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The Changing Relationships between Government Bond Yields and Capitalisation Rates: Evidence from the UK, USA and Australia

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Introduction

The global financial crisis was a sharp shock to real estate markets and while interest rates and government bond yields fell in response around the world, real estate yields (cap rates) have risen. The objective of this paper is to analyse the gap between government bonds (index-linked and long dated) and real estate yields/capitalization rates over time for the UK, Australia and the USA. The absolute gap levels and their variation over time in the different countries are compared and linked to the theoretical reasons for the yield gap, and in particular a changing real estate risk premium. Within this context it assesses whether there have been structural breaks in long term relationships during booms and busts based on ARCH models. Finally the paper provides further insights by constructing statistical models of index linked and long dated yield gaps.

The underlying pricing of real estate is based on a fundamental equation which relates to the yield gap between real estate capitalisation rates and government bond yields. This equation incorporates a risk premium for real estate that has historically been explained in terms of the inherent inefficiency in the property market, given for example its illiquid and imperfect information characteristics. This is the starting point for our task so the paper first sets out the fundamental property pricing equation as a framework. It then reviews the few studies that have attempted to statistically analyse this phenomenon over time. Although the yield gap between government bonds and real estate capitalisation rates has traditionally been seen in terms of ten year government bonds, there is an argument that a more appropriate gap is that between the yields on index-linked government bonds.

To assess these issues an international comparative analysis of the USA, UK and Australia are presented. These countries are adjudged by JLL(2014) to be the most transparent and liquid markets in the world and they also have the longest time series data on yields/ capitalisation rates and rents. These markets should therefore respond most efficiently to changing market fundamentals. The empirical analysis takes a tiered approach. This is undertaken because of the variability of the length of data series between countries. It starts with an overview analysis of yield gaps in the UK, USA and Australia since the 1980s, showing the similarities in trends (and minor differences). From there we test the existence of (parallel) structural breaks in these yield gap time series for the US and UK because they have long enough time series. Finally we can drill down further to highlight the underlying influences with analysis of the UK applying an error correction model.

Structure of the Gilt Yield Gap and the Concept of a Risk Premium

The fundamental investment pricing equation at its simplest is as follows:

$$y + g = r + rp$$

where

y = initial yield

r = risk free rate of return

rp = risk premium

g = expected net rental income growth

The essential arguments for the real estate risk premium relate to property market characteristics relative in particular to investing in the bond/stock market. In detail the justification is seen as a function of higher transactions and management costs, lower liquidity and marketability, and poorer information in the property market. In other words the premium is based on weak property market efficiency and suggests a degree of constancy over time. Theoretical models of portfolio investment also invariably treat the risk premium as constant and determined by the nature of the markets and the product (Tarbert and Marney, 1999).

The conventional traditional assumption was that this risk premium meant that the required rate of return on property was 2% over the redemption yield on long dated (ten year) government bonds (known as gilts in the UK), the long run risk free rate of return/cost of capital (Dubben and Sayce, 1991). However, it was recognised that the precise figure was not set in stone, for example Mackmin (1995) quotes a rule of thumb for this UK risk premium in the valuation literature of 1-2% while Hargitay and Yu (1993) describe 1.5-2.5% as a rough guide.

Sayce et al (2006) note that the underlying influences on the property risk premium also include a tenant not renewing, namely lease risk, and tenant default. They present a notional breakdown of a property yield by reference to the different risk elements. Baum (2009) suggests that indicative risk premiums vary with property type from 2% for standard shops through to 4% for secondary offices and industrials, as well as by town, lease type and building. A similar stance is taken by Wyatt (2013) without quantifying the differential premiums.

Notwithstanding these professional rules of thumb, a series of papers by Fraser (1985, 1986a, 1986b) attempt to dissect the arguments underpinning the risk premium. In his view the 2% premium applied to the non-inflationary inter-war years, but with the rise of inflation it was no longer applicable. Seen as a long term investment in an institutional portfolio, Fraser argues that real estate is less risky in terms of volatility than government bonds and shares and is a good portfolio diversifier. This implies a negative risk premium or discount of say 2%, rather than the reverse although the essential argument is muddled by the use of valuations in property statistics series that dampen volatility.

At the same time, as a long term investment property is only at a small disadvantage relative to government bonds in terms of its liquidity, marketability, transactions costs and management, giving a positive risk premium. Fraser (1993) places notional values on these 'plus' and 'negative' components but his analysis is arbitrary. Reflecting the view that risk should vary with market conditions, particularly inflation, Fraser finds there is no reason why the risk premium should be constant. He estimates it to be in the range +2% to -2% for the UK.

There have been only a few other attempts at measuring the risk premium from published data series. Baum (2009) reports on a UK study by Property Funds Research that estimates a long term risk premium of 2.5% as a historic mean with a tolerance of 1% either way. The detailed results presented in the Table 1 suggest that the risk premium is falling over time although the individual study periods reflect the use of different data sources/variables. Table 1 also shows considerable variation in these ex-post premiums from year to year.

Table 1 Long Term Trends in the UK Risk Premium

Period	1921-38	1947-70	1971-2002	1981-2002	1921-2004
Risk Premium	3.84	3.69	3.12	1.43	3.65
Minimum	-7.11	-4.69	-28.51	-24.31	-28.51
Maximum	27.15	17.15	23.98	18.58	27.15
SD	10.34	6.22	11.88	9.94	9.79

Study periods are defined by data source availability. Source: Baum (2009)

Blundell (2009) more recently estimates the risk premium based on long term averages from UK IPD data for 1981-2008, by breaking down the components of the fundamental pricing equation as follows:

All property initial yield	6.4
Plus income growth	6.3
Less depreciation	2.3

Risk Premium 3.1

However, he argues that the evidence suggests that the risk premium fluctuates significantly around this 3% level in the UK depending how expectations for income growth inflation and other factors vary. Hence at the mid-point of 2007 following the same basic research method incorporating an estimate of expected income growth, Blundell estimates the implied risk premium is only 1.6%. Subsequently the IFA Census survey (2008 - 2014) for the UK indicates an average expectation of a margin of circa 3.5% return over the risk free rate. Besides the cyclical dimension Blundell (2009) also points to changes in property as an investment class that are likely to raise the risk premium in the future.

Tarbert and Marney (1999) ostensibly undertake a more formal statistical analysis of the realisable risk premium based on UK JLW quarterly and annual returns indices and conventional gilt yields over the periods, 1978-96 and 1968-96 respectively.

The traditional measurement of the risk premium is relative to long dated gilt yields, but there is also a view that it should be benchmarked against an alternative risk free rate of return, the yields of index-linked government bonds that were introduced in 1981 (Goobey, 1989; Scott, 1992). The essential argument is that as rents should logically keep pace with inflation the difference between the yields on property and index-linked government bonds would be a long term risk premium. Short term variations in this index-linked yield gap would therefore reflect deviations in expected rental growth from general inflation. Very little research has been undertaken on this 'index-linked yield gap'. Tarbert and Marney (1999) examine this gap but for a very short period, 1985-96, reflecting data availability.

The results of Tarbert and Marney's quarterly time series results can be summarised as follows:

- The mean excess property return and risk premium over conventional government bonds was zero over the study period.
- There was a negative property risk premium over index-linked government bonds of 1.3%.
- There was a negative property risk premium over equities of 1.4%. However, there are very different results for annual data:
- The property risk premium over conventional government bonds was 2.9% although there is considerable volatility.
- There was a tendency for the premium to decline through the study period and to be less than 2% after 1978.

The variation in the statistical results for both quarterly and annual series casts some doubt on their reliability. However, they suggest that the variation in the risk premium oscillates around a mean (except for the quarterly risk premium series linked to index-linked government bonds). This variation around a mean is not easily explained but seems consistent with Fraser's ideas, and the tendency for a declining premium also fits with Fraser's arguments and the research by Baum. However, these conclusions of Tarbert and Marney are essentially dependent on the time period studied which is quite short for the quarterly series, and certainly the declining risk premium is challenged by Blundell (2009).

All these studies use different statistical approaches which are not fully documented and a range of data sources, and so it is difficult to verify and compare the results. Some of the empirical results are questionable and seem intuitively debatable. However, these studies all suggest that the risk premium is variable over time despite the traditional convention. In support of this conclusion Tarbert and Marney (1999) argue that theoretical investment models do not provide any substantive case for a constant risk premium.

Further insights as to why the risk premium should not be constant can be gleaned from the empirical literature on risk premiums **within** the real estate sector. There are a number of

studies that discuss the variation in risk within the property market, and the implications for the risk premium. Hutchison et al (2011) test the view that risk premiums should be applied to valuations of individual properties depending on the covenant strength or status of tenants, but find no market evidence. Studies by Dunse et al (2007), Gunnelin et al (2004) and Sivitanidou and Sivitanides (1999) have identified the potential existence of location specific risk premiums, linked to small local markets being thin, and illiquid, or volatile (amplitude of cycles). The analysis by Gunnelin et al (2004) using cross-sectional individual real estate valuation data for offices in Sweden finds that standardized capitalisation rates differ by property type, location and lease in Stockholm, Malmö and Gothenberg. Dunse et al (2007) not only find differential risk premiums across provincial office centres in the UK, but also that they vary over time. Yields in cities generally follow national cycles although the yield differentials of individual cities show considerable changes.

Two studies by Jones (2009, 2010) have looked at the changing yield differentials within the retail real estate sector. He argues that the maturation and establishment of new retail formats such as retail warehouses as mainstream institutional investments from the early 1980s is reflected in changing risk premiums. These can be measured as equivalent yield trend differences relative to standard shops. At the beginning of this process in the 1980s the equivalent yield (cap rate) of standard shops was the lowest of the five retail forms reflecting its position as the more secure investment form. During the recession of the late 1980s/early 1990s this position is consolidated and the differences in yields are magnified. Through the 1990s these risk premiums are eroded and in the 2000s the position of the retail formats is reversed, with only in town shopping centres having a higher yield than standard shops. The reasons for these changing risk premiums over time are a combination of an investment market being established and the retail formats/products being refined and the threat of perceived obsolescence receding.

Translated to the national average, there are a range of reasons why the real estate risk premium could change over time including structural changes to the investment sector such as liquidity, risk of obsolescence and the macroeconomic cycle/interest rates, shortening leases structures and greater international capital flows with globalisation. Fraser (1985, 1986a, 1986b, 1993) also linked variability in the risk premium to inflation. More generally there are cyclical influences linked to (increased) macroeconomic volatility and inflation/interest rates that create uncertainty about expected rental growth. This is illustrated with international investment in the emerging markets of central and eastern Europe from the 1990s on, where information performance constraints and other uncertainties meant initially high risk premiums (Adair et al, 2006).

A further factor is investment sentiment. The required rate of return is not simply a function of the risk free rate of return and a risk premium linked to property market characteristics but also to the relative returns from alternative investments, notably company shares traded on the stock market. In reality the risk premium is therefore also potentially a function of the returns from the alternative investments on the stock market. Put another way there is clearly an identification problem between a risk premium that relates to inherent property market characteristics and dynamics, and the relative returns from the stock market. In addition it is important to note that fixed coupon government bonds are no longer seen as risk free because of the inception of large scale quantitative easing in the aftermath of the global financial crisis, arguably they now represent 'return free risk' rather than a 'risk free return'. Insight on the influence of the stock market can be seen from the limited econometric studies of real estate yields. These have not attempted to isolate a 'real estate risk premium', but have generally estimated a function of the following form:

$$y = f(\text{expected rental growth, } r, \text{ stock market performance})$$

British econometric studies have applied different stock market indicators to capture this 'indirect' effect of stock market returns on yields but have not found a strong statistical

relationship (Dunse et al, 2007; Hendershott and MacGregor, 2005; McGough and Tsolacos, 2001; Watkins et al, 2012). It seems that while there is some consensus that stock market returns affect property yields the relationship is not easy to quantify. Baum (2009) sees investment sentiment as influenced say by a specific event rather than attributable to precise relationships between the relative returns of asset classes. In econometric terms this could be seen as equivalent to structural breaks in yields or risk premium time series. In broad terms Baum for example points to historic shifts in the relative yields (cap rates) of property and government bond yields, known as the yield gap. Historically the yield gap was positive, ie government bond yields higher, but it became negative from the latter half of the 1990s in the UK and USA. This could be because of a fundamental reappraisal of real estate's risk premium.

In summary there has been only one recent study (Blundell, 2009) that has statistically evaluated the property risk premium, and the links to index-linked government bonds have had very limited scrutiny. Valuation text books tend to view the risk premium as determined from the underlying characteristics of the property market that are implicitly constant. But even these characteristics are changing over time, for example the greater liquidity in the sector (Jones et al, 2012; Scofield 2013) would imply a falling risk premium. On the other hand shorter leases would have the reverse effect, as would an increased risk of obsolescence. The statistical analyses generally suggest the premium is on a falling trend although most of these studies are crucially dated, based on data up to 2004.

The risk premium is not just a function of property market investment characteristics as in the original definition, but also has what can be described as a 'cyclical component' including uncertainty about rental growth expectations. The yield gap between property and ten year government bonds is a useful benchmark to look at the variation but this difference incorporates rental growth expectations. A purer estimate of the (long term) risk premium is given by the index-linked yield gap as both include inflation expectations.

Econometric studies of yields have incorporated a stock market returns variable but have not been able to establish a clear relationship with the stock market although the relative investment sentiment between shares and property is an accepted factor. Such sentiment probably reflects events and cyclical influences, and so the results from statistical studies will depend on the period under review. It is likely that there are structural breaks in sentiment and hence risk premium patterns over time. The paper now analyses recent statistical trends to assess these issues.

Statistical Trends

This section compares the trends in the differences between government bond yields and property equivalent yields (capitalisation rates) in three countries, the UK, USA and Australia. The analysis considers both the differences (yield gaps) between 10 year and index-linked bond yields and equivalent yields. The data is drawn from IPD for the UK and Australia and NCREIF for the USA. The analysis is dependent on the availability of time series which vary with country:

- The longest time series are available for the UK – annual series of equivalent yields start in 1981 but detailed analysis is focused on monthly data that begins in 1987 through to 2013. The monthly time series is chosen for the later econometric analysis because it gives more data points while still encompassing two major downturns. Index-linked government bonds were established in 1981 and the yield series begins in 1983.
- In the USA annual capitalisation rates data begin with the fourth quarter of 1982 but index-linked bond yields are only available from 1997. The data series is available through to 2013 quarter 3.
- Australian data relate to 1994 through to 2011 quarter 3.

The analysis is presented on an annual basis for each country.

UK Experience

Figure 1 shows that UK equivalent yields (cap rates) were at their highest through the 1980s and the first half the 1990s, reaching a peak following the recession at the juncture of these two decades. There is then a modest downward trend through to the global financial crisis in 2007, when the average yield shoots up to a level not seen since the early 1990s. However, the upturn is relatively short-lived with a peak in 2008.

The trend for yields of ten year government bonds is more markedly downward reflecting the long term trend in inflation. The yield on ten year government bonds begins well above property yields at almost 15% but by the end of the period is only just over 3%. There is a major spike in government bond yields in 1990 when the yield rises to 11%, but after this peak there are only minor modest upturns. Even during the immediacy of the global financial crisis the yield creeps up to just above 5%.

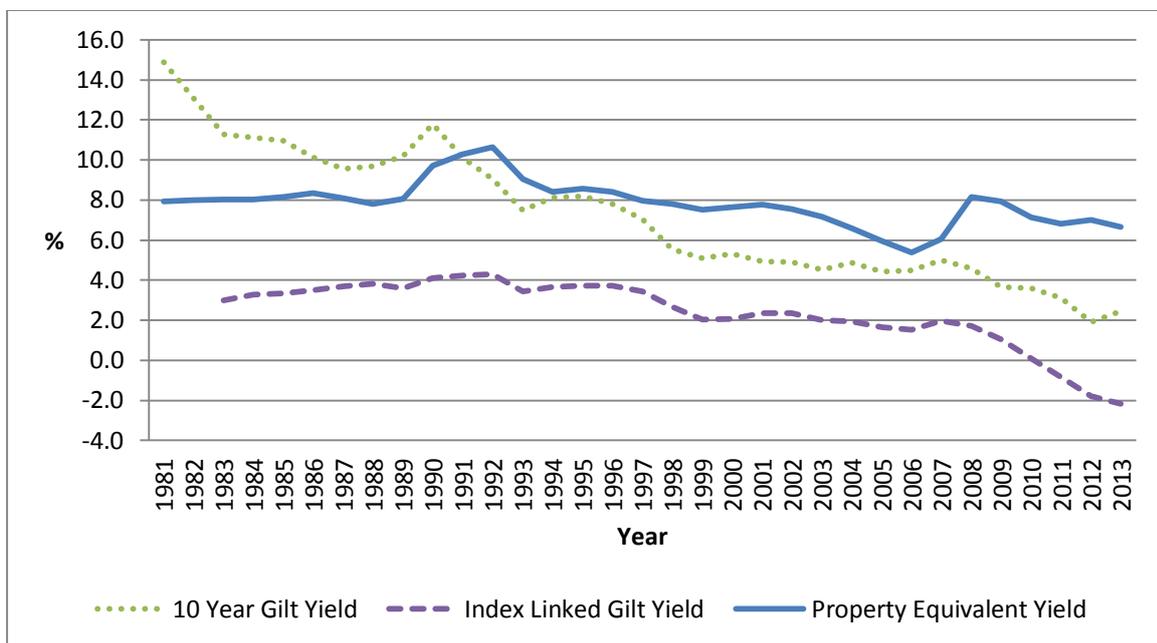


Figure 1 UK Property Equivalent Yields, Ten Year and Index-Linked Gilt Yields compared on an annual basis, 1983-2013

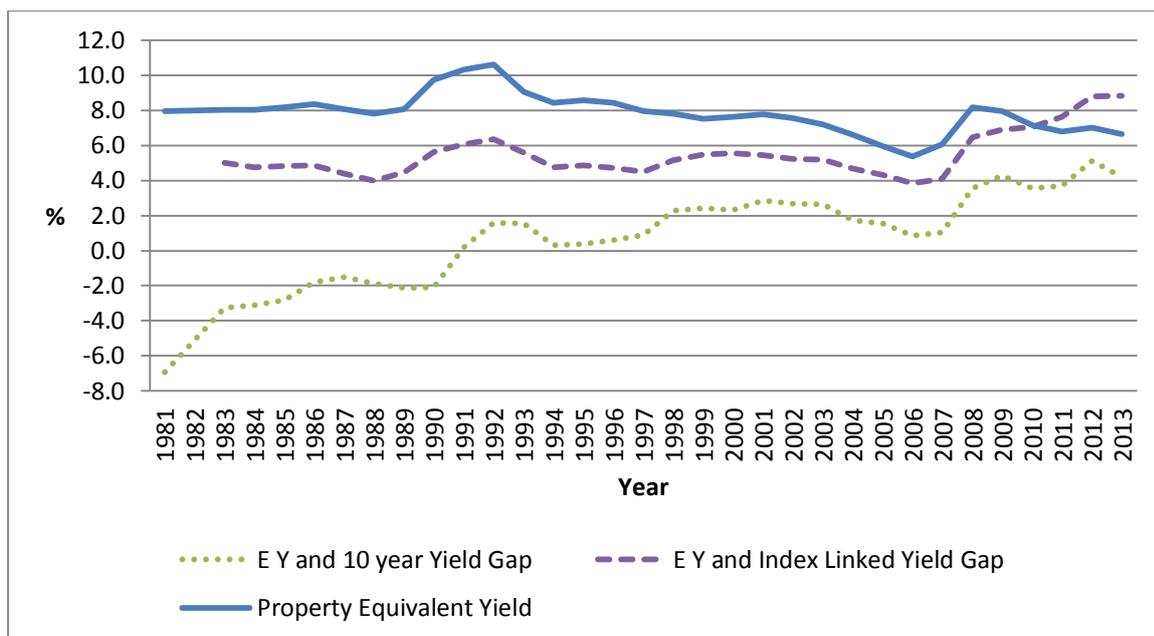


Figure 2 UK Property Equivalent Yield and Yield Gap Trends on annual basis, 1983-2013

The implications for the yield gaps between government bonds and property yields are seen in Figure 2. Ten year government yields fall below equivalent yields for the first time in 1991 and the gap remains not only positive hence forth, but on a rising trend. Nevertheless there are periods when it narrows. It is only marginally positive between 1994 and 1997, and looking on a monthly basis reveals brief periods when there were negative gaps again during this period.

As property yields fall to their lowest level in the mid-noughties the gap almost disappears again but is marginally positive. Indeed the monthly perspective reveals a brief negative gap in 2007. With the impact of the credit crunch the gap widens again and stabilises around 3.8%. This is a historically high yield gap.

The yields on index-linked government bonds rose through the 1980s peaking in 1992 before a gradual decline to 2006. An upward correction in 2007 is followed by a sharp fall in yields which are increasingly negative from 2011 (see Figure 1). The yield gap with property equivalent yields is relatively stable usually between 4.3 and 6%, centring on 5%. This is because statistically property yields and index-linked government bond yields have similar 'cyclical' patterns in the sense that there tend to be matching peaks and troughs to each time series. However, since 2007 the gap has become much wider at over 7% as Figure 2 demonstrates, suggesting investment risk aversion.

USA Experience

In the USA property capitalisation rates have been more stable than equivalent yields in the UK. In fact as Figure 3 demonstrates capitalisation rates were on a plateau of around 9% through the 1980s and 1990s, before a substantial fall from 2003 onwards. There is an abrupt rise with the onset of the financial crisis until 2009, and then another sharp downward adjustment in 2010 that continues through 2012.

The trend for yields on ten year government bonds is more markedly downward reflecting the long term worldwide trend in inflation, including in the UK. The yield on these ten year bonds begins well above capitalisation rates at almost 15%, but by the end of the period is only just over 3%. There is a modest plateau in bond yields in the late 1980s around 8%, but after this pause there are only minor modest upturns in a long downward trend. Even before the global financial crisis the yield creeps up to only just above 5%.

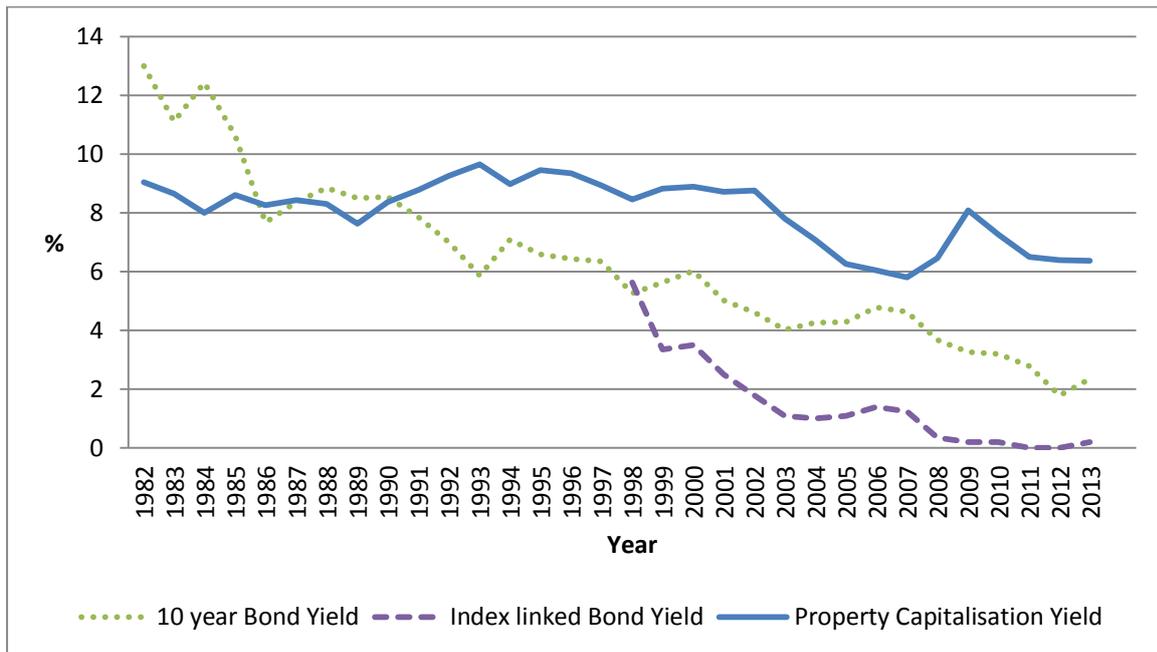


Figure 3 US Property Capitalisation Rates and Ten Year and Index-Linked Government Bond Yields compared on an annual basis, 1982-2013

The greater fall in government bond yields relative to property capitalisation rates over the thirty year period results in the yield gap not only moving from negative to positive in 1992, but the long term trend is for the yield gap to widen. The major exception to this trend is the mid-2000s just prior to the global financial crisis, when capitalisation rates are at an all time low. It is noticeable that in the post credit crunch period bond yields have fallen while capitalisation rates have shown a modest rise.

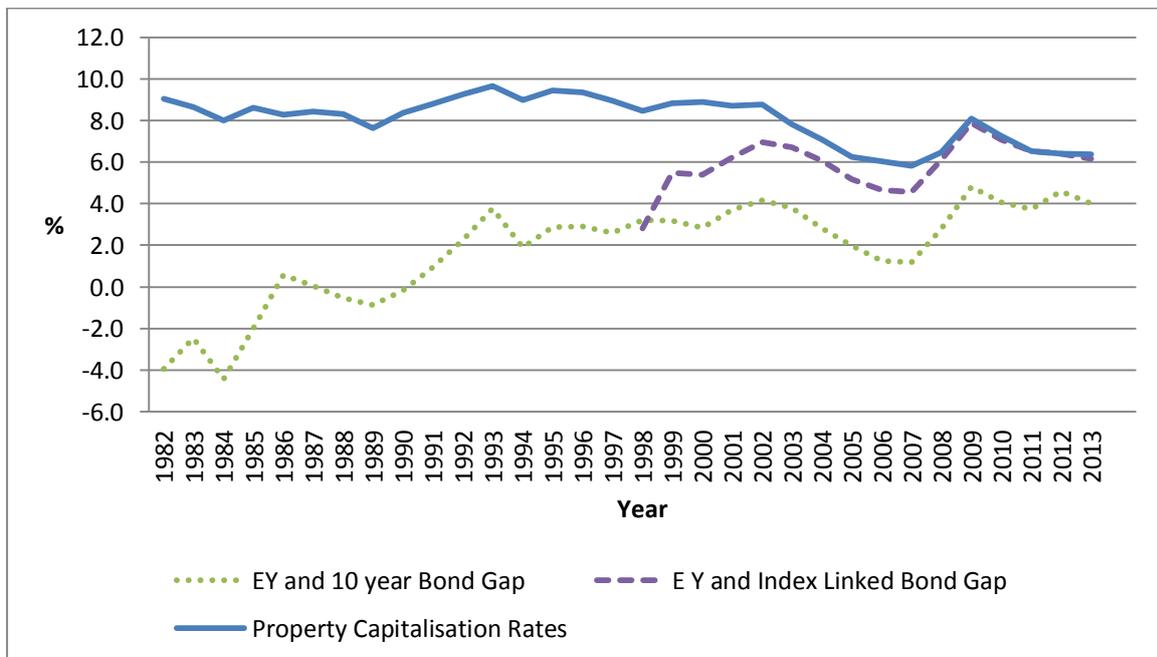


Figure 4 US Property Capitalisation Rates and Yield Gap Trends on annual basis 1981-2013

The yields on US index-linked bonds (TIPS) have shown very little variation since they were

introduced in 1997. There is a marginal upward trend from 1.01 to 1.44 as Figure 3 shows. There is therefore little relationship with property capitalisation rates. As a result the relationship between the yield gap between index-linked government bonds and capitalisation rates shown in Figure 4 is almost parallel to capitalisation rates.

Australia

Australian property capitalisation rates are available from 1994 and as Figure 5 shows exhibit an overall downward trend. There are two periods when the capitalisation rate falls relatively sharply, between 1995 and 1998 and 2004 and 2007. Interestingly the first of these periods coincide with falling bond yields, but the second significant fall occurs partly to a backdrop of rising bond yields. This illustrates the importance of expected rental growth trends on the yield gap.

Ten year government bond yields are broadly stable from 1997 to 2010, in the range 5-7%. Property capitalisation rates are only briefly below bond yields, so the ten year bond yield gap is only negative in 1995 and 1996 as shown in Figure 6. The gap does almost disappear again in 2007 and 2008. Interestingly the gap is normally around 2 and its maximum value is 2.7. It has been on an upward trend since the global financial crisis. Figure 5 shows the relationship between index-linked bond yields and capitalisation rates. With long term falling yields on these bonds the index-linked yield gap has risen over time, particularly again after the global financial crisis. Nevertheless the range of this yield gap is only between 3.3 and 4.8 except for 2011 when it reaches 5.1 as shown in Figure 6.

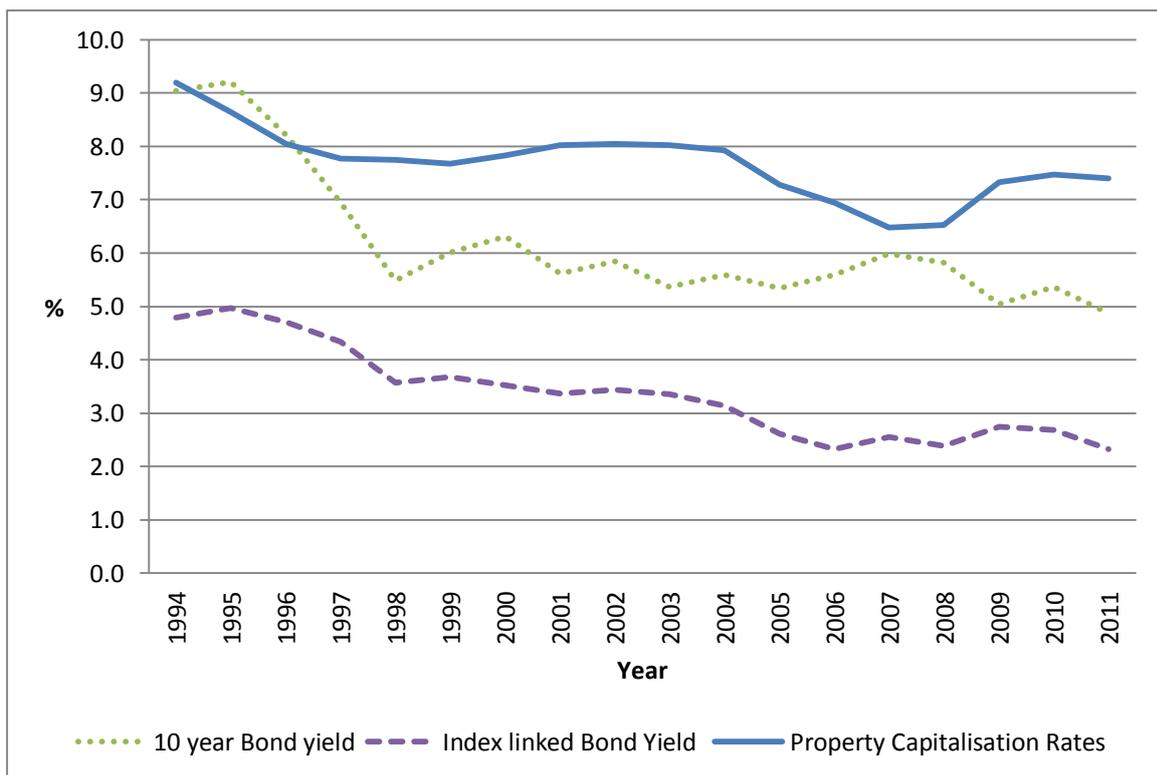


Figure 5 Australian Property Capitalisation Rates and Ten Year and Index-Linked Government Bond Yields compared on an annual basis, 1994-2011

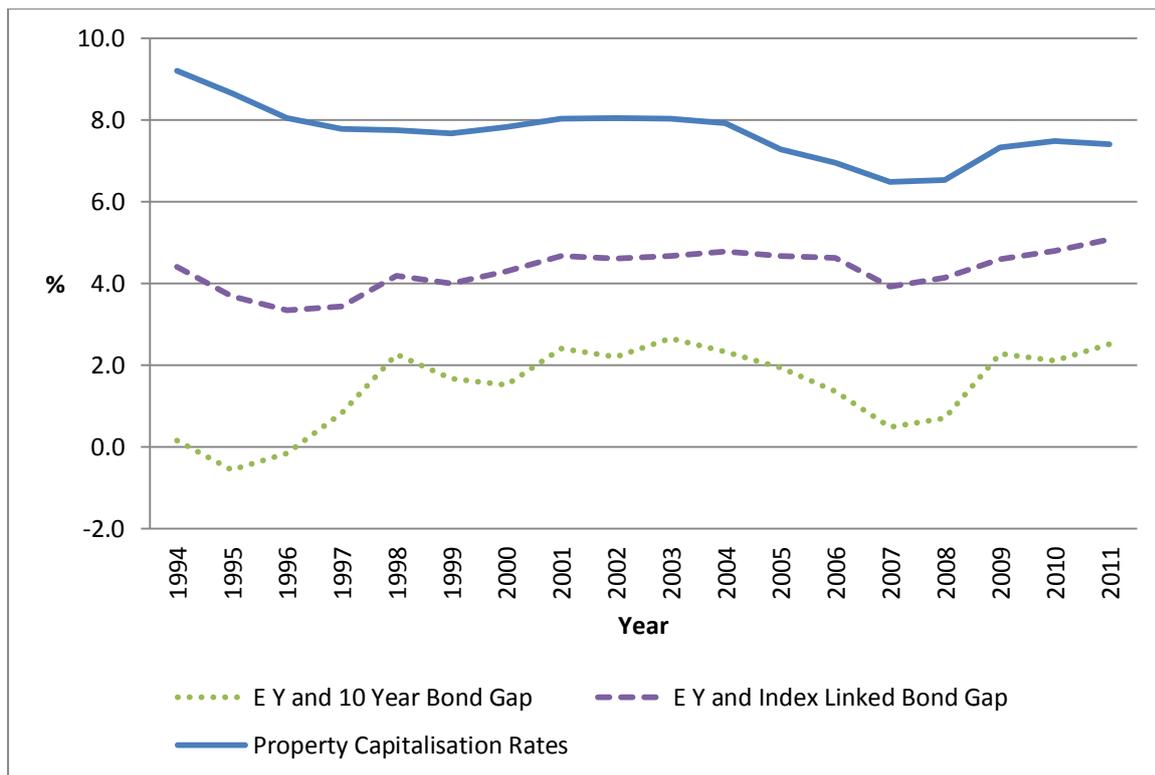


Figure 6 Australian Property Capitalisation Rate and Yield Gap Trends on annual basis 1994-2011

In summary all three countries experienced similar falling trends in bond yields since the 1980s. There are some differences in property equivalent yield/capitalisation rate trends but the first half of the last decade saw them falling, and then rising in the aftermath of the global financial crisis. The yield gap with ten year bonds becomes positive for the first time in all three countries in the late 1980/early 1990s. Over the study periods the gap while exhibiting cyclical tendencies is on a long term increasing trend in all three countries, contrasting with some previous studies over either shorter or different periods suggesting the risk premium had been falling. This trend implies that lower expectations about inflation/rental growth have been a persistent influence on the yield gap. This view is affirmed by the coefficients in the regression models for the UK presented later. The gap narrows/disappears in the mid-noughties just before the global financial crisis, but the subsequent impact of the credit crunch is to widen the gap substantially to a historic high in each country.

The yield gap is highest in the USA although the analyses are based on different periods. The crude means are 0.78 in the UK, 1.5 in Australia and 3.3 in the USA. Given that levels of market information and transparency in each country are similar the differences may be the result of weaker planning/supply constraints in the USA increasing real estate investment risk. However, there are other contributing factors such as the differential spatial distribution of investment properties within national urban systems.

The index-linked yield gap is more stable in the UK and Australia than the 10 year bond yield gap. In the UK it varies between 4.3 and 6%, centring on 5%. The range in Australia is mainly between 3.3 and 4.8. The respective means are 5.2 and 4.3. The gap has risen substantially in the UK since the global financial crisis and least in Australia that has suffered least from the event. Yields on US index-linked bonds show very little variation. But for a jump in the index-linked yield gap in 2009 it has also been very stable in the USA since 2005. In all three countries there is a higher correlation between equivalent yields/capitalisation rates and the yield on index-linked government bonds than ten year bonds.

Overall these statistical trends present a picture a rising yield gap as inflation falls, but beyond this phenomenon there are many unanswered questions about the nature of the cycles of both types of yield gaps and how events have influenced investment decisions. In particular there appear to be structural breaks in sentiment toward real estate investment leading to relatively sudden reappraisals of the yield gaps. The next two sections consider these issues beginning with a statistical assessment of the existence of structural breaks and then econometric models of the underlying relationships.

Structural Changes

In the previous sections a number of reasons were identified to explain potential changes in the risk premium and the yield gap over time. Some of these influences are incremental over time but others are more transient such as investment sentiment and it was earlier acknowledged that there is a cyclical element to risk premiums. This section revisits the time series of yield gaps presented above for the UK and USA to test for the existence of structural breaks. This is based on monthly time series for ten year and index-linked yield gaps for the UK and quarterly data on the ten year yield gap for the USA (the other time series are too short beginning in the mid or late 1990s).

Visual inspection of the time series above reveals that significant changes in yield gaps are associated with booms followed by recessions in all three countries. This is confirmed by an autoregressive conditional heteroscedasticity ARCH model that tests for clusters of volatility. The heteroscedasticity ARCH model was first proposed by Engle in 1982 (Engle, 1982) and focuses on the volatility dynamic of time series. This non-linear model does not assume that the variance is constant, and instead describes how the variance of the errors evolves. It has been applied in a real estate context by amongst others Simlai (2014) in relation to the Boston housing market and Tsai (2013) with regard to the volatility of returns by Asian REITs.

The traditional UK yield gap time series gives a mean coefficient for the ARCH model of -0.80 indicating the existence of at least one structural break. A graphical illustration from arch model, the volatility cluster graph shown in Figure 7, suggests that there are structural breaks during the 1990s, the mid-2000s and the late 2000s. Repeating the ARCH model tests for the UK index linked yield gap time series finds an overall mean coefficient of -0.74 implying also the existence of a structural break(s). The volatility cluster graph in Figure 8 indicates breaks during the 1990s and the latter half of the 2000s.

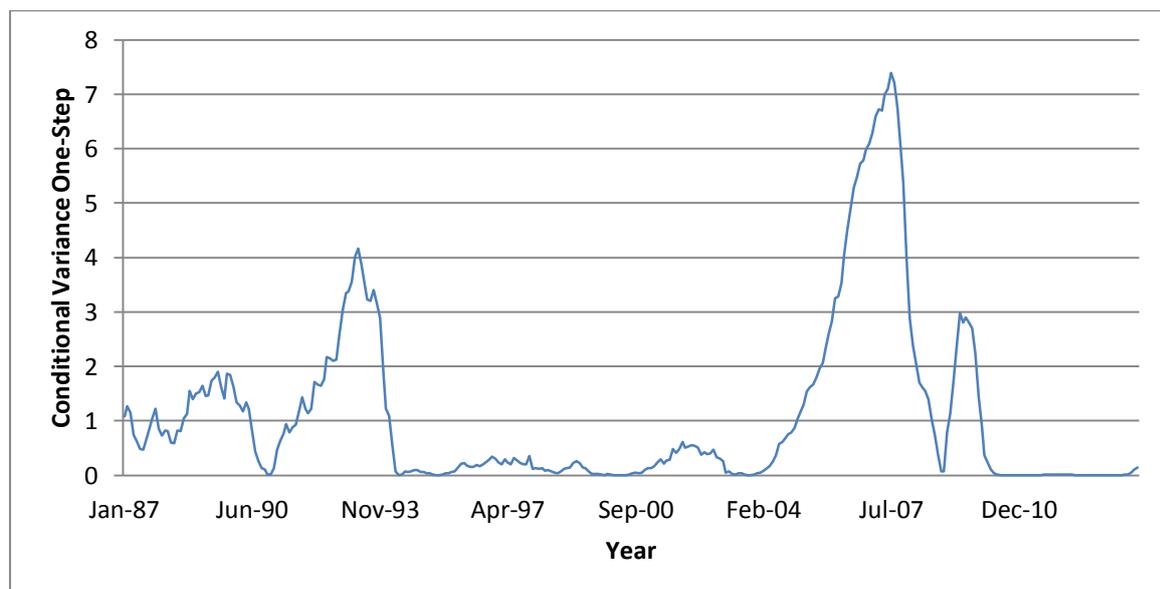


Figure 7 Volatility Cluster Graph for the UK Ten Year Gilt Yield Gap based on monthly data

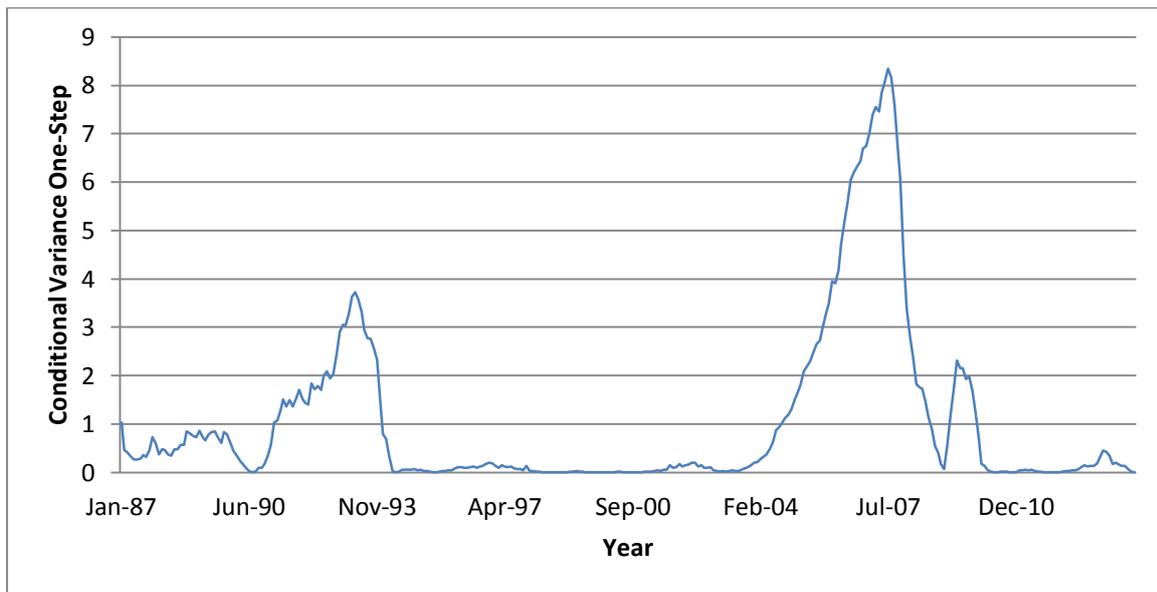


Figure 8 Volatility Cluster Graph for the UK Index-linked Yield Gap based on monthly data

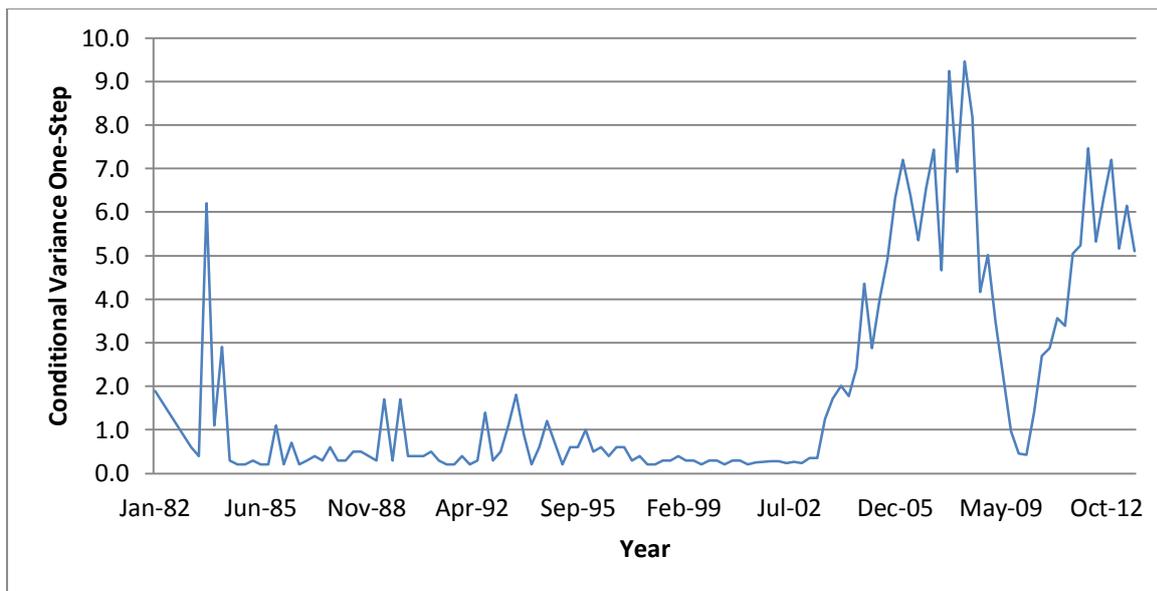


Figure 9 Volatility Cluster Graph for the US Ten Year Yield Gap based on quarterly data

The equivalent ARCH analysis of the ten yield gap for the USA based on quarterly data is over a longer period encompassing almost the whole of the 1980s. With a mean coefficient of -0.97 it too reveals the likelihood of structural breaks. The volatility cluster graph of Figure 9 suggests a number of potential breaks during the latter half of the 2000s, and finally at the beginning of this decade.

One explanation of the incidence and timing of the statistical structural breaks is the sudden unexpected rises in UK bond yields in early 1994 and 2008, although this is likely to be only part of the story. A further possible explanation for the apparent structural break in the early 1990s could be a real estate crisis of confidence in the UK amongst institutional investors; following the large losses they had suffered on development projects, and widespread questioning as to whether commercial property was a suitable asset for pension and

insurance funds (Fraser, 1993). Likewise, the apparent structural break that began in 2005 was probably, at least in part, due to the boom and subsequent bust in property lending. These results can best be viewed as cyclical outcomes when there are severe rapid adjustments in the real estate market. From this perspective these structural breaks are about substantial changes in sentiment through a cycle.

From our fundamental equation above changes in yield gaps occur either as a consequence of a re-evaluation of the risk premium, or expected rental growth or both. In other words it could be investors responding particularly to property upturns and downturns differently, for example being (over) optimistic about rental growth expectations in a 'boom' and (over) pessimistic forecasts in the 'bust'. The flip from one to the other could cause a statistical structural break. This certainly occurred during the credit crunch. As the global financial crisis began to unfold investors were still projecting substantial rental growth and returns (Ellison, 2008), only for these expectations to be dramatically and swiftly downgraded (IPF, 2010). In the aftermath pricing at best assumed no growth. In the summer of 2009 applying zero expected rental growth in our fundamental pricing equation implies a risk premium of 5.4 at that time.

An alternative explanation could be that significant property market downturns act as a catalyst for structural change to investment strategies and the property market. The mid-noughties saw the increasing adoption of shorter leases, the UK retail sector was profoundly affected by the recession and shopping on the web (Jones, 2010), and the office sector was beginning to adopt the green agenda as a marketing tool to let properties (Jones, 2013). Only industrial sheds were arguably left unscathed from structural change that accelerated obsolescence after the global financial crisis. More detailed research at the sector level is required. All these changes would have increased the overall risk premium and contributed to the statistical structural break. Further insight into the changing risk premium is now gleaned from a quantitative analysis of how underlying relationships influence yield gaps, through the estimation of econometric models that capture underlying relationships.

Underlying Relationships

In this section the analysis is based on models that focus solely on the relationship between gilt yields, rental growth and the yield gap as the dependent variable. This innovative approach is applied to highlight explanations of changes in the yield gaps, whereas previous similar real estate research has focused on yields (see Watkins et al, 2012). The models are based on the fundamental equation above and estimate yield gaps based on UK monthly data from 1987-2013 using an error correction framework. Rental growth is taken as a proxy for expected net rental growth. This is a limitation as expectations of rental growth are formed in a more complex way and are not simply extrapolations of current rental growth (Dunse et al, 2007). Part of these expectations is based on inflationary expectations which are to a degree captured in the government bond yield variables.

The first step was to test for cointegration amongst the independent variables. Based on appropriate critical values for the Johansen test for cointegration three potential time lags were derived for each yield gap model. Vector error correction models were then applied with the respective equivalent yield gap as the dependent variable. The vector error correction model builds on the seminal work of Johansen (1991,1995), and derives a dynamic system. It allows the measurement of a category of multiple time series models that directly estimate the speed at which a dependent variable returns to equilibrium after a change in an independent variable.

On the basis of these results the ten year government bond yield gap regression model was then estimated incorporating two month lags for the independent variables, government bond yield and rental growth. On the same basis the index linked yield gap model was derived with only a lag of two months for the bond yield. The regression models were estimated using ordinary least squares (OLS), chosen because of its ease of use mathematically and the surety to find only one best fitting line (Greene, 2012).

Table 2 Regression Equation for UK Ten Year Government Bond Yield Gap

Independent Variables	Coefficient	Standard Error	T statistic
Constant	6.33	0.12	51.9
Rental growth (-2)	-0.20	0.08	-14.2
Ten year gilt yield (-2)	-0.69	0.02	-36.6

Number of Observations 324

R square 0.86

Adjusted R square 0.86

Table 3 Regression Equation for UK Index-Linked Gilt Yield Gap

Independent Variables	Coefficient	Standard Error	T statistic
Constant	7.34	0.08	94.2
Rental growth	-0.93	0.08	-11.3
Index-linked gilt yield (-2)	-0.62	0.03	-22.2

Number of Observations 324

R square 0.69

Adjusted R square 0.69

The results are presented in Tables 2 and 3 for the traditional and index-linked yield gaps respectively. The r squares relate to the efficiency of these monthly models rather than the overall relationship between the respective yield gap and government bond yields.

The regression equations mean that the following long term relationships hold:

- 1% annual rental growth equates to a 20 basis points fall in the ten year yield gap
- 1% annual change in ten year bond yield equates to a 69 basis points fall in the ten year yield gap
- 1% annual rental growth equates to a 93 basis points fall in the index-linked yield gap
- 1% annual change in the index linked bond yield equates to a 62 basis points fall in the index-linked yield gap

These results suggest that the variation in yield gaps relates closely to market conditions. The rise in gilt yields is linked with an expected improvement in the economy and associated rental growth. The yield gaps narrow with more positive rental projections feeding into investors' calculations of yields.

Any change in the risk premium is more difficult to quantify as it is not directly observed, and not included directly in these equations. Figures 10 and 11 demonstrate the relationship between the forecast values from the regression equations and actual values for both yield gaps over time. The models over-estimate the gap in the lead up to the global financial crisis and the immediate aftermath. They also underestimate the gap since 2010. There are a range of possible explanations as already discussed. The rising level of transactions activity in the first half of the last decade could increased perceived liquidity reducing the risk

premium. However, the obsolescence issues that emerged in the last decade have probably been magnified since the crisis, with continuing demands to reconfigure property and this has magnified the risk premium.

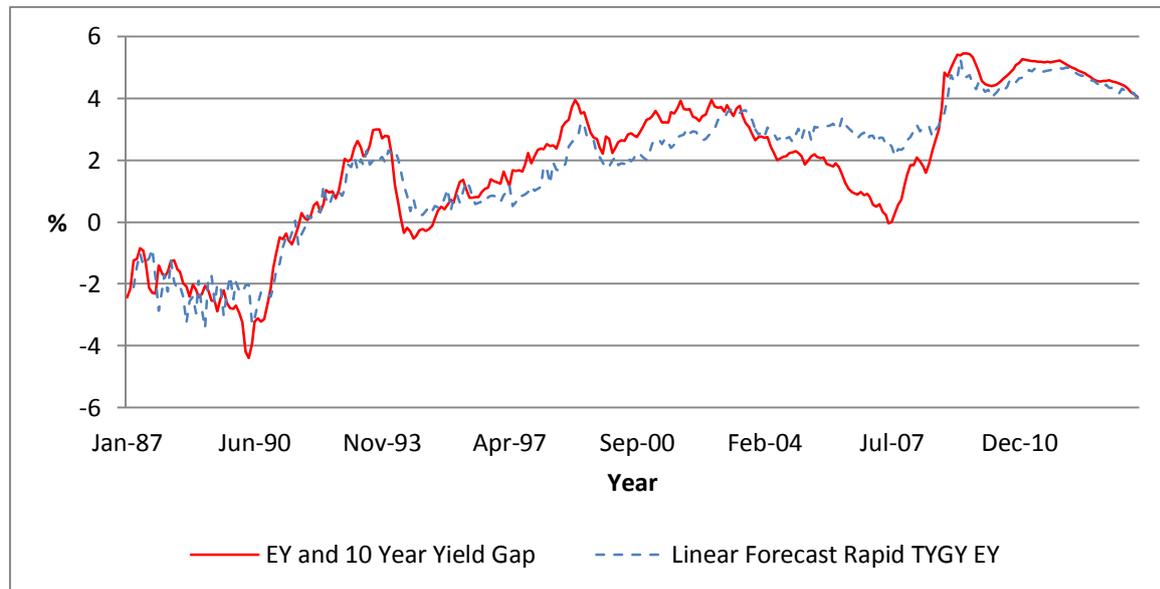


Figure 10 Actual and Forecast Ten Year Gilt Yield Gaps

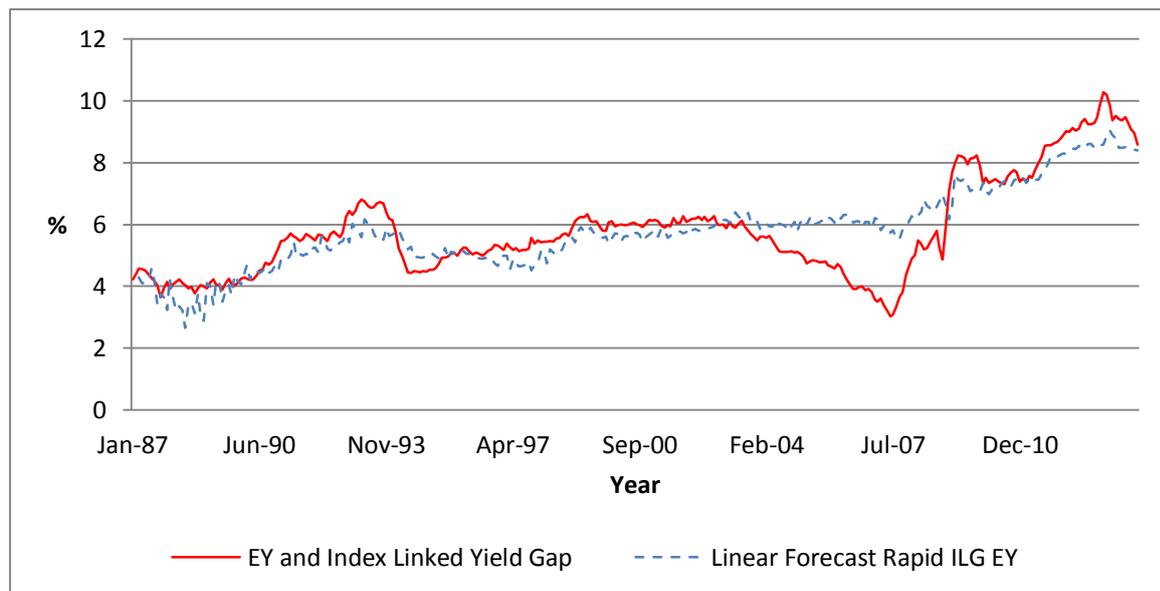


Figure 11 Actual and Forecast Index-linked Gilt Yield Gaps

The picture is more complicated though than simply a changing risk premium. It can be characterised by the following discussion. As the index-linked yield gap has the steadiest pattern with a long term average gap of 5% then on that basis property yields should be at around 3.2% in the UK in 2014 instead of above 7%. However, the economy and property market have been subject to an unprecedented severe downturn and low interest rates that have almost certainly created structural change. The consequence is seen in a reappraisal of the risk premium leading to a substantial rise.

Conclusions

The fundamental pricing of real estate is determined by the yield gap between real estate capitalisation rates and government bond yields. This yield gap incorporates a risk premium for real estate that is linked to the characteristics of the property market, including the propensity for obsolescence, liquidity and slow adjustment processes. This paper has sought to re-evaluate the concept of the yield gap by examining trends in the UK, USA and Australia, the most transparent investment markets in the world. The analysis has considered both the traditional yield gap with ten year government bonds, and that with the index-linked government bonds. It looks at the fundamentals of these yield gaps and their statistical trends over time. Previous research is mainly dated, has been limited and piecemeal, but has suggested the gap was falling and had a cyclical component.

The time series presented here confirms the latter but finds the yield gap(s) have risen since the 1980s in all three countries probably reflecting the lower inflationary environment. In absolute terms the average ten year yield gap is highest in the USA and lowest in the UK reflecting possibly the relative strength of planning and supply constraints, generating a greater investment risk premium in the former. Despite the usual focus on the ten year yield gap the analysis of statistical trends in the UK and Australia finds that index-linked government bonds have a closer relationship with property yields than conventional government bonds.

The relationships between bond and property yields go through a traumatic time around the period of the global financial crisis. This is true not only for the UK but also the USA and Australia, and probably most western economies. There is evidence that these changes are sufficiently strong to be statistically defined as 'structural breaks' in the time series. However, it is possible to see the sudden switch in the yield gaps as a consequence of an extreme change in sentiment towards expected rental growth. The severe downturn may have also stimulated a greater appreciation of structural change in the property market, and hence the risk premium through the realisation of increased probability of obsolescence. Together these could amount to a change in general investment sentiment toward property.

Certainly the current yield gaps are at record high levels in all three countries. In the UK, like many western countries, the macro-economy has experienced a very slow recovery and unprecedented low interest rates since the global financial crisis. As the economy/property market emerges from this period there is likely to be upward pressures on property yields/capitalisation rates rise counterbalanced by rental growth. However, while the yield gaps should fall the downward movement it will be moderated by the upward re-evaluation of the risk premium following the global financial crisis.

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