main features of the UK gilt market while Section 4 considers the key characteristics of the UK commercial property market. Section 5 details the data sources and the methodology employed in the paper and Section 6 focuses on the quantitative analysis of UK gilt returns. Section 7 considers investors' rationale for selecting the risk free rate and Section 8 presents conclusions.

2.0 The risk free rate and UK Gilts

2.1 Risk free criteria

For an asset to be considered risk free, the actual return must always be equal to the expected return and for this to happen, Damodaran (2002) suggests that two conditions need to be met. The first condition is that there can be no default risk and secondly that there can be no reinvestment risk. With regard to the former, it is generally accepted that there is a minimal risk of default on all issuances of UK government bonds, while to satisfy the latter all reinvestment rates would require to be known in advance. This second condition would seem to encourage the matching of investment horizons as say for example, the task was to estimate the expected risk free rate of return on a asset over a 10 year period, the use of say 3 month Treasury bills would not be suitable, as there is no way of knowing in advance what the Treasury Bill rate will be in three months time, thus exposing the investment to risk. The coupons on all bonds require to be reinvested at rates that cannot be predicted in advance and therefore all coupon paying bonds suffer from this weakness. In such a scenario, Damodaran (2002) recommends that only the expected return on government issued zero coupon bond would fully eliminate the reinvestment risk. The problem for investors is that there are few government issues of zero coupon bonds to use as the benchmark.

2.2 Bond Pricing

The discount rate charged on a bond is determined by both the general level of interest rates and a default risk premium, both of which can fluctuate over time. The general level of interest rate includes expected inflation, a risk premium for unexpected inflation, and a measure of real return. For most bonds, the coupon payments are fixed at issuance and the bonds are issued for a set period of time. If the market price and cashflows are known for certain then the internal rate of return, (the yield to maturity or gross redemption yield) can be calculated. As UK government bonds are considered virtually default free, the differences in the gross redemption yields primarily depend upon the impact of interest rate changes on the maturity of the bond and on the coupon rate, and this relationship is discussed further below.

In consequence of the negligible risk of default, UK gilts are generally recognised as an appropriate proxy for the risk free rate for investors investing in the UK market, and the remainder of this section will examine in more detail the UK gilt market.

2.3 UK Gilts: Issuance

The UK government issues bonds to help pay for the national debt. Conventional gilts and index linked gilts, account for 99% of the gilt market in the UK (DMO, 2010). Conventional gilts constitute the largest share of liabilities in the Government's portfolio and are denoted by their coupon rate and maturity (e.g. Treasury 5%, 2025). The coupon rate usually reflects the market interest rate at the time of the first issue of the gilt. Consequently there is a wide range of coupon rates available in the market at any one time, reflecting how rates of borrowing have fluctuated in the past. Conventional gilts also have a specific maturity date. Recent issuance of conventional gilts have been of 5, 10 and 30-year maturities, but in May 2005 the Debt Management Office issued a new 50-year maturity conventional gilt (DMO, 2010)[1].

Index-linked gilts form the largest part of the gilt portfolio after conventional gilts and were first issued in the UK in 1981. As with conventional gilts, the coupon on index-linked gilts reflects borrowing rates available at the time of first issue. Index-linked gilts differ from conventional gilts in that the semi-annual coupon payments and the principal are adjusted in line with the UK Retail Prices Index (RPI). This means that both the coupons and the principal paid on redemption of these gilts are adjusted to take account of accrued inflation since the gilt was first issued. A further category of gilts are known as undated stock (e.g. 3.5% War Loan stock). The redemption of these bonds is at the discretion of the Government, but because of their age, they all have low coupons and so there is little current incentive for the Government to redeem them.

Conventional gilts are attractive to investors who seek a fixed cash payment and a guaranteed return of the principal sum on a set date. As the timing of the cash flows is certain, investors are able to match their specific liabilities. Conventional gilts provide certainty of nominal income, nominal capital and nominal IRR to redemption, but no certainty of real returns as they are all subject to unknown future inflation. Index linked gilts offer certainty of real income, real capital and real IRR to redemption, but no certainty of nominal returns due to inflation.

The yield on conventional gilt reflects compensation for the time value of money and expected inflation, plus a risk premium to compensate for unexpected inflation. The level of risk premium for unexpected inflation will fluctuate depending on whether the market is stable or volatile. Gilts must deliver a competitive return and market prices adjust to changes in interest rates and expected and unexpected inflation. The relationship between the rate of interest and time is known as the yield curve, and is influenced by short and long term inflation expectations and interest rate risk (Geltner *et al*, 2007). The yield curve illustrates the average discount rate used to value gilts of different maturities (Sayce *et al,* 2006). For example, if inflation is currently low but expected to rise, investors will demand a higher coupon for lending for 5 years than say 3 months. However, the nearer a bond gets to redemption, the nearer the secondary price moves to the par value, so the less important interest changes or inflation expectations are on the price, known as the 'pull to redemption'. In general, long dated bonds are highly sensitive to interest rate changes and have a higher standard deviation of return compared to short dated bonds, although this sensitivity is mitigated the higher the coupon rate (see section 2.5 below). Thus for those investors with short term holding intentions, there is a larger risk if investing in long dated bonds. However, for those investors with a known holding period seeking to exactly match their liabilities, gilts offer certainty of cash flow and a known level of return, if held to redemption.

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[1] As at September 2010, 47 different conventional gilts are on issue and 17 index linked gilts. Maturity dates range from November 2010 to January 2060 and coupon rates from 2.5% to 12%, reflecting the prevailing market interest rates at issuance (DMO, 2010).

2.4 Liquidity of UK gilts

The Debt Management Office (DMO) annually issues bonds to manage the UK government's fiscal requirements. These issuances vary in terms of their maturity and issuance. The DMO sells the bond to investors by means of an auction via market makers. The bonds are later traded in the secondary market, post their issuance. The secondary market is not as transparent as equities, as it is not traded over an exchange. Thus, the liquidity estimates and bid-offer spreads on these instruments could vary from source to source. Figures 2 & 3 below indicate Bloomberg prices for the 10-year UK benchmark yield. This could be different from those quoted by a trader. This task is not made easier by the thin market of undated bonds (see Fig. 1) and lack of pricing information. Despite this limitation, there are other means to quantify liquidity of UK gilts from market quotes.

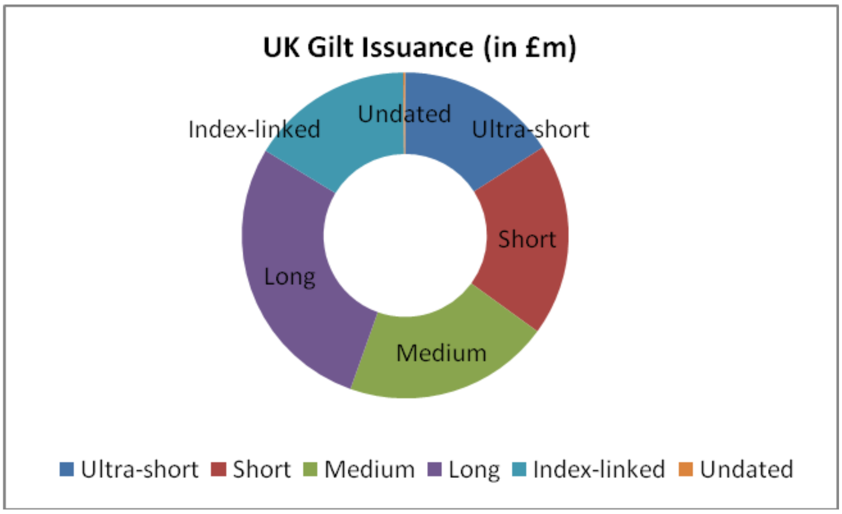
i) Theoretical yield error: This would be a purely quantitative framework of capturing liquidity. It is computed as the difference in the theoretical yield of a bond, implied from the spot yield curve, and the actual yield of the bond as observed in the market price. This "error" will theoretically capture the risks that are not related to interest rate. This exact logic causes it to sometimes over-estimate liquidity as the yield error could also be contributed by the issuer's credit quality deterioration (Choudhry, 2009).

ii) Trader's survey date: Alternatively, it is possible to get the bid-offer data from traders and compile it historically. However, such a methodology has a drawback if there is not sufficient liquidity in the underlying market. Moreover, the trader's inventory can sometimes cause a bias on liquidity.

However, from a practical viewpoint, the theoretical yield error is more likely to be consistently applied across the yield curve than the survey data.

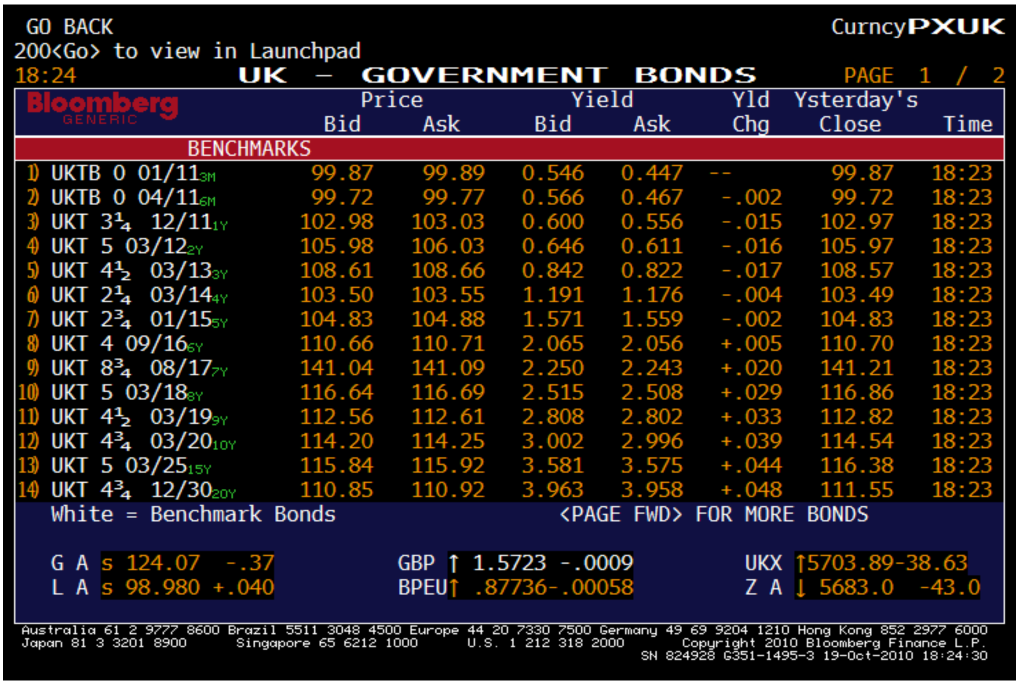
Typically, gilt issues of up to 10 years maturity are very liquid with the bid-offer spreads sometimes as narrow as £0.01 on the price of the bond (Choudhry *et al,* 2003, pp.55).

Figure 1 – UK gilts issuance



(Source: Debt Management Office, 2010)

Figure 2. Indicative bid-offer values quoted for UK Gilts



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18:24 UK – GOVERNMENT BONDS PAGE 1 / 2

Bloomberg GENERIC

	Price Bid	Price Ask	Yield Bid	Yield Ask	Yld Chg	Ysterday's Close	Time
BENCHMARKS							
1) UKTB 0 01/11 3M	99.87	99.89	0.546	0.447	--	99.87	18:23
2) UKTB 0 04/11 6M	99.72	99.77	0.566	0.467	-.002	99.72	18:23
3) UKT 3¼ 12/11 1Y	102.98	103.03	0.600	0.556	-.015	102.97	18:23
4) UKT 5 03/12 2Y	105.98	106.03	0.646	0.611	-.016	105.97	18:23
5) UKT 4½ 03/13 3Y	108.61	108.66	0.842	0.822	-.017	108.57	18:23
6) UKT 2¼ 03/14 4Y	103.50	103.55	1.191	1.176	-.004	103.49	18:23
7) UKT 2¾ 01/15 5Y	104.83	104.88	1.571	1.559	-.002	104.83	18:23
8) UKT 4 09/16 6Y	110.66	110.71	2.065	2.056	+.005	110.70	18:23
9) UKT 8¾ 08/17 7Y	141.04	141.09	2.250	2.243	+.020	141.21	18:23
10) UKT 5 03/18 8Y	116.64	116.69	2.515	2.508	+.029	116.86	18:23
11) UKT 4½ 03/19 9Y	112.56	112.61	2.808	2.802	+.033	112.82	18:23
12) UKT 4¾ 03/20 10Y	114.20	114.25	3.002	2.996	+.039	114.54	18:23
13) UKT 5 03/25 15Y	115.84	115.92	3.581	3.575	+.044	116.38	18:23
14) UKT 4¾ 12/30 20Y	110.85	110.92	3.963	3.958	+.048	111.55	18:23

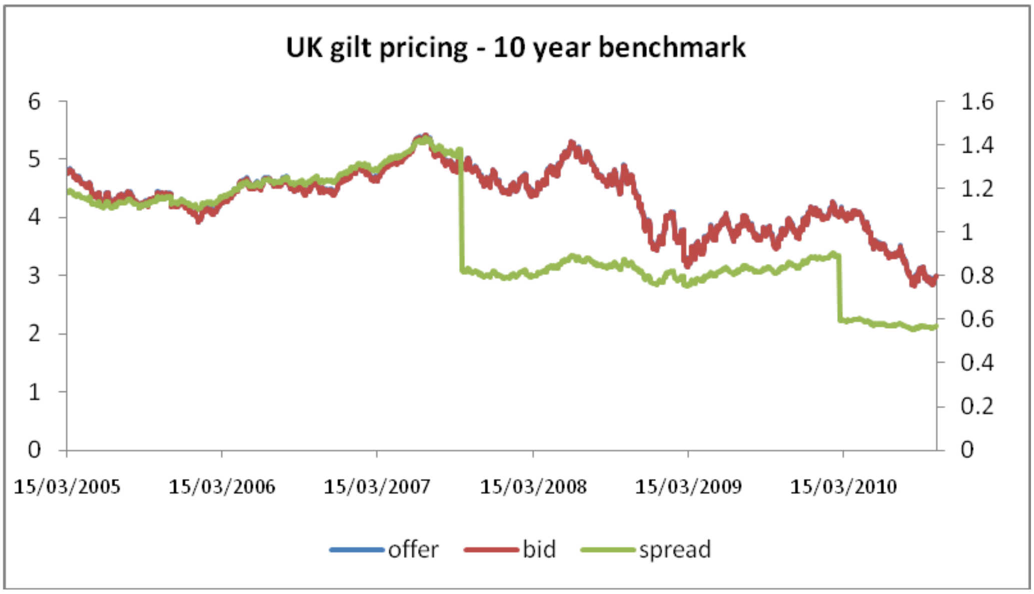
White = Benchmark Bonds <PAGE FWD> FOR MORE BONDS

G A s 124.07 -.37 GBP ↑ 1.5723 -.0009 UKX ↑5703.89-38.63
L A s 98.980 +.040 BPEU↑ .87736-.00058 Z A ↓ 5683.0 -43.0

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2010 Bloomberg Finance L.P.
SN 824928 G351-1495-3 19-Oct-2010 18:24:30

(Source: Bloomberg)

Figure 3. UK gilt pricing and spread estimates over time

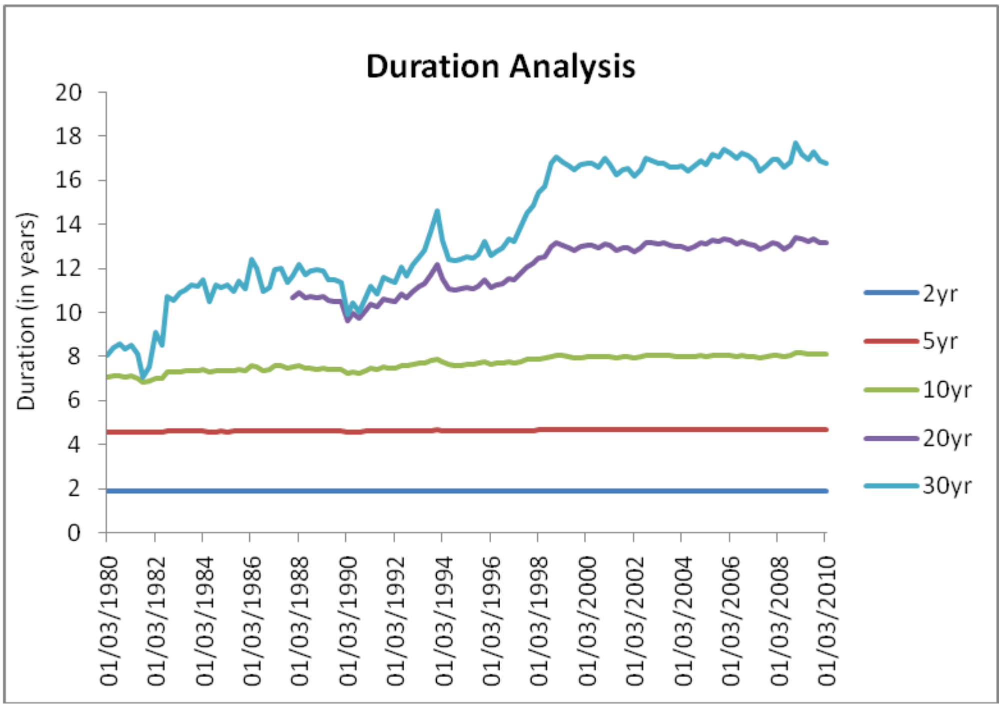


(Source: Bloomberg)

2.5 Duration of UK gilts

A formal definition of duration is the present value weighted average of the number of years the investors have to wait to recoup their investments. Thus, coupon rate is inversely related to duration while bond maturity is directly proportional. Duration is a popular measure within fixed income investors in gauging an asset's interest rate risk. The duration of UK benchmark bonds is shown in Figure 4 below.

Figure 4. Duration of UK benchmark bonds



(Source: Ecowin)

Simple statistical analysis (see Table 1) suggests that the shorter end of the curve is less sensitive to interest rates changes, whereas the longer end (20 year, 30 year) responds more dynamically to any interest rate changes. The 10-year bond's duration over time has been quite stable at around 7.7 years whereas the duration of the 30-year bond has increased to over 16 years. However, in 1980, the two bonds were much closer at around 7.6 and 8 years respectively.

Table 1 – Key statistics of UK benchmark bonds' duration

	2yr	5yr	10yr	20yr	30yr
Expected Value	1.91	4.64	7.68	12.09	13.58
Std Deviation	0.00	0.04	0.34	1.14	2.94

Duration would have a significant impact on an investor portfolio, as one would have to pay attention to their holding's interest rate risk. Comparing an individual or portfolio of property to a bond's duration could give the investor an understanding of the portfolio's interest rate sensitivity. However, it is necessary to understand the gilt maturity which best matches to their asset and nature of individual leases, to make any sensible comparison.

2.6 Which gilt to use?

Baum and Crosby (2007) suggest that the life of the bond and the proposed holding period should match. However, Sayce *et al* (2006) suggest that there a number of possible risk free rates that could be used. First, that as properties are valued in perpetuity then the yield on undated gilts should be adopted. Secondly, that long dated gilts should be used as property is a long term asset. Thirdly, that as the average holding period for property has fallen to under 10 years and lease length is shortening, that the gross redemption yield on medium dated gilts is more appropriate. Fourthly, that the yield on 3 month Treasury Bills should be used as they have virtually no default or interest rate risk.

Geltner *et al* (2007) dismiss the use of 3 month Treasury Bills for use in real estate investment on the grounds that it is too short term and instead recommend “the average T-bill rate expected over the long term investment horizon” p 251. They argue however, that the 10 year T-Bill is not riskless and includes some risk premium in the market place and that some adjustment is required. They suggest deducting from the GRY of 10 year T-bills the average ‘yield curve effect’, the difference between the yield on short and long term government debt to obtain the an average expected risk free rate for the next 10 years. Typically in the US they suggest that the difference been short and long debt has been around 100 to 150 basis points, but no analysis period is given. The results from the UK show a rather different picture as over the period 1Q1985 to 1Q2010 the average difference between the yield on 3 month Treasury Bills and 10 year gilts was only 24 basis points but with a wide variation, and the yield curve was inverted in 50 out of the 101 quarters. Table 2 compares the results from the UK and US over this period.

Table 2. Yield Curve Effect: 1Q1985 to 1Q2010

	UK	US
Average	0.24	1.77
Std Dev	1.74	1.21

Diermier et al (1984) employ a risk free rate based on the average of LIBOR which is a common benchmark that fits investor requirements in the US and UK markets, given LIBOR’s global application. They note that alternative measures such as the 3 month T Bills for the US and the UK intra-bank interest rate were tested as proxies, but neither offered any significant statistical or theoretical advantages. Term structure is the spread between a long term interest rate proxy and the short run LIBOR. The extended term rate for the US is based on the 10 year Treasury bond. The UK’s rate is derived from the return for 5-15 year gilts.

The spread between short-term and long term interest rates in the UK is negative inferring an inverse yield curve in the debt capital market, the inverse situation of pricing short term risk over long term spreads. A positive yield curve is noted for the period from 2009 into 2010 which infers a concern with long term asset risk at the height of the crisis. A negative slope is observed in the capital market, focussing on pricing of assets in the short run. The yield curve related to term structure is much more positive in the US; the long term rate is higher than the short term reflecting a positive slope from the short term rate to long term. This indicates a major difference between the UK and US capital structures (Grissom et al, 2009).

As there are significant differences in the yields of the various maturities of gilts the choice of the appropriate gilt yield is not insignificant. The literature would suggest that the holding period is the key criterion in the selection of the risk free rate, but lease length is also mentioned as a potential factor. They are to same extent interrelated and both are considered in Section 3 below.

3.0 UK Commercial Property Market

3.1 Holding periods

For investors in any asset class the length of the holding period depends on a number of factors; the current state of the market, the level of market return expected and achieved to date, the liquidity of the market and the level of transaction costs and all these factors are considered below. In addition for commercial property, differences exist between the sectors and the decision to retain or sell is also affected by the lease length remaining and the period to rent review. Investors are reluctant to purchase standing investments where there is an imminent rent review and uncertainty on the likely agreed rental value.

In the UK, the purchase of commercial property suffers from high transaction costs compared to buying equities. First year costs of around 6% are normal based on a stamp duty charge of 4% (on properties over £500,000), significantly higher than the 0.5% stamp duty paid on equity investments, in addition to standard legal and surveying fees. Furthermore, during the holding period, the landlord will also be faced with further professional fees at rent review and lease renewal.

The state of the market is obviously a crucial factor in a decision to sell, with more buyers evident in a rising market. For example, from 2003 to 2007, the UK commercial property market was characterised by 'a wall of money' chasing limited prime product, driving down cap rates and temporarily, producing high total returns. The funds were chasing limited prime product and the competition for a position in the market drove down yields. The sheer weight of demand from investors pushed prices well beyond normal valuations, enabling investors who took up a position in the market early in the cycle to achieve their expected return perhaps sooner than expected.

The level of return expected and achieved to date is an important determining factor on whether or not to dispose of an asset and depends upon the investor's specific requirements, type of fund (opportunistic or long term hold), the initial purchase price paid, price movements to date, as well as the mix of income and/or capital gain. For all assets, exit timing is important, but this is particularly true where the investment is purely a capital gain play, although this is not normally the case for property where income is the key driver of return in the long run. Over the 26 year period 1981 to 2007, IPD UK average total return was 10.7% p.a., with income return at 6.6% p.a. (std. dev. 1.0%) and capital growth 4.1% p.a. (std. dev. 8.1%). During a depressed market, investors are reluctant to accept a book loss and may hold their investments longer than they expected in the hope the market will recover.

In general, the commercial property market suffers from a low level of liquidity. Research by the IPF (2004) stressed the multi-dimensional concept of liquidity encompassing not only the time taken to execute sale, but also the 'frequency of trading; the cost of trading; time on the market; market volatility in the trading period; price uncertainty; holding period; uncertainty as to achieved sale price; and the price impacts of buying and selling' (p6). All these factors create potential barriers to frequent trading and imply longer holding periods. The research found that the median time to sale was 6 months, that there were differences between sectors and that the time taken depends on the state of the market. This would tend to rule out the use of 3 month Treasury Bills as the risk free rate, if the matching of holding periods is considered the key criterion.

Research by Collett *et al* (2003) examined both the timing and holding periods of institutional real estate using IPD data and found that the median holding period varied over time, falling from around 12 years in the early 1980s to less than 8 years in the late 1990s. Their research also confirmed that the higher the return achieved, the more willing the investor was to sell. Also using IPD data, research by Gardner and Matysiak (2005) analysed 5000 offices purchased between 1983 and 2003 and found that the since 1993 the median holding period of sold office properties fell, and that the holding period was in the range from 4.6 years to 5.4 years. Research by MacGowan and Orr (2008) supported this finding, reporting that the average holding period was just over 5 years.

3.2 Lease length

The BPF IPD Annual Lease Review (2010) reports that the average lease length of all new leases weighted by rent (including break clauses) fell to 8.6 years in 2009/10, compared with 14.3 years in 1999 (Table 3). Lease lengths are now at their lowest point on record**.** The BPF also reported that

72% of all leases granted in 2009/10 were for a period up to 5 years, although on a rent weighted basis they make up 43% of all new leases. The proportion of leases with break clauses increased to 29.45% in 2009/10, compared with 28.2% in 2008/09. By sector, retail units have the longest lease lengths followed by offices while industrials have the shortest lease lengths.

Table 3. Average lease length – weighted by rent passing

Year	Average lease length
1999	14.3
2000	14.0
2001	12.9
2002	12.3
2003	11.7
2004	12.4
2005	11.0
2006	9.8
2007	10.6
2008	9.7
2009	8.6

(Source: BPF/IPD)

The critical evaluation of the literature indicates that there are significant differences in the yields of the different maturities of gilts so the choice of the appropriate gilt is not unproblematic. The holding period is identified as the key criterion in the selection of the risk free rate. In this respect the reduction in holding periods of institutional real estate investments together with the fall in average lease length may be significant factors in the selection of the risk free rate in property pricing. The impact of these factors will now be examined in the quantitative analysis of UK gilts of different maturities over the long term to determine empirical relationships and to test these against the quantitative views of a sample of fund managers.

4.0 Data and Methodology

The methodology utilised in the paper comprises both quantitative and qualitative elements. The first strand involves the quantitative analysis of UK gilt yields from first quarter 1980 to first quarter 2010. As this study is focusing on the selection of the appropriate risk free rate of return for UK property investment, UK gilts were chosen for analysis. Conventional (vanilla) gilts of different maturities were analysed: 2 year, 5 year, 10 year, 20 year and 30 year maturities. (Data for the 20 year gilts was only available from 4Q1987 to 1Q2010.)

Due to the smaller issuance of index linked gilts, it was not possible to find data on constant-maturity inflation-linked yields to match all the conventional gilt maturities. Instead, data was available for 10 year real zero coupon bonds from 1Q1985 to 1Q2010. It is acknowledged that zero coupon bonds are not directly comparable with conventional bonds as they do not pay coupons on a regular basis, but this series of zero coupon bonds does allow us to compare one set of nominal and real returns of the same maturity. The conventional gilt data was obtained from Datastream[2] and the index lined data from the Bank of England. Quarterly data rather than annual data were used to gain a better understanding of the volatilities.

[2] www.datastream.com

In order to facilitate comparative quantitative analyses, the percentage annualised yields were continuously compounded by being transformed into (quarterly, decimalised) natural logarithms as follows :

$$\ln(gy_t) = \ln(1 + (gy_t / 400)) \qquad (1)$$

where ln denotes the natural logarithm and gy_t the gilt yield under consideation.

The second strand of the research involved a questionnaire survey of UK property investment fund managers and advisors. A sample of fund managers was selected from major UK financial institutions. Twenty managers were asked to complete a short questionnaire in November/December 2010 with fourteen responding. Some of the questionnaires were completed in face to face interviews and some returned by email. Although it is acknowledged that this was a small sample, all those interviewed were senior investment analysts, who managed or advised on a variety of funds some of which included commercial property assets. These ranged from profits life funds, pooled pension funds, retail investor property funds, property unit trusts, UK and pan European property funds, open and closed funds, sovereign wealth funds and opportunistic funds.

5.0 Performance UK Gilt Yields

5.1. Summary Statistics

Summary statistics for the key variables of interest (including nominal *and* real 10 year gilt yields) are reported in Table 4. The 10 year nominal gilt reports the highest mean yield at 2% per quarter with its real counterpart achieving 0.7% per quarter over a similar (but not identical) sample period. Similarly, the 20 year gilt exhibits the lowest average yield at 1.6% per quarter. The ex post risk as measured by standard deviation, and reflecting in the maximum and minimum values, is lowest for the real 10 year yield and highest for the 2 year gilt yield. Distributions, as measured by the Jarque Bera (J-B) statistics, tend to be normal, at the 5% significance level, for the 2 and 30 year yields only. The J-B statistics and probability values would also suggest that non-normality tends to rise with maturity until the 30 year horizon with middle-dated gilts (10 and 20 year yields) exhibiting most non-normality. Positive skewness dominates the non-normal distributions of the 5, nominal 10 and 20 year gilt yields while the significant negative skewness statistic on the real 10 year gilt indicates a long left-tail on the distribution of this inflation-adjusted yield. In every case the Kurtosis statistic is less than 3 hence indicating distributions which are flat relative to normal.

Table 4 also reports Augmented Dickey-Fuller (ADF) tests for unit roots in the yield series thus indicating the stability of the variables over time. The statistics show that the null of a unit root can be rejected at conventional levels of significance for 2 and 5 year nominal gilts and the real 10 year gilt, implying in turn that these yields are stationary having stable means and variances thus exhibiting mean-reverting tendencies. The behaviour of the real 10 year gilt is however in contrast with that of the 10 year nominal gilt where the null of a unit root can only be rejected at the 10% level of significance: it would appear that inflation has a significant impact of the time series characteristics of the 10 year gilt yield. The ADF statistics however are unable to reject the null of unit roots in the 20 and 30 gilt yields at all conventional significance levels. Overall, the results discussed above suggest that (nominal) 10, 20 and 30 year gilt yields are non-stationary exhibiting characteristics which do not infer stability of means and variances over time. However, it may be the case that while these yields are inherently non-stationary when viewed in isolation, they may have a stable long-run relationship with each other which renders the 10, 20 and 30 year term structure stationary. We now turn to this issue by testing for cointegration between the 10, 20 and 30 year gilt yields.

5.2. Johansen Cointegration Tests

As a descriptor of the long-run relationships between the (non-stationary) 10, 20 and 30 gilt yields, we report in Table 5 results from Johansen tests for the cointegration of these series. Evidence of cointegration between these three non-stationary yields is weak with only the Trace statistic rejecting the null of no cointegration. However, when the (restricted) 20 year yield series is excluded from the test, evidence of cointegration between 10 and 30 year yields is stronger with both the Trace and Max-Eigen value tests indicating a significant cointegrating vector at the 5% level of significance. Hence while those two yields might deviate in the short-run, they have an inherent tendency to move together in the long-run.

An implication of the results from the unit root and cointegration tests discussed above is that the yield curve is segmented with 2 , 5 and real 10 year gilts being 'independent' of each other and the other yields, while 10, possibly 20, and 30 year yields have a long-run relationship with each other. Hence while they may drift apart in the short run they have time series characteristics which drive them together in the long-run. In other words, these non-stationary yields appear to be a function of the distance they are apart.

5.3 U.K. Gilt Trends and Cycles

In order to further compare and contrast the behaviour of U.K. gilt yields over time we utilise the Hodrick-Prescott (H-P) Filter to decompose the yield series into their long-term trend and cyclical components. The aforementioned trend and cyclical components are illustrated in Figures 5 and 6.

Not surprisingly we can see that the estimate of the long-term trend component of the real 10 year U.K. gilt is far smoother than its nominal counterpart and of any of the other nominal yields. As would be expected, the long-term trend of the real 10 year gilt is relatively gently rising between 1985 and 1990 but falling after that. What is quite noticeable are the quite dramatic changes in 2 year gilt long-run trends during 2007 (Q 2), followed by 5 year and 10 year trends. There would appear to be little difference in recent 20 and 30 year gilt trends.

As far as the cyclical components are concerned, we can see that with the exception of the real 10 year gilt yield, yields started to fall below trend (indicated .000 on Figure 2) 2008 Q4 and rising towards trend thereafter. Near-dated gilts tend to fall furthest with the 10 year (nominal) gilt yield being at trend at the end of the sample period. Cyclical deviations from trend appear to be short-lived with the greatest peak-to-trough arising between 1990-1994.

The dramatic changes in near dated gilt yields over the period 2008-2010 support the Grissom *et al* (2009) analysis of a positive yield curve which infers a concern with long term asset risk at the height of the global financial crisis. The next section of the paper examines the perceptions of fund managers in their selection of the risk free rate in pricing property investment decisions.

Table 4. Quarterly UK Gilt Yields: Q1- 1980 to Q1-2010*

Maturity/Statistics	2 year Gilt LNQGY2	5 year gilt LNQGY5	10 year gilt LNQGY10	20 year gilt LNQGY20	30 year Gilt LNQGY30	Real 10 year LNRZC10YR
Mean	0.019	0.019	0.020	0.016	0.019	0.007
Median	0.017	0.018	0.019	0.129	0.020	0.008
Maximum	0.038	0.039	0.038	0.028	0.039	0.012
Minimum	0.002	0.006	0.008	0.010	0.009	0.002
Std Dev	0.009	0.008	0.008	0.005	0.007	0.003
Skewness	0.162	0.287	0.315	0.482	0.447	-0.206
Kurtosis	2.159	2.043	1.946	1.692	2.354	1.753
Jarque Bera (J-B) p-Values	4.097 (0.129)	6.282 (0.043)	7.598 (0.022)	9.908 (0.007)	6.139 (0.046)	7.261 (0.027)
Observations	121	121	121	90	121	101
ADF Unit Root Tests	-3.489	-4.191	-3.314	-2.063	-3.077	-3.806
p-Values	(0.035)	(0.006)	(0.069)	(0.559)	(0.117)	(0.020)

*Data for 20 year gilts covers the period 4Q1987 to 1Q2010 and for the real 10 year gilt yield, 1Q1985 to 1Q2010. The J-B statistic tests whether the series is normally distributed . ADF denotes the Augmented Dickey-Fuller statistic which tests for unit roots in the series. Figures in parenthesis below the J-B and ADF statistics are probability values . The ADF critical values are: 1%, -4.363; 5%, -3.448; 10%, -3.149.

Table 5. Cointegration Tests on U.K. 10, 20 and 30 Year Gilt Yields.*

	Johansen Trace Test of No Cointegration	Johansen Eigenvalue Test of No Cointegration	Model Specification	Lag Specification for Differenced Endogenous Variables
LNQGY10, LNQGY20, LNQGY30	No cointegrating vectors: 43.723* (0.041) At most 1 cointegrating vector: 20.272 (0.217) At most 2 cointegrating vectors: 3.982 (0.745)	No cointegrating vectors: 23.552 (0.097) At most 1 cointegrating vector: 16.190 (0.137) At most 2 cointegrating vectors: 3.982 (0.745)	Intercept and trend	1-1
LNQGY20, LNQGY30	No cointegrating vectors: 27.260* (0.033) At most 1 cointegrating vector: 7.559 (0.290)	No cointegrating vectors: 19.701* (0.045) At most 1 cointegrating vector: 7.559 (0.290)	Intercept and trend	1-1

* In each case the null hypothesis is that the variables are not cointegrated. An asterisk denotes rejection of the null at the 5% significance level. The sample periods are as noted above in Table 2.

Figure 5. Hodrick-Prescott Filter: Trends of UK Gilts

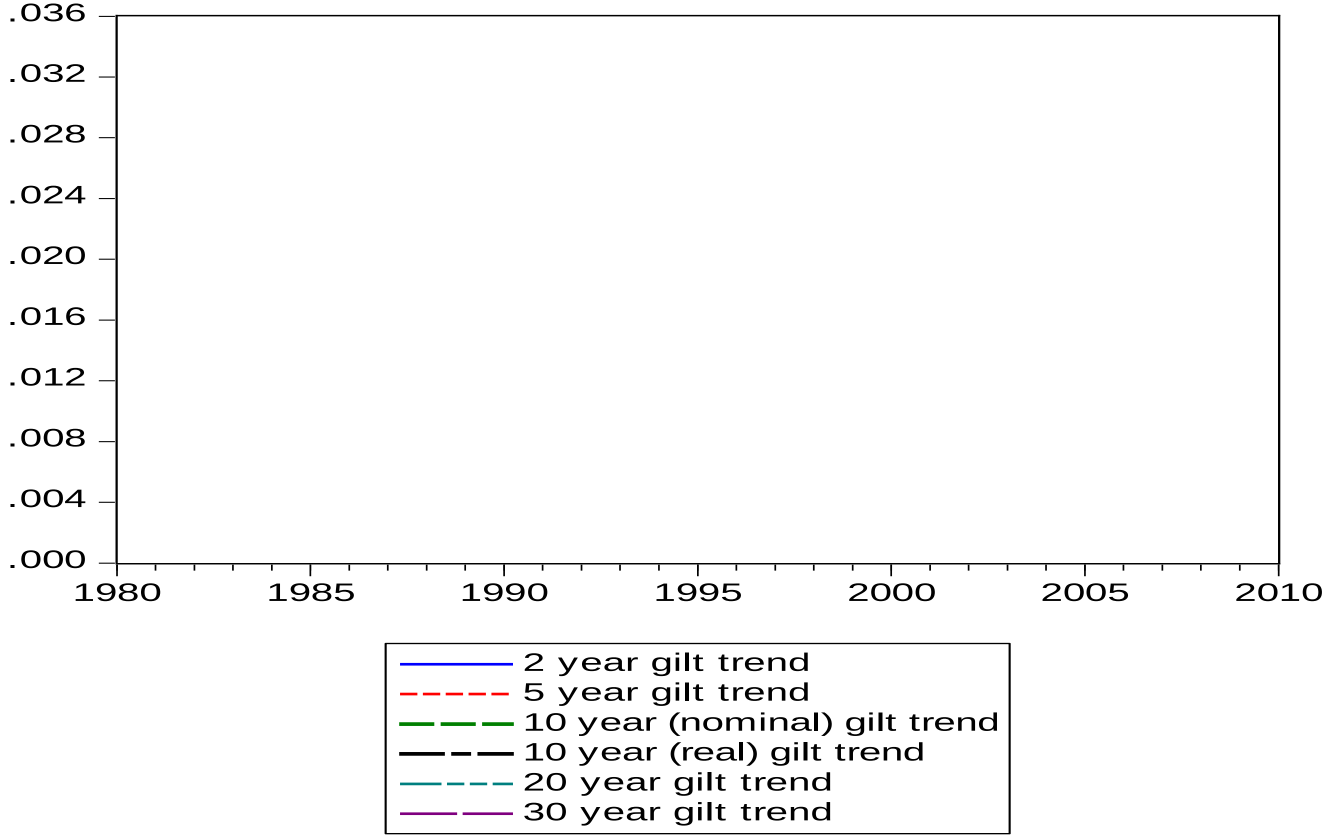
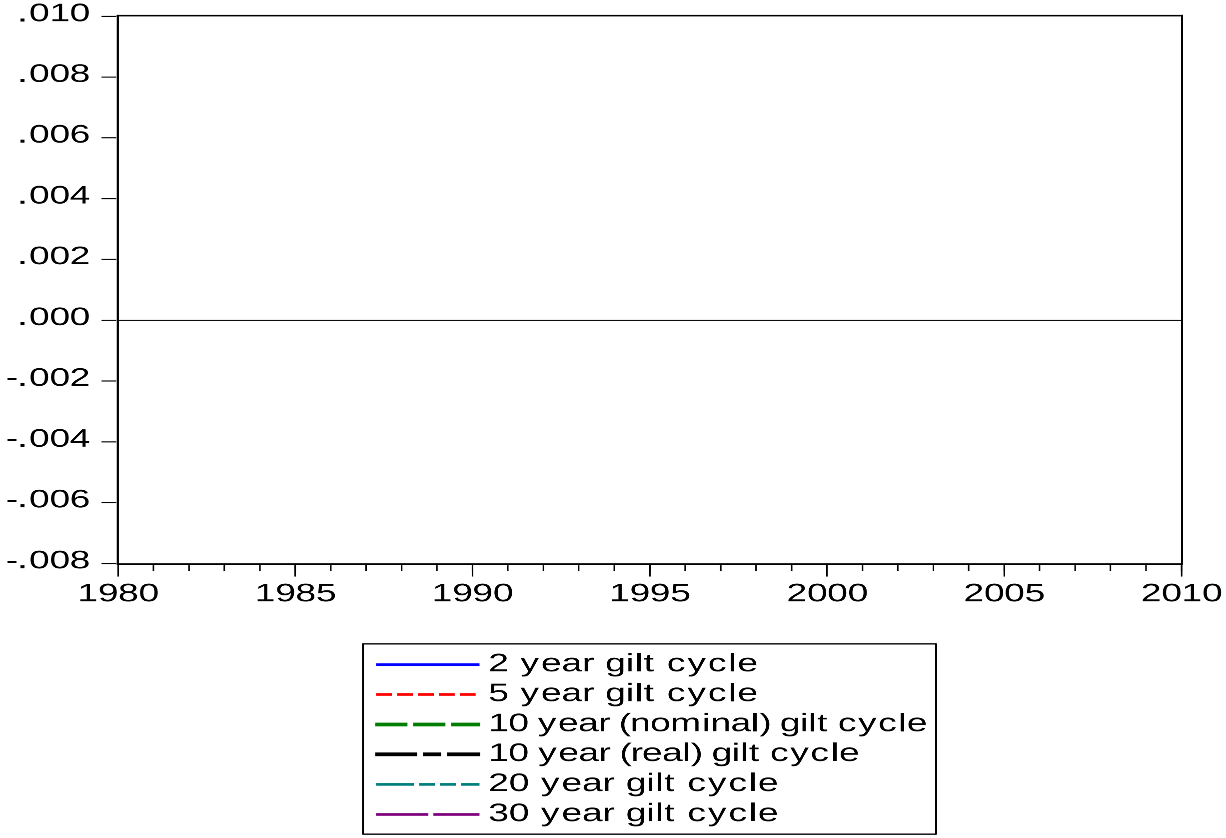


Figure 6. Hodrick-Prescott Filter: Cycles of UK Gilts



6.0 The Investors' Perspectives

The questionnaire instrument was divided into three sections. Section A considered the selection of the risk free rate and asked follow up questions on whether the decision was influenced by the duration of the bond, the liquidity of the bond and the reduction in average lease length. Section B focused on the expected holding period and whether there are any differences between the sectors, while Section C concentrated on the analysis period. The questionnaires were completed on the understanding that the answers would be pooled and non attributable.

The majority of respondents used the GRY on 10 year gilts as their risk free rate of return, although it was not necessarily the only rate being used for reference. One used the lower of the GRY on 10 year and 15 year gilts, one respondent used the GRY on 20 year gilts, two respondents used the GRY on long dated index linked gilts, and another did not use risk free rates to compile a required return. Another respondent looked at both 10 and 5 year gilts in order to match the bond rate to the lease profile of the assets considered. Several different reasons were given for their choice of yield and a selection of the responses is summarised in the Table 6 below:

Table 6. The rationale for selection of the risk free rate

Risk free rate chosen	**Rationale**
GRY 10 year Gilts	10 years for international comparison purposes. The most widely available rate.
	While the true risk free rate is probably the Treasury Bill rate, real estate has a much longer duration. The 10 year bond can be viewed as too short a duration, but until recently the UK yield curve has sloped downward so an ultra long bond would have suggested lower risk free rate than the 10 year bond.
	We could use 5 years, but tend to use 10 years as it reflects a long run, cash-on–cash risk free rate.
	We take the 10 year gilt rate as we are long term holders of property.
	10 year bonds have been adopted as the general international standard for long-dated bonds by investors. We use 10 year gilts as a benchmark for all other UK assets, not just property. This reflects the fact that we are making allocations across assets and the property team has to use the same metrics as the other investment teams.
	We are influenced by the long term expectations of our fixed income managers. Since 2008 the key assumption in our asset allocation strategy has been that 10 year gilts will 'normalise' and average 5% over the next 20 years.
	We use the 10 year rate, but there are issues over whether you should use the current or forecast gilt rate.
	We are global investors and take the 10 year average of the local 10 year government bonds of the country that we are investing in. The logic behind this is that the local bond yield reflects the risk free rate in each country with risks, inflation and exchange rate risk priced in efficiently (in theory). If you use local bond yields in the same way as local investors you are less likely to price yourself out of the market. The 10 year rate is the most common rate used.
	Assumes multi asset investors compare yields across asset classes in nominal terms.
Lower of GRY 10 year or 15 year Gilts	We consider the duration of the gilt equates to real estate duration.
GRY 20 year Gilts	We would use the 20 year gilt rate for an annuity product.

GRY on long dated index linked Gilts	This is as close as one can get to 'risk free' – backed by government and inflation proofed. We know that it isn't entirely risk free, given patterns of payments, but it is as close as it can be.
Absolute return	We don't discuss gilt yields much except trying to guess what institutions might look for when we sell to them.

For most of the respondents neither the duration nor the liquidity of the bond were considered key influences in the selection of the risk free rate, while commenting that the decision to use a UK gilt rate was based on the assumption of a high degree of liquidity. However, concern was expressed at the liquidity of some overseas government bonds markets. This opened up the question of whether or not to use the local bond yield or an international comparator say the UK or US yield, when investing overseas. By not adopting the local benchmark yield, investors risk being out of step with local competition, making purchases difficult in markets with low bond yields.

One of the respondents had changed their choice of risk free rate in line with reductions in lease length, and a further three mentioned that this could influence their choice in the future. One commented that lease length is only partially relevant as the asset has a residual value and the principal is not repaid when the lease expires.

For the majority of respondents at the time of purchase of the property investment, the average expected length of the holding period was between 5 and 7 years, but with some wide variation between sectors and depending on whether the property was a 'dry asset' or a development opportunity. Mention was made that as offices are perceived to be the most volatile sector that an office investment is mainly about trying to anticipate the cycle and that the holding period maybe 3-4 years, but that for industrial and shopping centres the holding period tends to be longer say 7-9 years and for major developments the holding period is often 15 years plus. However, three of the respondents indicated that they were very long term holders, 30 years plus, and one who reported there were no 'a priori' expected holding periods and that they review the fair value of their assets each quarter and compare this with the observable price in the market place. For all respondents the average DCF analysis period was between 5 and 10 years with no difference between the sectors.

7.0. Conclusions

To conclude, past literature would suggest that the choice of the risk free rate should be dependent on the investment horizon or holding period of the property. Research would suggest that holding periods have fallen over the last 30 years, with evidence from the office market suggesting that holding periods are on average 5 years, with retail and industrial stock held only slightly longer and normally less than 10 years. Holding periods are however dependent on the performance of the market and are not fixed.

The analysis in Section 5 of gilt yields over the period 1980 to 2010 produced five main results with regard to stability and yield distribution. First, 10 year nominal gilts were positively skewed with a long right hand tail, with low values having the highest frequency. Second, 10 year real gilts were negatively skewed with a long left hand tail, with high values having the highest frequency. Thirdly with regards to stability, (stable means and variances), the ADF statistics suggest that the 10 year real gilt is more stable than the 10 year nominal gilt, as are the 2 and 5 year nominal gilts. Fourthly, an implication of the ADF and cointegration tests is that the yield curve is segmented with 2, 5 and real 10 year gilts being 'independent' of each other and the other yields, while 10 year nominal, possibly 20, and 30 year yields having a long-run relationship with each other. Finally that trends and cycle analysis also show the real 10 year yields being more smoother (trend) and relatively less volatile (cycle).

What does this analysis tell us with respect to which yield to use? The 2 and 5 year nominal yields as well as the 10 year zero coupon yield are more stable as defined above. The results show that inflation is an issue with respect to stability of yields from the 10 year maturity upwards and as far as stability is concerned (according to ADF tests, trend and cycles and independence issues), the 10 year real appears to be most stable, if that is a virtue analysts are seeking. Also the 5 year nominal appears to be more stable than 10 yr nominal (as well as being independent), so if conventional gilts are preferred then 5 year nominal is preferred to 10 year nominal as far as stability is concerned.

The findings provide a better understanding of how the different maturities of gilts behave thereby demonstrating that the aim of the research has been achieved. However the analysis is not so conclusive regarding the selection of an appropriate benchmark risk free rate suitable for the pricing of property investments in the UK.

In our survey of UK property investment fund managers and their advisors, the majority, but by no means all of the respondents, used the 10 year nominal gilt yield as their risk free rate of return. The rationale for this approach appears to be partly because the 10 year gilt rate is a recognised, widely available and easily understood benchmark, and partly because it matches the expected length of their holding period of between 5 and 7 years on average. However, the results were not entirely clear cut as for example, some investors used the 10 year gilt rate even if their expected holding period was 30 years or more. Furthermore, concern was expressed whether it was appropriate to use the current rate on gilts, particularly when rates in 2009/10 had fallen to such a low level. It was suggested that perhaps an average rate either based on gilt yields over the last 10 years, or a forecast rate might be more relevant. This assertion remains to be tested. Clearly, as the results from our analysis show, whether spot or average rates are used, investors require to be fully aware of the financial characteristics of the maturity of the gilt chosen.

References

Baum, A & Crosby, N. (2008) *Property Investment Appraisal*, Blackwell, Oxford.

BPF/IPD (2010), *Annual Lease Review 2010*, BPF/IPD, London.

Choudhry, M., (2009) The Value of Introducing Structural Reform to Improve Bond Market Liquidity, *European Journal of Finance and Banking Research*, Vol.2, No.1, pp 13-35.

Choudhry, M., Cross, H.G. & Harrison, J., *The Gilt-Edged Market*, 2003, Elsevier, Great Britain.

Collett, D., Lizieri, C. & Ward, C. (2003) Timing and the Holding Periods of Institutional Real Estate, *Real Estate Economics*, 31, 2, pp. 205-222.

Diermier, J.R., Ibbotson, R. and Siegel, L. (1984) The Supply of Capital Market Returns, *Financial Analysts Journal*, March-April, pp 74-80.

DMO (2010), Debt Management Office United Kingdom, www.dmo.gov.uk.

Hoesli, M. & MacGregor, B. (2000) *Property Investment: Principles and Practice of Portfolio Management*. Pearson, England.

Gardner, A. and Matysiak, G. (2005) Holding periods and investment performance: Analysing UK office returns 1983-2003, European Real Estate Society Conference, Dublin, Ireland.

Geltner, D.M., Miller, N.G., Clayton, J. & Eichholtz, P. (2007), *Commercial Real Estate: Analysis & Investments*, South-Western, USA.

Grissom, T., Lim, L.C. and Haran, M. (2009) *Arbitrage and Cyclical Effects in the Performance of UK and USA Property Markets*, paper presented at the European Real Estate Society Conference, June 2009, Stockholm.

IPF (2004) *Liquidity in Commercial Property Markets*, Investment Property Forum, Working Paper Five.

MacGowan, R.J., Orr, A.M. (2008) A behavioural study of the decision process underpinning disposals by property fund managers, *Journal of Property Investment and Finance,* 26, 4, pp.342-361.

Sayce, S., Smith, J., Cooper, R. & Venmore-Rowland, P. (2006), *Real Estate Appraisal: From Value to Worth*, Blackwell, England.