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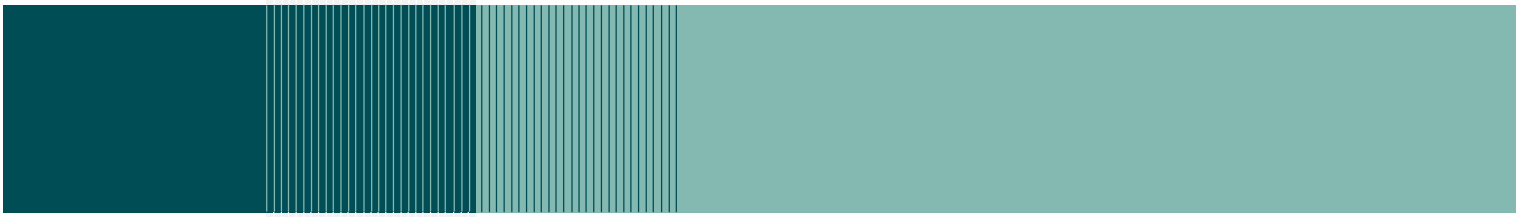
A Review of the CAA's Assessment of the Risk Free Rate for the 2007 Airport Price Control Review

A Report for EdF Energy and Central Networks



NERA
Economic Consulting

MMC Marsh & McLennan Companies

Project Team

Dr Richard Hern
Susanne Toft
Phillippa Lowe
Tomas Haug

NERA Economic Consulting
15 Stratford Place
London W1C 1BE
United Kingdom
Tel: +44 20 7659 8500
Fax: +44 20 7659 8501
www.nera.com

Contents

Executive Summary

EdF Energy and Central Networks asked NERA to prepare a report on the CAA's assessment of the risk free rate used in the CAPM calculation of the cost of equity for Heathrow and Gatwick Airports.[1]

The CAA's recommendations to the Competition Commission on the cost of capital for Heathrow and Gatwick Airports are based on the assumption of a risk free rate of 2.0%. The CAA's assumption of a real risk free rate of 2.0% is based largely on the work of Europe Economics (EE).[2]

Whereas the CAA has undertaken a detailed analysis of many of the other cost of capital parameters for Heathrow and Gatwick airports, it has taken a different approach to the risk free rate, stating its intention to have regard to the analysis of the Competition Commission in setting an estimate of the risk free rate. As a result, the CAA states that it has "*only undertaken a high-level analysis at this stage*".[3]

This paper shows that the CAA's assumption of a risk free rate of 2.0% is not based on robust analysis. Our criticisms of the CAA's method of calculating the risk free rate can be grouped under the following headings:

- Arbitrary interpretation of evidence;
- Methodological inconsistencies;
- Biases in UK Gilt Yields as a proxy for the CAPM Risk Free Rate.

(i) Arbitrary Interpretation of Evidence

The CAA have relied on the conclusions of EE that state the appropriate risk free rate is between 1.65% and 2.25% based on an analysis of recent regulatory precedent and real yields on UK Index Linked Gilts (ILGs).

Our analysis in this paper shows that EE's conclusion that the risk free rate lies within a range of 1.65% and 2.25% is not consistent with the evidence that it has presented in its final supplementary report. Specifically, EE's choice of the lower bound of 1.65% is stated to be based on regulatory precedent; however this is misleading as the 1.65% is a lower bound of Ofgem's *initial proposals* range for the Transmission Price Control review. In fact, Ofgem's actual estimate of the risk free rate in this price review was 2.5%. By using Ofgem's actual estimate of the risk free rate, the range of regulatory precedent is 2.0% to 3.0%.

In addition to accepting a range that is inconsistent with the evidence presented, the CAA's estimate of the risk free rate of 2.0% is reached by making a series of arbitrary choices:

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1 "*Airport Price Control Review: CAA recommendations to the Competition commission for Heathrow and Gatwick Airports*", UK Civil Aviation Authority, March 2007.

2 Europe Economics (2007) "CAA's price control reference for Heathrow and Gatwick airports, 2008-2013: Supporting paper II, Cost of capital – analysis of responses to CAA's initial proposals", hereafter EE (2007).

3 CAA (2007), op.cit., p.135.

selected to be slightly higher than the mid-point of the range of 1.65% to 2.25% with no quantified justification.

This disconnection between available evidence and conclusions is worrying, as it injects a degree of arbitrariness into the outcome of the price control review which undermines transparency and incentives.

(ii) Methodological Inconsistencies

For the sake of internal consistency, the methodology for estimating the risk free rate needs to take account of the methodology used to estimate other CAPM parameters and the methodology for the cost of debt.

EE present a time series of yields of UK ILGs and state that the most relevant data for determining the real risk free rate are the latest spot rates. This approach contrasts with the recent approach taken by other UK regulators (eg. Ofgem, Transmission Price Control Review, 2006) who have based their estimates of the real risk free rate on averages of rates over time.

The use of long-run time series evidence on the risk free rate is justified because other components of the cost of equity, such as the Equity Risk Premium (ERP) and beta, are also generally estimated using averages of long-run time series. If regulators continue to base their estimate of the ERP on averages of long-run time series data, then there is a strong argument for estimating the risk free rate on time series evidence. This is because there is strong empirical evidence that the ERP and risk free rate are inversely correlated over time. That means spot yields of risk free assets below long-run levels implies that the spot ERP is likely to be above long-run levels. However, there is no way of forming a spot ERP objectively, so it is better (more consistent with the theory and more transparent) to estimate both parameters from long-run data series.

(iii) Biases in Government Bond Yields as a proxy for the CAPM Risk Free Rate

One argument made by EE for a real risk free rate of 2.0% is that it lies slightly above the most recent evidence on ILG yields and will therefore "provide *insurance to the company against rises*" in the real risk free rate over the regulatory period.[4]

However, both EE and the CAA have ignored all evidence presented by UK regulators and their academic advisors, and other market evidence, that clearly shows that there are downward biases to UK ILG yields as a measure of the "true" risk free rate.

UK gilt yields have been distorted for many years by the effects of pension fund regulations (such as the Minimum Funding Requirement, FRS17, IAS19 and the Pension Protection Fund) that have led to highly inelastic demand at times of low levels of supply. The effect of these distortions is to depress observed yields on the affected range of bonds below the true risk free rate by the amount that pension funds are willing to pay to meet their legal obligations. For this reason, UK ILGs do not provide an accurate measure of the real risk free rate for estimating the cost of capital.

[4] Europe Economics (2006) "Estimation of Cost of Capital of BAA London Airports", para 2.13.

Until recently international index-linked bond yields provided better evidence on the true risk free rate than UK bonds. However, evidence presented in this paper shows that international index-linked government bond yields have recently fallen significantly, for similar reasons to those observed in the UK that relate to new pension fund regulations. This means that these international yields are also biased as a proxy for the real risk free rate.

An alternative way of explaining the bias in government bond yields is to say government bond yields contain a "uniqueness premium" that drives down yields relative to the true risk free rate. As well as pension fund regulations that have led to high demands for government bonds, the other unique characteristics that make government bonds attractive to investors include (i) the high liquidity of government bonds relative to other securities; (ii) the preference of governments to invest in government bonds (their own or other) over other securities; (iii) the acceptance of government bonds as collateral for loans and as margin "good faith money" for positions in futures markets; (iv) the certainty and simplicity of government bonds which means that less sophisticated investors prefer these to other more complex securities. Evidence of these factors is supported by many academic studies that show that credit spreads on corporate bonds (above government bonds) are wider than is implied by default risk.

UK regulators including the Competition Commission have previously made adjustments to the observed UK ILGs to set the CAPM risk free rate. These adjustments are between 30bp and 50bp.

Other Evidence on the Risk Free Rate

This paper sets out alternative methods for estimating the risk free rate. We explain the concept of swap rates and discuss the reasons why swap rates (as opposed to government bond yields) are a better benchmark for estimating the "true" risk free rate which is most appropriate for estimating the cost of equity within a CAPM framework.

The finance literature highlights the following advantages of swap rates as a benchmark of assessing the performance and pricing of fixed income securities (as opposed to government bond yields):[5]

- The swap market is highly liquid with narrow bid/ask spreads for a wide range of maturities;
- Swap rates across different markets are easier to compare, due to the absence of governmental regulation of the swap market;
- The supply of swaps is less likely to be distorted by technical market factors; and
- Swap rates reflect similar low credit risk across countries, which make comparisons more meaningful.

Swap rates are, however, not default free rates. Swap rates include the credit risk of the banking sector which is associated with a AA credit rating. However, with the maturing of the credit derivatives market in recent years and with it the development of the Credit Default

[5] See for instance Fabozzi (2004) "Fixed Income Analysis", published by Frank J. Fabozzi Associates, 2nd edition, p266.

Swaps (CDS) market, the CDS market is now sufficiently deep to adequately price credit risk. CDS are essentially an insurance policy to protect against the risk that a bond's issuer will suffer credit default event (including a downgrade to its credit status). Hence it is possible to remove the credit risk premium inherent in swap rates in order to receive a clean benchmark measure for the true risk free rate. This method of estimating the risk free rate rests on the assumption that the swap market and CDS market are fairly priced.

We calculate that the yields on nominal UK gilts are currently around 26bps lower than the risk free rate that is implied by UK swap rates for short term maturity bonds. The difference would be around 50-60bps if one measures the real risk free rate using short term indexed linked securities, and even higher if medium to long term maturity indexed linked securities are used as the basis for the risk free rate.

In our report, we also present other studies on the implied bias in nominal government bond yields undertaken by two economists of the Bank of England, Copper and Scholtes (2001) and recently by NERA (2007), co-authored by Professor Grundy from Melbourne University. These studies show a bias in the range of 42 bps to 70 bps for different markets and different maturities at different points in time.

Conclusions

The CAA have relied on the latest spot rates in the UK Index Linked Gilt market as evidence for their risk free rate assumption of 2.0%. This paper shows that yields on UK ILGs are biased as a measure of the risk free rate due to the effects of pension fund regulations that have led to highly inelastic demand at times of low supply. Our analysis shows that recent spot rates on UK ILGs have been downwardly biased as a measure of the "true" real risk free at that time by at least 50bp.

This paper does not specifically estimate the real risk free rate to be applied in the CAA price review of Heathrow and Gatwick airport since for the sake of internal consistency, the methodology for estimating the risk free rate needs to take account of the methodology used to estimate other CAPM parameters. We emphasise that if regulators estimate other CAPM parameters such as the ERP on averages of long-run time series data, then there is a strong argument for estimating the risk free rate on the same basis. Since UK gilt yields have been distorted for many years by the effects of pension fund regulations, regulators should examine time series data on other market instruments such as interest rate swaps and international gilt yields to derive an internally consistent measure of the CAPM risk free rate.

1. Introduction

EdF Energy and Central Networks asked NERA to prepare a report on the risk free rate as an input to work on the cost of capital for UK regulated utilities. The specific focus of this report is to respond to the CAA's risk free rate estimate and methodology set out in its recommendations to the Competition Commission (CC) as part of the price review for Heathrow and Gatwick Airports.

This report is structured as follows:

- Section 2 reviews the CAA's methodology for estimating the risk free rate;
- Section 3 presents evidence to show that UK gilt yields are biased as a proxy for the CAPM risk free rate;
- Section 4 examines evidence on international government bond yields;
- Section 5 examines alternative ways of estimating the real risk free rate including evidence from UK and international interest rate swap markets and market evidence on credit default swaps (CDS).

2. The CAA's Recommendations to the Competition Commission on the Risk Free Rate

The CAA's recommendations to the Competition Commission (CC) on the cost of capital to be applied as part of the 2008-13 price control for Heathrow and Gatwick Airports include a proposed real risk free rate of 2.0%.[6] This proposal is based on the work of Europe Economics (EE) on the cost of capital.[7]

2.1. CAA's Initial Proposals[8]

The CAA's approach to setting the cost of capital at the initial proposals stage was informed by three consultants reports: a paper by EE on the policy framework for setting the cost of capital, a paper by EE on estimating the cost of capital for the London airports and a paper on the capital markets context to the setting of BAA's cost of capital by Ernst & Young.[9]

In its initial proposals, the CAA adopted a point estimate of 2.0% as its best estimate of the forward looking rate. The CAA have relied on the conclusions of EE that state the appropriate risk free rate is between 1.65% and 2.25% based on an analysis of recent regulatory precedent and real yields on UK government Index Linked Gilts (ILGs).

In reaching their conclusions that the risk free rate lies between 1.65% and 2.25% EE presents the following evidence:

- EE presents evidence on UK regulatory precedent on the real risk free rate since 1999 and state that regulatory estimates of the risk free rate have ranged between 1.65% and 3.0%.
- EE presents evidence on 5, 10 and 20 maturity ILG yields over the period January 1994 to August 2006, which shows yields between around 1.3% (20 year) to 1.7% (5 year).

In their discussion of recent regulatory precedent on the risk free rate, EE states that previous regulatory decisions *"have been cautious in trusting the then recent market evidence on the risk free rate, consistently using ranges fully above the prevailing long-term government gilt yields"*.

However, EE argues that "*the risk free rate in the economy*" has been low for some time and that ignoring this might be seen as giving a windfall gain to the regulated utilities. EE states that the current level of yields shows the market expectation of what the rate will be in the future, and the rate could fall as well as rise from the present level.

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6 CAA (2007) "Price control review – CAA recommendations to the Competition Commission for Heathrow & Gatwick Airports", March 2007, hereafter CAA (2007).

7 Europe Economics (2007) "CAA's price control reference for Heathrow and Gatwick airports, 2008-2013: Supporting paper II, Cost of capital – analysis of responses to CAA's initial proposals", hereafter EE (2007).

8 CAA (2006) "Price control review – initial proposals for Heathrow, Gatwick and Stansted Airports", March 2007, hereafter CAA (2006).

9 Europe Economics (2006a) "Policy Framework for Setting Cost of Capital for BAA", hereafter EE (2006a), Europe Economics (2006b) "Estimation of Cost of Capital of BAA London Airports", hereafter EE (2006b) and Ernst & Young (2006) "Capital markets context to the setting of BAA cost of capital", hereafter E&Y (2006).

They state that in principle the current market level of yields is the correct value, but acknowledge that setting the risk free rate on this basis could still be seen as too "*harsh and risky*" for regulatory purposes.

In reaching their conclusions, EE overlook the higher end of the ranges used by regulators but state that their view of the appropriate risk free rate is a range of 1.65% to 2.25%, recommending a value of 2.0% for use in estimating the cost of capital.

The CAA adopted EE's recommendations and proposed a point estimate for the risk free rate of 2.0%. The CAA notes that its approach reflects some of the downward movement in yields that occurred in the late 1990s, but stops short of fully reflecting the very low current market rates (it refers to the bottom of EE's range).

2.2. CAA's Final Proposals

In its recommendations to the CC, the CAA reiterates its intention to have regard to the analysis of the CC on the risk free rate and notes again that it has only undertaken a high level analysis at this stage. CAA (2007) maintains the 2.0% real risk free rate adopted in its initial proposals, stating that it "*refreshed*" its high-level analysis, and is of the view that 2.0% continues to be an appropriate assumption to adopt within its calculations.

The CAA's final proposals also took account of an updated report by EE (2007).

EE (2007) presents updated regulatory precedent, taking into account Ofgem's final decision of 2.5% for the risk free rate for the Transmission Price Control Review. This alters the range of regulatory precedent previously reported by EE (2006b) from 1.65% to 3.0% to 2.0% to 3.0%. EE (2007) however does not change its view on the risk free rate, despite the fact that its original range was based on regulatory precedent, and notes with respect to Ofgem's updated decision that "*this figure comes from the earlier Smither's & Co (2003) paper, a result of analysis of equilibrium real risk free rate over long term, and as such does not necessarily reflect the more recent relatively stable market evidence of low risk free rate*".

EE (2007) notes that recent regulatory precedent ranges from 2.0% and 3.0% and states that "*regulators have remained reluctant to move the estimates in line with prevailing lower market rates*".

EE (2007) presents updated evidence on UK ILG yields between January 2004 and January 2007, which shows a range of 1.2% on the twenty year gilt to 2.0% on the five year gilt. EE states that it does not consider the falls in the twenty year gilt (relative to August, the end-date of the yields presented in EE (2006b)) merit a reduction in its estimate of the risk free rate. As in EE (2006b), EE (2007) states that since spot rates are forward-looking, the most relevant data are the latest. However, EE (2007) again does not provide any indication that its estimate of the risk free rate is quantifiably based on the yield evidence presented.

EE states that low long-term rates suggest expectation of further falls in the short-term rates, but that from its superficial inspection, it does not see this as a reason to alter its point estimate of 2.0%. It notes that the CAA's chosen range of 1.65% to 2.5% continues to encompass all recent movements in rates.

EE (2007) concludes by continuing to discount the higher end of the figures used in recent UK regulatory precedent, "*while recognising the CAA might wish to maintain a buffer against future rate rises*".

2.3. NERA Commentary

The analysis presented by EE (2006b, 2007) and used by the CAA contains a number of flaws, inconsistencies and subjective choices. It also fails to recognise key problems acknowledged by nearly all regulators with its data source of UK ILG yields.

§ Arbitrary Interpretation of Evidence

The CAA have relied on the conclusions of EE that state the appropriate risk free rate is a range of 1.65% to 2.25%. However, the upper and lower bounds of EE's range are not consistent with either recent regulatory precedent or real yields on UK ILGs presented in the EE March 2007 paper:

- The range of recent regulatory precedent on the risk free rate is shown as 2.0% to 3.0%.
- Recent yields on UK ILGs show a range of 1.2% (20 year bond) to 2.0% (five year bond).

The upper and lower bounds of the evidence presented by EE are therefore 1.2% and 3.0% respectively.

EE's choice of the lower bound of 1.65% is stated to be based on regulatory precedent; however this is misleading as the 1.65% is a lower bound of Ofgem's *initial proposals* range for the Transmission Price Control review. In fact, Ofgem's actual estimate of the risk free rate in this price review was 2.5%. By using Ofgem's actual estimate of the risk free rate, the range of regulatory precedent is 2.0% to 3.0%.

In addition to selecting a range that is inconsistent with the evidence presented, the CAA's estimate of the risk free rate of 2% is reached in arbitrary way; selected to be at the upper end of the range of 1.65% to 2.25% with no quantified justification.

§ Internal Inconsistencies

For the sake of internal consistency, the methodology for estimating the risk free rate needs to take account of the methodology used to estimate other CAPM parameters.

EE present a time series of yields of UK ILGs and state that the most relevant data for determining the real risk free rate are the latest spot rates. This approach contrasts with the approach taken by nearly all other UK regulators who have based their estimates of the real risk free rate on time series evidence.

The use of long-run time series evidence on the risk free rate is justified because other components of the cost of equity, such as the ERP and beta, are also generally estimated using averages of long-run time series.

Although the CAA have not undertaken analysis of the equity risk premium to be used in calculating the cost of capital of Heathrow and Gatwick airports, they have used a range of

3.5% to 5% which is the same as the range used in the NATS review and is based on time series evidence.

If regulators continue to base their estimate of the ERP on averages of long-run time series data, then there is a strong argument for estimating the risk free rate on the same basis. There is strong empirical evidence that the ERP and risk free rate are inversely correlated over time. That means that an estimate of the risk free rate set below long-run levels implies that the ERP is above long-run levels. However, there is no way of making this adjustment objectively, so it is better (theoretically consistent and more transparent) to estimate both parameters from long-run data series.

§ Biased Outcome

Both EE and the CAA have ignored all evidence presented by UK regulators and their academic advisors, and other market evidence, that show that there are downward biases to UK ILG yields as a measure of the CAPM risk free rate.

EE notes several times that regulators have set rates above market rates, but at no point analyses why. A reading of the precedent EE cites would show that the regulators in question have acknowledged structural influences which have caused depression to yields. For example, the CC (2000) explicitly acknowledged the impact of pension funds regulations on UK yields, and accordingly took an upside view on the appropriate risk free rate.

EE (2007) also notes several times that long rates are lower than short rates, but incorrectly assumes that this indicates expectations of low or further falls in interest rates in the longer term. The inversion of the UK ILG yield curve is widely attributed to the demand by pension funds for long term bonds, as a result of their need to match assets with liabilities. It is acknowledged that demand at the long end (and consequently low yields) has little to do with standard yield curve inference.[10] Any view that the risk free estimate made by EE is on the generous side, based on the assumption that low long rates imply future falls in short rates, is therefore erroneous.

The next section examines evidence on the biases in the UY ILG market in more detail.

[10] "This auction was boosted liability-driven demand rather than anything to do with inflation expectations" Reuters News (28/11/06) "Strong demand for UK's 2027 index-linked gilt sale".

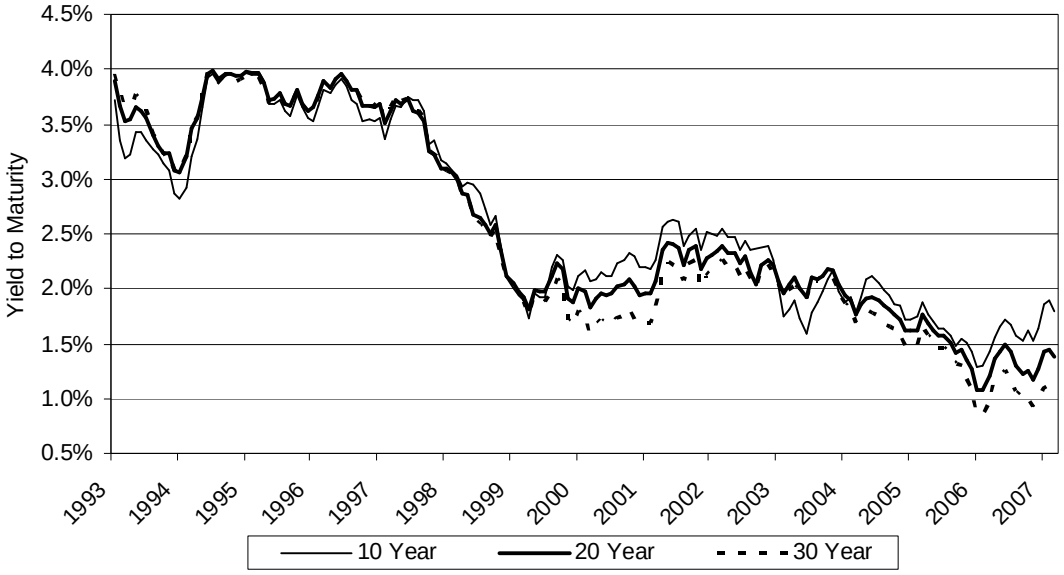
3. Biases in UK Gilt Yields as a Proxy for the CAPM Risk free Rate

This Section sets out historical evidence on UK nominal gilt and index-linked gilt (ILG) yields and discusses the drivers of the fall in yields since 1997.

3.1. Historical Evidence on Nominal and ILG Yields

Figure 3.1 shows historical yields on 10, 20 and 30 year maturity UK ILGs since 1993.

Figure 3.1
Monthly Average Yields on ILGs for Maturities of 10, 20 and 30 Years (1993-2007)



Source: Bloomberg. Yields shown are yields on generic indices constructed by Bloomberg, based on yields on actual ILGs in issuance at the time.

The Figure shows that ILG yields ranged from 3.0% to 4.0% over the period 1993 to 1997. Between 1997 and 1999 yields fell from around 3.7% to less than 2.0%. Between 2000 and 2003 yields recovered slightly to between 2.0% and 2.5%. From 2003 yields fell steadily hitting below 1.0% (30 year) and 1.3% (10 year) in early 2006. Since then, monthly average yields have fluctuated between below 1.0% and 1.3% (30 year) and 1.5% and 1.8% (10 year).

Appendix Figure A.1 and Figure A.2 show a time series on UK nominal gilts and the implied real yields backed out from yields on nominal gilts (referred to as real from nominal yields hereafter). These Figures show to that observed in ILG yields over time, although real from nominal yields are about 0.7%-0.9% higher than the corresponding ILG yields.[11]

[11] Generally, real from nominal yields are higher than the yields on ILGs. There are three possible reasons for this. Firstly, nominal yields contain an inflation risk premium which compensates investors for bearing the inflation risk associated with a nominal coupon. Secondly, we have deflated nominal yields using RPIX whereas ILG coupons are

Another feature of recent yields on ILGs and nominal bonds is that yields on the 20 and 30 year maturity bonds have typically been lower than yields on the 10 year bond since 1997.[12] The persistent inversion of the real gilt yield curves over the past ten years is contrary to economic theory that predicts upward-sloping yield curves.

The steep decline in real yields from 1997 onwards is widely recognised by commentators such as the Bank of England to be mainly associated with the introduction of the pension fund regulations such as the Minimum Funding Requirement (MFR) in 1997 and subsequent further pensions regulations.[13] Other reasons for the fall in yields that have been suggested include the volatility of equity markets seen after the collapse of the Dotcom "bubble" in 2000/01 which drove investors into safe assets – the "flight to safety".

High levels of inelastic demand related to institutional factors (such as pension fund regulations or government issuance) and low levels of supply cause yields to be distorted from the true risk free rate. This is because these factors are not related to fundamental changes in investors' preferences over risk. Genuine changes in investors' risk preferences, such as the flight to safety, do cause changes to the true risk free rate.

We assess the impact of the pension fund regulations on UK ILG yields in more detail in the next section.

3.2. Pension Fund Demand

The MFR was introduced in 1997. It set a target ratio of assets to liabilities that companies had to meet in stages. The valuation of liabilities for this purpose was partly undertaken using gilt yields.[14] Whilst the MFR did not specifically dictate the types of asset classes that had to be held, it caused pension funds to move into gilts.[15]

The impact of the MFR in the late 1990s/early '00s was recognised by regulators including the Competition Commission, who noted that institutional factors including the MFR and increasing maturity of pension funds had depressed ILG yields. [16] The Competition

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indexed to RPI. Since RPI has typically been higher than RPIX, this would imply lower yields on ILGs, all else equal. However, over the longer horizon we would expect this difference to be smaller. Thirdly, the downward pressures on nominal yields arising from demand and supply-side factors may be lower than for ILG yields.

[12] See Appendix Figure A.3.

[13] See for example the Bank of England: "*The Minimum Funding Requirement led to strong institutional demand for ILGs. The combination of strong and rather price-insensitive demand (largely from pension funds) with limited supply, has pushed real yields down, perhaps more than in the conventional gilt market. Consequently, real yields in the ILG market may not be a good guide to the real yields prevailing in the economy at large"*[13] (Bank of England (1999) *Quarterly Bulletin*, May).

[14] Under the MFR, liabilities were divided into two types for valuation. The present value of pensions already in payment was calculated using gilts yields as the discount rate. For pensions not yet being paid, the discount rate used to calculate the present value of the liability was widely assumed as the long-term equity rate of return before retirement, and the gilt yield once retirement has occurred. The discount rate for those liabilities of pension holders not yet retired was adjusted by a 'market value adjustment' MVA factor to reflect prevailing UK equity dividend yields.

[15] See Appendix B for further details.

[16] Competition Commission (2000) "Mid Kent Water Plc: A report on the references under sections 12 and 14 of the Water Industry Act 1991", para 8.13. See also Competition Commission (2003) and (2006) for comments on the impact of the MFR in the late 90s/early 00s. See Appendix A.1 for full citation.

Commission took these factors into account when determining a real risk free rate of 2.75% to 3.25% for Mid Kent Water and Sutton and East Surrey Water, which lay significantly above the range of 1.7% to 2.1% shown on medium and long term ILG maturities at the time.[17]

Increases in ILG yields observed in 2001 may be attributable to the proposed decision to abolish the MFR.[18] However, between 2002 and 2006, ILG and real from nominal yields again declined, despite issuance in 2005 of 50-year gilts which were designed to satisfy pension fund demand for long dated gilts. The introduction of the FRS17 in 2005 (and the implementation of the similar IAS19) is attributed as the primary cause of these falls.[19]

The main component of the FRS17 and IAS19 that has driven gilt demand is the requirement that companies express their pension schemes surpluses/deficits on profit and loss accounts. This has encouraged pension funds to match assets with liabilities. Given that liabilities are generally long-dated and inflation-linked, demand for long-dated index-linked assets by pension funds is high. As the supply of long-dated corporate bonds is limited relative to demand, this demand has focused on gilts.[20,21] This influence on yields was noted by the Bank of England in the early part of 2006.[22]

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[17] Medium and long term maturities are relevant here, as the Competition Commission (2000) states that: "*Equities should clearly be regarded as longer-term investments and medium-/long-term index linked gilts are a closer substitute for equities than short-term securities. We are concerned with the cost of equity (and hence, in the current context, the risk free rate) over the next five years, during which the current price control operates.*" (para 8.9).

[18] DMO (Annual Review 2000/2001) "*Towards the end of the financial year Index-linked gilts were affected, as were conventionals, by the Government's decision to replace the MFR; although benign inflation data also took real yields higher.*"

[19] The FRS17 was initially thought to be likely to cause a reallocation by pension funds from gilts into high quality corporate bonds through the specification of an AA discount rate in calculating the current value of liabilities. Commentary following the announcement of the abolition of the MFR indicated that in the short-medium term the FRS17 was expected to continue to place downward influences on yields, primarily via a "spillover" effect, as AA corporate bond spreads declined *"However the AA sterling market is small relative to the value of investible funds held in UK pension funds. Pension funds may consequently move more into AAA-bonds, the gilts market and other mixed portfolios of gilts and corporate bonds..."* (DMO (2002) "Annual Review 2001-02", p11).

[20] FRS17 was issued by the Accounting Standards Board in November 2000. It is mainly concerned with 'defined benefit' schemes: for all defined benefit schemes (other than certain 'multi-employer' schemes), FRS17 requires the scheme assets and liabilities to be valued on a 'fair value' basis and the resulting surplus (or deficit) to be recognised as an asset (or liability) by the reporting entity. The FRS17 specifies that liabilities be discounted using yields on AA rated bonds. The FRS17 required presentation of gains and losses on the Statement of Recognised Gains and Losses. The IAS19 is a similar international accounting standard currently being implemented by a number of companies. It also requires that liabilities be discounted using yields on AA rated bonds. The IAS19 allows gains and losses to be reported in full in year on the Statement of Recognised Income and Expenditure (fair value approach), but also a number of "spreading" approaches are available under IAS19 – such as amortisation of gains and losses over a given threshold in the income statement. Both (FRS17 and IAS19) accounting standards require statements of deficits (depending on calculation of gains and losses) on the balance sheet.

[21] Issuers such as utilities have very recently issued very long-dated debt, but the government is currently still the predominant issuer. AFX International Focus (21/3/7) "UK issuance of long-dated paper 'not huge' compared to pension fund demand": *"the very long market is important because it is only available in gilts realistically and not corporates.."* The Bank of England has also noted the relative lack of comparable high quality long dated corporate bonds.

[22] *"At long horizons, both real and nominal sterling forward rates fell over the review period such that the impact on implied inflation was fairly small (Chart 12). This suggests inflation expectations remained stable. It may also be consistent with pension funds being primarily concerned with matching the duration of their assets and liabilities, rather than hedging their inflation exposure, or with dealers and other market participants being prepared to take on*

A particular driver of the fall in yields arising from this asset-liability matching policy by pension funds was the "vicious cycle" effect on yields. Pension funds use a combination of gilt yields and yields on AA rated securities (specified under FRS17 and IAS19) to value liabilities. The Bank of England noted that this feature of liability valuation meant that when yields declined, valuation of liabilities increased, encouraging further purchases of long-dated assets:

> *"To the extent that yields on government bonds influence the discount rates that pension funds use to assess their future liabilities, the recent falls in real interest rates could have further widened deficits between the value of their assets and liabilities. In turn, this may have reinforced the demand for long-dated assets."* [23]

The levy charged to pension plans by the recently established Pension Protection Fund was also thought to have fuelled heavy investment in gilts in early 2006.[24] The Pension Protection Fund was set up as a compulsory insurance scheme, to ensure that in the event of insolvency, a pension provider's liabilities are met. The levies paid into this fund are partly based on the risk-rating assigned to a fund, including the riskiness of its assets, and the scale of its deficit (asset – liability deficit). The levies are lower for low risk schemes and schemes with smaller deficits. The scheme values liabilities using long-dated gilt yields. It has therefore been argued that the scheme rewards pension plans that invest in low-risk securities such as government bonds and encourages holdings of gilts in order to enable funds to match assets with valued liabilities.[25,26]

Therefore, whilst depression of yields is attributed to all four regulations – the MFR, FRS17 IAS19 and PPF, the latter three appear to be responsible for the recent low level of gilt yields and the steepening of the inversion of the yield curve.[27] It is widely recognised that long dated nominal gilt yields have been affected by asset-liability matching demand from pension

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the long-dated inflation risk." Bank of England (2006) "Quarterly Bulletin Spring 2006". See citation of further commentary from this publication in Appendix A.1.

[23] See Bank of England commentary in Bank of England (2006) "Quarterly Bulletin Spring 2006". Citation of key commentary is set out in Appendix A.1.

[24] Financial Times (13/03/06) "Funds see the rainy days catching up - OVERVIEW: Warren Buffett said that 'when the tide goes out, you find out who's not wearing shorts'. Here, Philip Coggan looks on from the shore": *"Investing in bonds has become the new mantra of the actuarial sector on the grounds that pensions are bond-like liabilities. Accountancy standard FRS 17 and the formula for calculating the Pension Protection Fund levy also use bond yields as a means of calculating liabilities. That creates an incentive to invest more heavily into bonds.…This seems to have played its part in driving bond yields down to their current lows with 30-year gilts offering just 3.9 per cent and the 50-year index-linked gilt at one point offering a real yield of less than 0.4 per cent."*

[25] The Wall Street Journal Europe *"Low yields in UK draw concern."*

[26] Pensions Week (06/02/06) "Schemes locked in PPF levy investment merry-go-round" *"The Pension Protection Fund's (PPF) risk-based levy, which comes into force in March for companies with defined benefit pension schemes, has caught plans in a vicious cycle. Pension funds have been forced to invest in long-dated fixed income assets to assuage pension liabilities ahead of the levy, which has driven down the gilt yield, widening deficits further and leading to more investment in gilts, according to Neil Sutherland, a fixed income investment manager at Axa Investment Managers. "Companies are struggling to put money into pension funds before March, to reduce their [PPF] levy. The PPF is increasing the scramble for companies to close their deficits," said Sutherland. "Companies are struggling to buy bonds before March which has a perverse impact on increasing deficits. The squeeze on the bond yield means liabilities go up, deficits increase, creating a vicious cycle to buy bonds.""*

[27] In particular, the MFR specified the use of short to medium term gilt yields in discounting liabilities (15 and 5 years).

funds.[28, 29] This was highlighted by the fall to record lows of both ILG and nominal gilt yields in early 2006. In January 2006 the FT stated that "*This is a bubble on top of what may well be a global bond market bubble*"[30]

Since early 2006, both real from nominal yields and ILG yields have increased by around 0.5%, before falling again very recently. ILG yields on 20 and 30 year bonds are currently around 1.5% and 1.0% respectively, both lower than at any time between ILGs were first issued and the historic lows of early 2006.[31] Commentary continues to indicate that pension fund regulations are the driving force of high demand for bonds and consequently low yields for long-dated maturities.[32] The FT recently noted that *"The government bond markets have increasingly been driven by institutional regulation, prompting a hunt for liability-matching assets, without much sensitivity as to price and yield. This has upset historical notions about value in bonds".*[33]

We understand that the extent of the bias to gilt yields since 1997 has received little academic attention, particularly recently. A 2000 Bank of England paper concluded that:

"around a third of the decrease in UK-US and UK-German bond yield differentials (for 10 year maturities) observed since the beginning of 1997 may have been related to reduced net issuance of gilts combined with the increase in demand for long-dated gilts from pension funds and life assurance companies".

The study presented evidence to show that at the end of 1999 ten-year UK swap spreads over gilts were 60 and 80 basis points lower than the corresponding swap spreads for US Treasury and German Bunds respectively. [34]

In 2001, a paper by Bank of England economists found evidence that in both the United Kingdom and United States, nominal government bond yields had been depressed below true risk free rates. This was based on a comparison with swap spreads and intra-governmental bond yields. The authors attributed this depression to a reduction in supply relative to demand.[35]

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[28] Financial Times (25/01/06) "Yields on 50-year gilts hit auction low *Prices fail to deter strong demand by pension funds *Calls to increase supply of long-dated bonds". Full citation of is set out in Appendix A.1.

[29] Financial Times (16/02/06) "Gilts sale highlights pressure on rates." See Appendix A.1 for further commentary on nominal gilt yields with respect to pension fund demand.

[30] Financial Times (20 January 2006) "A dangerous bubble – ultra-low bond yields exacerbate UK pensions crisis".

[31] According to data available from Bloomberg.

[32] Bank of England (2006) "Quarterly Bulletin Summer 2006". See further commentary in Appendix A.1.

[33] Financial Times (26 February 2006) "The metamorphosis of fixed income". See further commentary in Appendix A.1.

[34] Brooke, Clare and Lekkos (2000) "A Comparison of Long Bond Yields in the United Kingdom, the United States and Germany" Bank of England Quarterly Bulletin, May 2000. The authors also note that "given that the MFR benchmark relates to the 15-year gilt, both of the above estimates of gilt market 'overvaluation' may be underestimates". This statement is supported by evidence presented in the study showing that fifteen year UK gilt yields fell by 290 basis points since the start of 1997, 65 basis points more than the decline in ten year yields.

[35] Cooper and Scholtes (2001), Bank of England "Government bond market valuations in an era of dwindling supply. "

The authors state that there are two conditions under which changes in supply of government bonds would result in yields ceasing to be an accurate measure of the risk free term structure of interest rates:

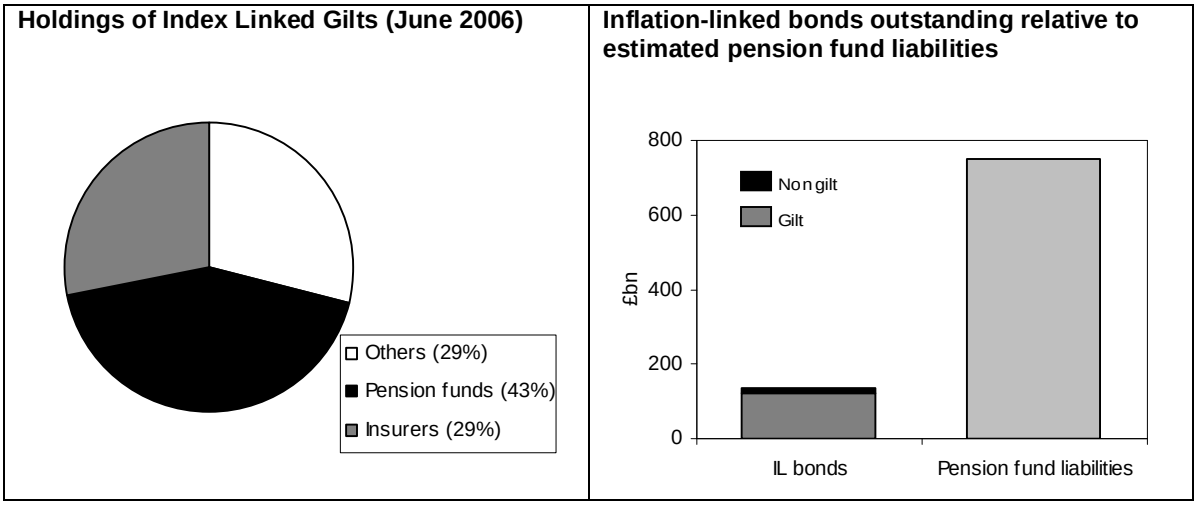
"There are two requirements: first, that there could exist a subset of investors with price-inelastic demand for government bonds; and, second, that the supply of bonds should fall sufficiently that these investors become the marginal and hence dominant investors that dictate the bond price."

Evidence indicates that these conditions have been met, albeit through increases in demand rather than reductions in supply (at least over the past couple of years). The Bank of England notes that pension funds are the dominant purchasers (directly and indirectly) of ILGs as shown in the Figure below. The Bank of England also notes that pension funds have significantly increased their demand for ILGs in recent years and that institutional investors are price-inelastic, leading to falls in yields as the demand to supply ratio increases.[36]

The Figure below, based on a 2006 Bank of England paper, sets out the holdings of index-linked gilts and the size of the index-linked gilt market relative to estimated pension fund liabilities.

[36] *"D(d) for long-maturity gilts from institutional investors can at times become relatively price inelastic… the combination of price-inelastic demand and the relative scarcity of long maturity bonds may result in investors paying a high price for long-dated gilts. This premium would tend to reduce the yield on such instruments, pushing long-maturity forward rates below the rate that would hold in the absence of these factors."* Bank of England (2006) "Quarterly Bulletin Spring 2006."

Figure 3.2
Pension Fund Demand Characteristics



Source: "Recent developments in sterling inflation-linked markets By Grellan McGrath and Robin Windle of the Bank's Sterling Markets Division." Bank of England (2006) "Quarterly Bulletin 2006 Q4"

The left hand figure shows that pension funds directly own 43% of outstanding ILGs. However, the Bank of England notes that holdings by insurers are either related to their own sale of pension products or are on behalf of pension funds. The Bank notes that holdings by "others" such as banks, dealers and hedge funds may also represent hedging of inflation-linked cash flows to pension funds, as institutional investors increasingly receive such cash flows via inflation swaps.[37] The right hand figure shows that pension fund liabilities dwarf the size of IL bonds in issue by a ratio of nearly 5.5:1. The scale of demand relative to supply is consistent with high bid:cover ratios of 2.0x to 3.3x for some IL and nominal gilts at recent auctions. These are set out in Appendix Table A.1. High bid to cover ratios are seen for certain issues at all maturities, consistent with depression on all gilt yields.[38]

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[37] "*Institutional investors dominate the index-linked gilt (IG) market, with pension funds and insurers directly holding around three quarters of IGs. The primary purpose of the majority of these holdings is for pension providers to hedge their liabilities which are typically linked to inflation. In addition to direct holdings by pension funds, this is also true of holdings by insurers, as they sell pensions products themselves. Holdings of IGs by banks, dealers and hedge funds may also represent hedging of inflation-linked cash flows to pension funds, since institutional investors increasingly receive such cash flows via inflation swaps. As explained later, much of the inflation-linked cash flows from an IG may be transferred to a UK pension fund even if the registered holder is a bank, dealer or hedge fund.*" Bank of England (2006) "Bank of England Quarterly Bulletin 2006 Q4".

[38] We note in Appendix A.4 that bid to cover ratios should be interpreted with caution, as these ratios are a function of the offer price at auctions. We therefore only consider this evidence in conjunction with commentary which has typically attributed ratios close to or over 2 as being a sign of strong demand. For example see Financial Times (25 January 2006) "Yields on 50-year gilts hit auction low – prices fail to deter strong demand by pension funds – calls to increase supply of long-dated bonds", which states that: "Amid strong demand from investors, the Debt Management Office which borrows on behalf of the UK government, sold Pounds 650m (face value) of 50-year inflation-linked bonds at a yield over inflation of just 0.46 per cent. That is the lowest real yield since linkers were first sold in 1981. In spite of these historically low yields the sale was oversubscribed, with demand reaching 1.75 times the amount on offer."

Evidence of excess demand for gilts is further supported by requests from pension funds for greater issuance of both nominal and index-linked gilts in response to demand. [39]

Evidence presented in this Section indicates that the historical low in current and recent yields is attributable mainly to pension fund demand, and that this position is likely to be sustained for the medium term. The Treasury Minister stated in March 2007 that:

> *"I can see that underlying conditions, notably the shape of the yield curve and strong demand for long-dated and index-linked gilts, are very similar to a year ago and also seem likely to be sustained over the medium term."*[40]

It is argued that over the much longer run, low yields are unlikely to persist for two reasons.

Firstly, demand is expected to ease as pension funds close their deficits and fund managers become more adept at investing in non-gilt securities. [41] The Financial Times, amongst others, noted that once the switch towards long-dated bonds had been completed, new demand inflows would drop off and a lower net new demand to supply ratio would cause yields to become much higher. [42,43]

Secondly, yields may increase as supply of corporate bonds increases. The DMO argued in 2002 that in the long run, bond issuers would take advantage of demand and increase issuance.[44] Most recently, corporate issuers of high quality debt have issued a number of very long dated bonds, which may alleviate some of the pressure on gilts over the longer run, although

Figure 3.2 shows that the non-gilt IL market is currently very small.[45]

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[39] "The National Association of Pension Funds has written to the Debt Management Office arguing real yields could turn negative without action, The Sunday Times said. "The NAPF believes that the DMO should increase issuance of both conventional and index-linked gilts at the long end of the maturity spectrum," the newspaper quoted, taking excerpts from NAPF investment council Chairman Chris Hitchen's letter." Reuters News (12/02/06) "UK pensions request 100 bln stg in gilts –newspaper."

[40] Ed Balls in the Financial Times (15 March 2007) "UK to keep gilt issuance bias to long-end, linkers"

[41] *"Over the long-term any distortions to the gilts market caused by changes to the regulatory or accounting environment should prove temporary, as market participants become more adept at investing in non-gilt securities and other borrowers enter the market to take advantage of the high demand for debt securities*." DMO (2002) "Annual Review 2001-02", p12

[42] Financial Times (24 January 2006) *"Make the most of low bond yields"*. See Appendix A.1 for full citation.

[43] Deficits may have started to decline recently. Research published by the Pensions Regulator in December 2006 showed that aggregate deficits under FRS17/IAS19 for Defined Benefits pension schemes (FTSE350 companies) have decreased from £90bn in early 2003 to £42bn as of October 2006. See The Pensions Regulator (2006) "The purple book: DB pensions universe risk profile". The Pensions Regulator notes the sensitivity of deficits to changes in gilt yields, and estimates that, given a 0% growth in the value of equities, a 0.1% reduction in gilt yields would lead to an increase in the aggregate deficit of £13bn (based on March 2006 aggregate deficit).

[44] See Footnote 41 for DMO (2002) view.

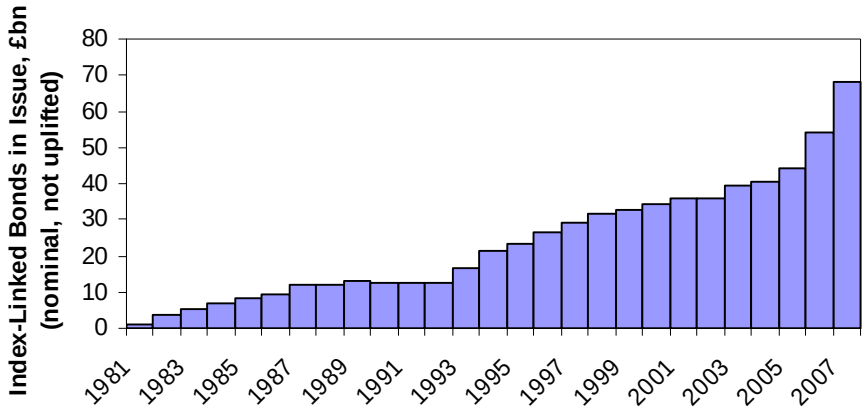
[45] High rated (at least single A) issues made in 2006-07 of new very long-dated (over 40 years) bonds include a number of utilities which have issued index linked bonds such as Yorkshire Water, United Utilities, Severn Trent, Thames Water National Grid, Western Power Distribution, and other companies such as Tesco, who issued a 50 year bond in February 2007.

In addition, we understand that the IASB (International Accounting Standards Board) is expected to review pensions accounting standards at some point in the near future. This review may result in a change in specification of accounting standards which reduces the incentives for pension funds to hold gilts.

3.3. Supply Side Influences

A second factor believed to have placed downward pressure on yields between 1997 and the early '00s is restrictions in supply. The Figure below shows the total amount of index-linked government bonds in issuance since the first issue was made in 1981.

Figure 3.3
Supply of ILGs in UK Market, 1981-2007



Source: DMO.

The Figure shows that the nominal market value of index-linked bonds in issuance grew steadily during the early to mid 1980s, before remaining flat until the early 1990s. The amount in issuance grew between the mid 1990s but flattened out during the late 1990's and early 2000's.

Since 2004, net issuance has increased substantially. The amount of ILGs outstanding increased by 23% between 2004 and 2005, and by 25% between 2005 and 2006.[46] Increased government borrowing and consultation with the pensions industry and other market participants caused the DMO to focus its issuance on long-dated index-linked bonds. Following specific consultation with the pensions industry, the DMO issued its first 50 year index linked bond in September 2005.

However, recently increased supply has been reported to be insufficient to satisfy demand, particularly for long-dated bonds.[47] Further commentary indicates that specific supply shortages are expected in the near future.[48]

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[46] Based on DMO figures for nominal value (not uplifted) of ILGs in issuance in 2004, 2005 and 2006.

[47] See previous section.

3.4. Other Reasons

Other reasons for the continued fall in yields from 2003 may include those underlying the fall observed in global interest rates. It is widely acknowledged that global interest rates are at historically low levels, and it is likely that a degree of downward movement in UK ILG yields can be attributed to underlying movements in fundamental drivers of the true risk free rate. These drivers include increases in savings and the increasing preference of investors for safe assets following equity market volatility at the turn of the Millenium ("flight to safety").

Another reason to explain the fall in gilt yields in the period following 1997 to early '00s is the increased average level of market volatility that was been observed over the period 1997 to 2004. The impact of increased market volatility on the yields of UK index-linked gilts was clearly documented in Bank of England Reports from 1997 to the early '00s.[49] Since then however, volatility has fallen substantially and this factor may be less relevant to recent lows in yields.

3.5. Summary

This Section has shown that:

- ILG yields have fallen substantially since 1997.
- Real yields backed out from yields on nominal gilts have also fallen over the period since 1997.
- Real yield curves on both ILGs (and to a lesser extent, nominal gilts) have been significantly inverted since 1997.

Commentators such as the Bank of England have acknowledged that these features are partly attributable to the impact of pension fund demand driven by new regulations and restricted supply. Bank of England academics have concluded that UK gilt yields are not an accurate measure of the true risk free rate.

There are also other reasons, related to fundamentals, why the underlying true risk free rate may have fallen in recent years. These include the flight to safety following periods of high stock market volatility at the turn of the Millenium and genuine increases in saving rates (unrelated to exogenous regulatory influences such as pension fund regulations). However, it is difficult to disentangle the genuine fundamental influences on the risk free rate from distorting factors such as pension fund regulation-driven demand over this period.

In light of the biases to yields arising from institutional factors, both current and historical evidence on UK gilts cannot be used as a measure of the risk free rate.

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[48] An FT article dated 22nd March 2007 states that: "The government's Debt Management Office will cut long-dated and inflation-linked gilt sales next year by £4bn, a move pensions experts described as not helpful to pension funds."

[49] *"It seems likely that high levels of uncertainty in financial markets raised the attractiveness of government debt. Other things being equal, this would tend to raise its price and lower its yield*", Bank of England (Feb 2003), Inflation Report, p5.

4. International Government Bonds

This Section presents historical evidence on international government bond yields and examines whether they might provide better evidence on the CAPM risk free rate than UK gilts.

4.1. European and US IL Government Bonds

Table 4.1 sets out details of European and US IL bonds currently in issuance.

Table 4.1
European and US IL Bonds in Issuance

Country	No of IL Govt Bonds Outstanding	Longest Maturity at Issue (Years)	Sovereign Credit Rating[1]	Nominal Market Value ($bn)	First Issued[2]	5Y Average Bid-Ask Spread[6]
Austria	4	20	AAA	N/A	2003	0.5%
UK	**12**	**50**	**AAA**	**262**	**1982**	**0.1%**
France	**11**	**33**	**AAA**	**166**	**1998**	**0.1%**
Germany	1	10	AAA	12	2006	0.1%
Greece	5	50	A	12[3]	1997	0.1%
Italy	8	55	A+	88[4]	2003	0.1%
Sweden	7	20	AAA	36[5]	1994	0.1%
US	**21**	**31**	**AAA**	**408**	**1998**	**0.1%**

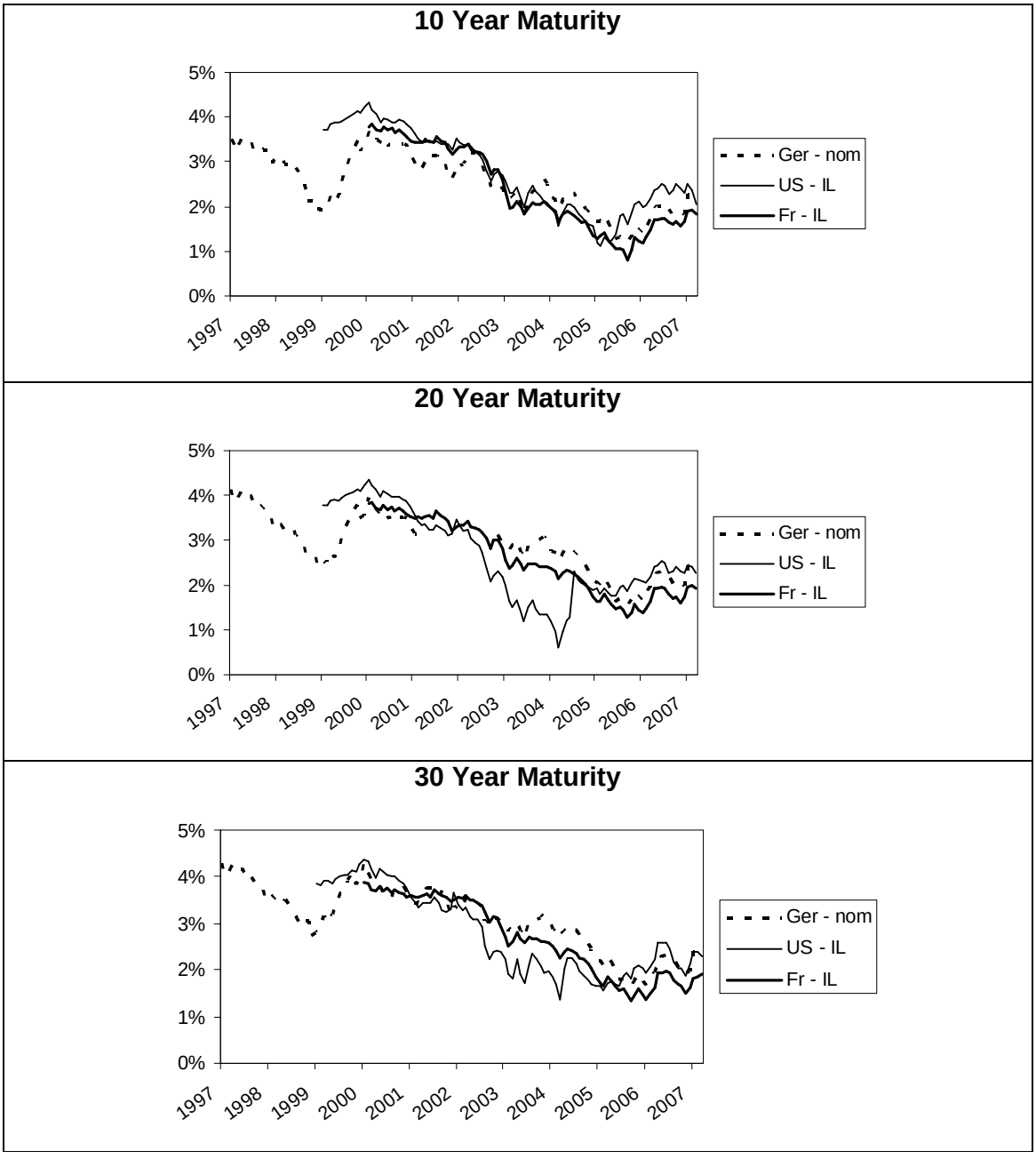
(1) S&P LT Foreign Issuer Credit Rating. (2) Of bonds currently outstanding. (3) DMO reports only one Greek bond outstanding, Bloomberg reports five. Market value outstanding reported by DMO may therefore be inaccurate. (4) DMO reports six Italian bonds outstanding, Bloomberg reports eight. Market value outstanding reported by DMO may therefore be inaccurate. (5) DMO reports six Swedish bonds outstanding, Bloomberg reports seven. Market value outstanding reported by DMO may therefore be inaccurate. (6) Or from date of issue. Source for market value data: DMO. Source for all other data: Bloomberg.

The Table shows that France, the UK and the US are by far the largest issuers in the European and US IL government bond market. In terms of number of bonds in issue, and maturity depth, these markets are also the most developed. Of the remaining markets, Greece and Italy are rated below the AAA highest credit rating. Of the other three AAA-rated issuers, Austria has a single bond on which yield data is available – on this bond liquidity is low (shown by a high (0.5%) bid-ask spread relative to other major market IL and nominal government bonds which typically have bid-ask spreads ranging from 0.02% to 0.10%), Sweden has a relatively small number of bonds and total market value, and Germany has a single bond outstanding. Liquidity is comparable between all markets, with the exception of Austria.

Since France and US are the largest and most developed markets in terms of bond numbers and maturities, they are most comparable to the UK market in terms of depth. We therefore do not consider further evidence on other index-linked government bond markets within this report. In addition to international index-linked evidence, we also consider implied real

yields on German government bond (bunds) as this is a major government bond issuer within the Eurozone. Figure 4.1 shows yields on constructed French & US IL and real yields implied by German nominal government bond indices for ten, twenty and thirty year maturities from January 2000 onwards.

Figure 4.1
Yields on Constructed French & US IL, Implied Real German Nominal Government Bond Indices



Source: NERA analysis of Bloomberg data. In order to construct index we interpolated linearly between yields for maturities falling between 10 and 30 years. For some months we extrapolated (by no more than two years) out (in) from maximum (minimum) maturity in order to derive 10 and 30 year maturity yields.

The Figure shows that yields on all maturities for all countries have fallen more or less steadily from around 4% in 2000 to around 1.0% on the 10 year and 1.5% on the 20 and 30 years in late 2005/early 2006.[50] Since then, yields increased slightly before falling again in late 2006. Yields have moved fairly closely together, with the exception of the US IL 20 and 30 year government bond indices (known as TIPS). The volatility in these yields may be associated with specific supply and liquidity issues. The US Treasury announced its decision to discontinue 30 year TIPS in 2001 and has committed to this position since. Supply influences associated with the nominal market may have also impacted longer maturity TIPS yields. The US Treasury suspended nominal 30 year issuance between 2002 and 2006.

Figure C.1, Figure D.1 and Figure E.3 in the Appendix set out the implied real yield curves for each of the indices shown above.[51] These show that:

- The French IL curve flattened from 2000 to 2005, and then inverted at the long end in 2006 and 2007.
- The US IL curve was inverted for much of the period between 2000 and 2005. Most recently, the curve has again slightly inverted at the long end.
- The German yield curve has also flattened substantially over the past couple of years, and has slightly inverted at times over the past year.

The fall in yields since 2000 and the inversion or flattening of the yield curve in 2007 in all markets is consistent with high inelastic demand for long-end bonds from pension funds, suggesting that similar influences to those placed on UK government bonds may pushing yields to below their fundamental levels.[52,53]

Press reports state that pension fund demand may have strengthened as international accounting standards requiring pension funds to state deficits in their financial accounts approach implementation stage.[54]

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[50] We note that, as for real yield implied from nominal yields for the UK, German implied real yields derived from nominal yields should be interpreted with caution, as nominal yields include the inflation risk premium and differences in reference inflation between markets may distort the read-across between different nominal yields, and IL government bond yields. For the IL bonds, differences in inflation reference indices may distort the read-across of real yields in UK terms. Currency differences may also impact interpretation of both nominal implied real and IL yields across countries.

[51] See Appendix B for further yield curve analysis for French IL government bonds.

[52] See for example, Bondweek (11/02/05) *"Long TIPS Yields Hit Record Low."*: *"The long end of the Treasury inflation-protected securities yield curve fell to an all-time low last week. The yield of the April '32s fell to 1.72% on Feb. 8, the lowest since the issue was released in 1998. Alex Li, interest-rate strategist at Credit Suisse First Boston, said he considers the drop surprising given the Federal Reserve continues to raise interest rates, but sees the buying of longer-dated paper by pension managers trying to match assets and liabilities as a major factor in driving up prices on the issuance (BW, 2/4)."*

[53] Financial Times (9 February 2006) *"A world turned inside out: why investors are re-evaluating the predictive power of bonds"* Comments with respect to demand for US TIPS: *"Demand for long-term investment is high - something today's reintroduction of the 30-year bond is expected to confirm. Pension fund managers are desperate for longer-dated paper.*

[54] *"They say changes in pension regulations in Europe, under which firms are required to highlight deficits from defined-benefit schemes in balance sheets, look set to sustain demand for safe sovereign bonds to year-end and beyond, and to more deeply entrench the present German yield-curve inversion. The super-long end of the European government bond curve is in the grip of pension and insurance funds that are more interested in cash flow than the economic cycle, said Calyon's Keeble."* Dow Jones Newswires (9/11/06) "Pension Funds To Keep Long Bond Yields In Check"

In particular, the Dutch pension system has recently been reformed. This may have had some downward impact on yields in Europe in a similar way to that seen in the UK.[55] The FT, amongst others suggested that the Dutch reforms have placed particular pressure on the French ILG market, which is the largest in the Eurozone.[56]

In the US, the Pension Protection Act was enacted in August 2006, mandating stricter funding requirements on defined benefit plans. The influence on yields of pension fund demand in the US has been noted by the Federal Reserve.[57]

The OECD observed in early 2006 that undersupply of the bonds demanded by pension funds was a global phenomenon:

> *"Very long-dated and index-linked bonds seem to be currently undersupplied relative to perceived or expected demand"* [58,59]

It appears that demand for pension funds is not just restricted to the long end of the yield curve. Yields on ten year Eurozone IL government bonds have fallen, albeit by less, in line with longer yields. The recent German ten year index-linked issue was expected by Reuters to receive strong demand from pension funds, including "spill-over demand" from UK pension funds.

> *"Germany's debut index-linked bond is likely to attract strong demand from pension funds and investors seeking to diversify their portfolios, but the government might have missed the best funding opportunity.. some British pension funds who might have felt short changed by punishingly low yields for*

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55 *"Dutch pension funds, among the largest in the world with more than EUR625 billion under management, started preparing for the Financial Assessment Framework (FTK), initially scheduled to come into force Jan. 1 2007, and have been adjusting their investment portfolios to raise cover ratios. Their interest in shoring up their cover ratios, particularly when equity markets were weaker at the start of the year, has been a major factor underpinning the long end of the bond market this year."* Dow Jones Newswires (9/11/06) "Pension Funds To Keep Long Bond Yields In Check"

56 *"There aren't many players in Dutch inflation so it's expensive and there's a tendency to use the euro convergence, for example French inflation-linked bonds," says Mr James. And while he accepts that in strict LDI terms the correlation between euro CPI (or even French domestic RPI) and Dutch wage inflation is not perfect, the shorter duration of the bonds they can use compared with the pension duration liabilities, reduce risk even further. But the market feels there is also a shortage of supply of euro-denominated inflation debt, although Germany has recently entered the market."* Financial Times (01/09/06) "Financial Times Mandate: Strategy Selection: Inflation-linked Bonds - Inflation-linked bonds wait for market to go Dutch." "LDI" in this article refers to liability-driven investment.

57 *"In the US, pension funds are required to reduce risk in portfolios by matching liabilities with less risky asset classes such as long-dated bonds. Stewart Cowley, head of fixed interest at Newton, says: "At present, there are insufficient fixed-interest securities for pension liability matching. Demand is not going to go away for long-dated bonds which should see a higher return for investors." That's a view that has received official backing also. In one of his first speeches as Federal Reserve Chairman, Ben Bernanke said the demand arising from changes in pension rules was "a third possible source of a declining term premium," the so-called yield curve conundrum.""* Investment Week (11/09/06) "Economic slowdown in US to benefit long-dated bonds"

58 As reported in Dow Jones International News (30 January 2006) *"Euro Yield Curve is Unlikely to Invert"*

59 See also *"The increased issuance of long-dated bonds by different European governments is not enough to meet investor demand for these instruments."* Financial Times (01/02/06) "Financial Times Mandate: News & Analysis: Products and Strategies - Clients call for more long-bonds."

> *index-linked bonds back home might see this as a good opportunity to get their hands on much-needed higher yielding, safe, assets."*[60]

In the US, excess demand has also been suggested at shorter maturities.[61] Historical and current yields may have also been influenced by specific supply issues. Most importantly, the US Treasury issued its last 30 year TIPS in 2001, and has committed to not issuing any more in the near future. Yields may also have been affected by the Treasury's decision not to issue nominal 30 year bonds over the period 2002-2006. Demand for the 2006 issue of the thirty year nominal bond was reported to be high.[62]

> *"Demand for the bond winds up outstripping supply by 2 to 1, sending prices higher and yields, or rates of return, lower. After the initial trading frenzy calmed down, John Ryding, chief U.S. economist for Bear Stearns, said the relatively small size of the 30-year bond sale, just $14 billion worth, was nowhere near enough to satisfy investor hunger. "This was like throwing a bucket of water into the desert," he said."*[63]

Despite demand for long-dated assets, the Treasury renewed its commitment not to issue any further 30Y bonds:

> *"The U.S. Treasury department sees ample demand from pension funds to support quarterly auctions of its 30-year bonds, but it has no plans to issue 30-year-inflation protected securities (TIPS), Treasury officials said on Wednesday".*[64]

4.2. Summary

Real yields on international government bonds have fallen fairly consistently since 2000. Reasons for this fall include: (i) increasing liquidity of international index linked bond markets; (ii) high levels of volatility in international stock markets including the dot-com

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60 Reuters News (28/02/06) "German linker bond seen luring investors."

61 "This ex ante imbalance between supply and demand of long securities has contributed to lowering the long rates by two means. First, in a very marginal way, it likely allowed a reduction in the liquidity premium to occur, and it was already quite low. Second, there was a reduction in the total real profitability demanded by investors (expected real yield and real term premium). This hypothesis is supported by the change in yield of TIPS, the US Treasury's inflation-linked bonds. The real 10-year yield of TIPS, which was 3.5% at the start of 2002, fluctuated between 1.5% and 2.25% in 2004 and 2005. This is a low level when seen in the light of potential growth, which is currently in excess of 3% and which, according to the Congressional Business Office, should continue in excess of 2.5% over the next ten years." Societe Generale France: Monthly Economic Report (02/02/06) "Focus: United States: A Structural Flattening Of The Rates Curve"

62 *"Demand was extremely high for the issue, noted Jim Midanek, chairman of institutional fixed-income firm Midanek/Pak Advisors. ``There's a need for about $165 billion in 10-plus-year debt in the U.S., by pension funds and other institutional investors, so $14 billion doesn't seem so big."* Pensions & Investments (20 February 2006) "$14 billion in 30-year U.S. Treasury bonds sold"

63 The Washington Post (01/02/06) "Strong Demand Greets Return of the Long Bond".

64 Reuters News (2 August 2006) "US Treasury sees pension demand, no 30-year TIPS."

crash at the turn of the Millenium; and (iii) pension reforms in the Eurozone and US that may have encouraged investment in government bonds in a similar fashion to the UK. [65]

The extent of excess demand arising from these possible influences is less clear than for the UK. Anecdotal evidence suggests that demand is outstripping supply, with the OECD noting a general shortage of long-dated and index-linked bonds, and evidence from recent auctions of the 30 year nominal Treasury in the US showing high demand relative to supply.

There is also some evidence that there are other unique characteristics that make government bonds attractive to investors include (i) the high liquidity of government bonds relative to other securities; (ii) the preference of governments (their own or other) to invest in government bonds over other securities; (iii) the acceptance of government bonds as collateral for stock loans and as margin "good faith money" for positions in futures markets; [66] (iv) the certainty and simplicity of government bonds means that less sophisticated investors prefer these to other more complex securities.

In summary, the Table below sets out summary evidence on UK and international government bond yields.

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[65] Other factors cited by the Bank of England in their Spring 2005 Quarterly Bulletin include the role of investment growth, growth in savings rates (actual and expected), growth in money supply and the growth of index linked bond markets as possible factors in explaining the lows. However, The BoE does not appear to reach definitive conclusions regarding the role of drivers of falls in global long term real interest rates over the period to 2004.

[66] Investors may be permitted to use leverage as part of a trade or trading strategy. There are several sources of funds available to an investor when borrowing funds. The most common practice for institutional investors is to use securities as a collateral for the loan. One such collateralized borrowing arrangement is called repurchase agreement or repo. A repo agreement is the sale of a security with a commitment by the seller to buy back the same security at a predetermined price and future date. The interest rate in a repo arrangement is called the repo rate. Repo rates are usually lower than interest rates for short-term bank borrowing. Repo rates depend, inter alia, on the quality of the collateral. This means the seller of a security in a repurchasing agreement can effectively borrow funds at a lower rate if the collateral is "special", i.e. in high demand due to its good credit quality. Governement bonds are likely to be considered "special" in a repo agreement. (Fabozzi (2004), p.267). To minimize credit risk traders in future contracts must post a margin which is around 5%-15% of the contract's value. Futures contracts are marked-to-market each trading day, which means contracts are closed and re-opened each day. Gains are credited to the margin account and losses are debited to margin accounts. Most clearing houses accept UK gilts as non-cash collaterals for their margin requirement.

Table 4.2
Real Yields on Nominal and Index-Linked Government Bonds

	10Y	20Y	30Y
Current (Month Average March 2007)			
UK – ILG	1.8%	1.4%	1.0%
UK – implied real from nominal	2.5%	2.1%	1.9%
France – ILG	1.8%	1.9%	1.9%
US – ILG	2.0%	2.3%	2.3%
Germany - implied real from nominal	2.2%	2.4%	2.4%
Five Year Average (2002 – March 2007)			
UK – ILG	1.8%	1.7%	1.6%
UK – implied real from nominal	2.1%	2.1%	1.9%
France - ILG	1.8%	2.1%	2.2%
US – ILG	2.1%	2.0%	2.1%
Germany - implied real from nominal	2.1%	2.4%	2.5%

The Table shows that current real yields range from 1.0% on thirty year ILGs in the UK to 2.4% implied by nominal yields on twenty and thirty year German bunds. Over a five year average period, real yields range from 1.6% on thirty year ILGs in the UK to 2.5% implied by nominal yields on thirty year German bunds.

The Table shows that the current yield curves for all groups of government bonds are inverted or flat at the long end. Whilst this may in theory reflect expectations of lower future interest rates, commentary has widely attributed inversion to depression of medium to long term maturity yields by excess demand from pension funds. Over a five year average period, this inversion is only present in UK yields, consistent with the earlier introduction (1997) of pension fund regulations in the UK relative to the US and Eurozone.

Overall evidence suggests that until recently international bond yields provided better evidence on the CAPM risk free rate than UK government bonds. However over the past couple of years the continued fall in yields has been attributed by commentators to demand – supply imbalances arising from institutional factors, namely increased pension fund demand as new accounting and pensions regulations are phased in internationally.

The use of international bond yields may therefore be biased as a source of evidence on the risk free rate, particularly over the past couple of years. The use of international evidence is further complicated by differences in inflation indexing, tax treatment and currency expectations.

5. Alternative Methods of Estimating the Risk Free Rate

In this section we present alternative methods in estimating the risk free rate when government bonds cease to accurately reflect the true risk free rate.

5.1. Use of Swap Rates (I)

In this section we explain the concept of swap rates and discuss the reasons why market participants have increasingly used the swap rate market as a basis for measuring the risk free rate. Due to the advantages of swap rates compared to government bond yields (see below), we consider the use of swap rates as a benchmark for estimating the true risk free rate.

An interest rate swap is an agreement between two parties that binds each party to make periodic interest payments on a predetermined set of dates in the future, based on a notional principal amount denominated in the same currency. One party is the fixed rate payer. The fixed rate (also referred to as the 'swap rate') is determined at the inception of the swap. The other party is the floating rate payer. The floating rate is determined during the lifetime of the swap by reference to LIBOR.[67] There are no exchanges of principal and there are only exchanges of net interest payments.[68]

The swap rate curve (also known as the LIBOR curve) is the series of swap rates quoted by swap dealers over maturities from 2 to 30 years. All major currencies will have their own unique swap rate curves.

In his seminal textbook "Fixed Income Analysis " Fabozzi (2004) states a number of advantages in using swap rates as opposed to government bond yields as a benchmark for evaluation the performance and pricing of fixed income securities.[69] These are:

- There are more maturity points available to construct a swap curve than there are for constructing a government bond yield curve. Also, the swap market is huge in terms of outstanding notional principal and has become highly liquid with narrow bid/ask spreads for a wide range of maturities.
- There is hardly any government regulation of the swap market, which makes swap rates across different markets more comparable than government bond yields. In certain countries, there are sovereign issues that offer various tax benefits to investors and, as a result, government bond yields across countries might not reflect their true yield because of these distortionary factors.

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[67] LIBOR is the London Interbank Offered Rate and is the interest rate which major international banks offer each other on Eurodollar certificates of deposit (CD) with given maturities.

[68] Most swaps are 'par swap', i.e. have zero value at the initiation of the contract. This is the case when the fixed rate is set in such a way that the fixed and floating "legs" of the swap have equal present value. To determine the fixed rate of a par swap, it is helpful to think of the cash flows of a par swap as the combination of a fixed coupon bond with the coupon equal to the swap rate and a floating rate note with the coupon equal to the reference LIBOR rate. At initiation of the contract it can be shown that the floating rate note is worth the notional principal. For the contract to have zero net present value, the fixed side must also be worth the notional principal. It follows from this that the swap rate must be equal to the coupon of a fixed-coupon bond trading at par (i.e. par yield).

[69] Fabozzi (2004) "Fixed Income Analysis", published by Frank J. Fabozzi Associates, 2nd edition, p266.

- The supply of swaps depends only on the number of counterparties that are willing to enter into a swap transaction. It is not affected by technical market factors (e.g. a government bond issue being "special" in the repurchasing market) that may result in the yield for a government bond issue being less than its true yield.
- Comparison across countries of government bond yields is complicated by the fact sovereign credit risk might vary across different countries. In contrast, the credit risk as reflected in swap rates are similar and make comparisons across countries more meaningful than government yields. Sovereign risk is not present in swap rates because swap rates can be considered as inter-bank yield rates or as AA yield rates.

It is important to note, however, that swap rates are not a default free rate. They include a premium for the credit risk of the counterparty to the swap failing to satisfy its obligation. Since the counterparties in swaps are typically financial institutions, the swap rate includes the credit risk of the banking sector. Banks usually have a AA credit rating.

It is, however, possible to remove the credit risk premium associated with a AA credit rating from swap rates through the usage of Credit Default Swaps (CDS). CDS are essentially an insurance policy to protect against the risk that a bond's issuer will suffer a credit default event (including a downgrade to its credit status). Since 2003 credit derivatives, of which CDS have a market share of 40% to 50%, have grown year-on-year by around 140%.[70] Hence, we assume that the market of CDS has become sufficiently mature in recent years in order to draw on reliable market information for credit risk. Hence, it is possible to remove the credit risk premium inherent in swap rates in order to receive a clean benchmark measure for the true risk free rate. It is important to emphasis that our analysis of the true risk free rate depends on the assumption that the swap market and CDS market are fairly priced.

We also estimate the extent to which the yield on government bond yields is a biased proxy of our measure of the true risk free rate. In order to estimate the bias in UK government bond yields, we compare our measure of the true risk free rate with government bond yields prevailing in the UK market.

Table 5.1 reports averages on UK swap rates of 5 years maturity (Column 2) and CDS premiums of the same maturity (Column 3). For data on CDS premiums, we draw on the iTraxx CDS "Senior Financials" index provided by International Index Company (IIC).[71] Assuming that swap and CDS markets are fairly priced, we calculate in Column 4 the implied true risk free rate as the difference of the swap rate and the CDS premium. Our estimate of the risk free rate is therefore associated with a 5 year maturity. We compare our measure of the true risk free rate with UK government yields with 5 years maturity (Column5) to calculate the implied bias (Column 6).

In Table 5.1, we present averages for the years 2005, 2006 and January to March 2007. In Appendix F we present monthly averages from 2005 – 2007.

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[70] See British Bankers Association, Credit Derivatives Report 2006.

[71] IIC is a joint venture of ABN AMRO, Barclays Capital, BNP Paribas, Deutsche Bank, Deutsche Börse, Dresdner Kleinwort, Goldman Sachs, HSBC Bank, JP Morgan, Morgan Stanley and UBS. A wide range of market makers submit to IIC a list of entities which should be included in the index. Only the most liquid entities are included in the index.

Table 5.1
Implied Bias in UK Government Bond Yields
(Using Swap Rates and CDS Premiums)

	Swap rate (5Y Maturity)	CDS premium (bps)	Implied RFR (5Y Maturity)	Gov't Yield (5Y Maturity)	Implied Bias (bps)
(1)	(2)	(3)	(4)	(5)	(6)
Average* 2005	4.71%	18	4.53%	4.37%	17
Average** 2006	4.97%	12	4.85%	4.61%	24
31/01/2007	5.54%	8	5.46%	5.20%	26
28/02/2007	5.58%	8	5.50%	5.25%	26
30/03/2007	5.48%	8	5.39%	5.13%	26
Average (Jan 07 - Mar 07)	**5.53%**	**8**	**5.45%**	**5.19%**	**26**

Source: NERA analysis
*Note: Data on Swap rates and government bond yields are provided from Bloomberg; data on CDS premiums are provided from iTraxx database for Senior Financials, Series 4-7; no data available for Jan 2005; Nov 2006 and Dec 2006; *excludes Jan 2005 value; **excludes Nov 2006 and Dec 2006 values; "bps" stands for basis points; one basis point is equal to 0.01%.*

Assuming the swap and CDS markets are fairly priced, we calculate true risk free rates which are 17-26bps higher than yields on UK nominal government bonds with the same maturity. We note the CDS market has become increasingly liquid only in recent years, which might suggest that the higher average premium of 18bps during 2005, as compared to 8bps during the period from January 2007 to March 2007 (see Table 5.1) reflects partly illiquidity rather than credit risk. This could explain why the implied bias appears lower in 2005 compared to the first three months in 2007.

Our analysis of the implied bias of using government bond yields is measured relative to *nominal* government bond yields. It is important to note that the bias is larger if one measures the real risk free rate using *indexed linked* securities, as it is has been currently done by the CAA.

In Table 5.2 we present the extent of the bias if the risk free rate was to be proxied by UK ILGs with 5 year maturities. In Column 2 of Table 5.2, we present UK nominal gilts deflated by expected inflation over a 5 year period. This gives an implied *real* yield which is based on nominal gilts. In Column 3 we present UK ILG yields for the same 5 year maturity. We then present the bias in UK ILG gilts as the difference between our measure of implied real yields (based on inflation adjusted nominal yields) and UK ILG yields (Column 4). Column 5 recalls the bias we found to be prevalent in the UK nominal government bond market. We then add the two biases together to get a measure of the total bias if the risk free rate was to be set equal to 5 year UK ILG yields (Column 6).

Table 5.2
Implied Total Bias in UK Indexed Linked Government Bond Yields

	UK nominal yield minus expected inflation (5Y Maturity)	UK ILG (5Y Maturity)	Difference between real yields implied by nominal gilts and ILG Yields (bps)	Implied Bias (nominal) (bps)	Total Bias (bps)
(1)	(2)	(3)	(4=2-3)	(5)	(6=5+4)
31/01/2007	2.67%	2.39%	28	26	54
28/02/2007	2.48%	2.12%	36	26	62
30/03/2007	2.63%	2.29%	34	26	61
Average (Jan 07 - Mar 07)	**2.59%**	**2.26%**	**33**	**26**	**59**

Source: NERA analysis
Note: Data on swap rates and government bond yields are provided from Bloomberg; data on CDS premiums are provided from iTraxx database for "Senior Financials", Series 7; nominal yields (Column 2) have been deflated using expected inflation over 5 years from Consensus Forecast (HM Treasury); "bps" stands for basis points; one basis point is equal to 0.01%

Table 5.2 shows that the differences between real yields implied by nominal gilts and ILG yields (bps) with a maturity of 5 years has been in the range of 28-36bps during the first three months of 2007. Hence, our analysis shows that yields on UK ILGs are biased in the range of 54-62bps as a measure of the current real risk free rate for a 5 year maturity.

It is important to note that the bias in UK ILGs is larger if longer maturities on ILGs are used. Evidence of this comes from the fact that the difference between real yields implied by nominal gilts and ILG Yields is even bigger at long maturities. Table 4.2 for example, shows that the difference between real yields implied by nominal gilts and ILG Yields is 70bps for 10 and 20 year maturities and 90bps for 30 year maturities.

In summary, our analysis shows that recent spot rates on UK ILGs are downwardly biased as a measure of the "true" real risk free by at least 50bp.

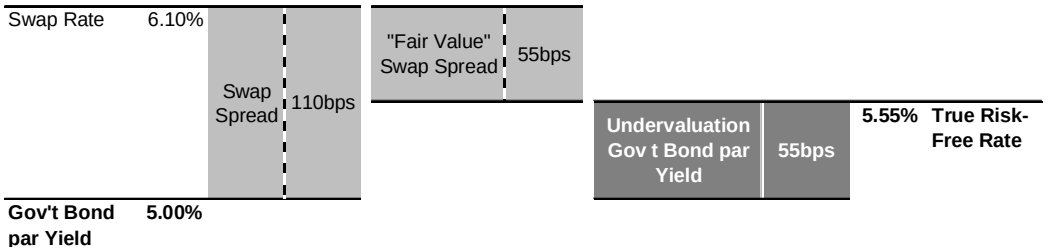
5.2. Use of Swap Rates (II)

Two economists of the Bank of England, Copper and Scholtes (2001), use swap rates to generate a measure of the extent to which government bond yields may have been pushed below the true risk free rate.

The difference between the swap rate and the government bond par yield with the same maturity is called the swap spread. Copper and Scholtes compare swap spreads with what they determine a "fair value". They derive the "fair value" for swap spreads using a model based on a simple trading strategy. Copper and Scholtes show that the swap spread is closely related to expectations of the future spread between GC repo (meaning "general collateral

repurchasing agreement")[72] and LIBOR. The authors prove this relationship by a simple trade strategy, which we do not explain here. What is important is that the authors proxy the swap spread as the difference of two yields (i.e. GC repo and LIBOR) of which *non* is based on distorted government bond yields. The difference in the swap spread and their estimate of the "fair value" is the measure of the bias of government bond yields as proxy for the risk free rate. Figure 5.1 illustrates their methodology of using swap spreads as a measure of relative valuation of the true risk free rate.

Figure 5.1
Using Swap Spreads as a Measure of Relative Valuation of the True Risk free Rate: Copper and Scholtes (2001)



Source: NERA illustration of Copper and Scholtes (2001) relative valuation methodology
Note: "bps" stands for basis points; one basis point is equal to 0.01%.

It is important to emphasise that the authors' analysis rests on the assumption that the swap market is unaffected by supply and demand side distortions of the government bond market.[73]

Copper and Scholtes find that a fair value of the swap spreads for the US dollar and sterling market is within the range of 40-50 basis points (bps) and around 30 bps for the euro market. The authors note that during financial crises the spread widens by around 10-15 bps, but reverts back quickly towards their mean levels. By comparison, Copper and Scholtes show that during 2000, direct market evidence on swap spreads with 10-year maturities were in the range of 110 bps and 100 bps for the sterling and US dollar markets, respectively and of around 60 bps for the euro market. Hence, the authors conclude that yields on 10-year gilts and Treasuries were depressed by around 60-70 bps, and yields on German Bunds (used as a proxy for the euro market) by around 30 bps, assuming that the swap market was efficiently priced. In other words, in order to obtain a cleaner measure of the risk free rate an additional 60-70 bps must be added to the yield of a 10-year UK and US government bonds, and 30 bps to a German government bond.

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[72] A repurchasing agreement (repo) is the sale of a security with a commitment by the seller to buy back the same security from the purchaser at a specified price at a specified future data. A repo is essentially a collateralised loan. Repo rates are usually lower than short-term bank financing. If the borrower of funds (i.e. the seller of the collateral) has a security that lenders of cash want, it is referred to as a "hot" collateral or "special" collateral. Repo rates for "hot" collateral are lower than for general collateral. A collateral that does not have this characteristic of being "hot" or "special" is referred to as a general collateral.

[73] We note, Copper and Scholtes (2001) reliance on the swap market as a benchmark is consistent with Fobozzi (2004)'s recommendation of using the swap market as the benchmark as opposed to government bond yields.

5.3. Use of Cross Country Spread Comparison

Copper and Scholtes (2001) also present a second method in estimating a relative bias in government bond yields in different currency markets. The authors draw on bond issues from supranational institutions, in particular, the European Investment Bank (EIB) and the World Bank (IBRD) which issue bonds in different currency markets.

One would expect spreads on bonds issued by supranational institutions to be very similar across the UK, US and euro markets if there is a reliable benchmark of the risk free rate over which the spreads are measured. The spread (i.e. the premium over the *true* risk free rate) of supranational bonds should be the same across all markets. In other words the observed difference in spreads over government bond yields in different markets are a reflection of the distorionary supply/demand side factors prevailing in the government bond markets in these counties.

Copper and Scholtes show that the spreads of the bonds measured over government yields vary considerably across the different markets. Spreads tend to be around 90bps for the sterling and US dollar markets and only 30 bps for the euro market. This suggests that in 2000 at the time of estimation, the benchmark, i.e. the UK and US government bond yields, is around 60 bps downwardly biased relative to euro government bond yields.

It is important to note that using *swap rates* as the benchmark to derive bond spreads of supranational institutions shows very similar pattern across the three markets. This confirms that premiums of bond yields issued by supranational institutions should be the same independent of the market in which the bonds trade. This also confirms Fabozzi (2004)'s point that swap markets are a better benchmark than government bond yields.

5.4. Use of Corporate Bond Yields

A recent NERA (2007) paper co-authored by Professor Grundy from Melbourne University examines the extent to which the yield of Australian government bonds is a biased proxy of the risk free rate used in the CAPM. Therefore, in estimating a true risk free rate, the extent of the bias (to which they refer as a "uniqueness premium" of government bonds) has to be added to the government bond yield. The paper is published on the website of "Victoria's Independent Economic Regulator for Essential Services". [74]

NERA (2007) draw on corporate bonds and use market data on Credit Default Swaps (CDS) in order to determine the extent Australian government bond yields are a biased estimate for the risk free rate. As noted above, CDS are essentially an insurance policy to protect against the risk that a bond's issuer will suffer credit default event. It follows that combining corporate bonds with CDS provide a portfolio that is risk free and hence should earn the risk free rate.[75] NERA (2007) then compare the portfolio's risk free rate with yields on Australian

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[74] Available at: http://www.esc.vic.gov.au/NR/rdonlyres/30E0CA54-0BE3-4D78-ABC9-9C0A9220B85E/0/MultinetExpertReportsNERAFinalreport.pdf

[75] Strictly speaking, the portfolio would only be considered risk free if the counterparty to the CDS (i.e. the insurer) has a low credit risk, so that the risk that both parties default is negligible.

government bonds. They attribute the difference to the "uniqueness premium" included in government bond yields.

NERA (2007) draw on CDS premiums published by the Reserve Bank of Australia (RBA). Drawing on June 2003 data, the authors estimate an implied bias in government yields of 15bps, using both A-rated and AA-rated corporate bonds with 5-year maturities. Drawing on recent January 2007 data, the authors estimate an implied bias of 42bps using A-rated bonds and 44bps using AA-rated bonds. This suggests current Australian government bond yields with 5-year maturity are 42-44bps below the true risk free rate.

We note the authors express some drawbacks from their analysis as it is based on only two data points which they use to infer to the bias in Austrian government bond yields as a measure for the risk free rate.

5.5. Conclusion

In the presence of distortions in government bond markets alternative methods in determining the true risk free for regulators are becoming increasingly important. Table 5.3 below summarises the results of the papers we have considered and our own work in measuring the extent government bond yields are a biased proxy for the risk free rate.

Table 5.3
Summary: Implied Bias of Government Bond Yields

Source	Year	Country	Maturity	Implied Bias (nominal)	Methodology
NERA (2007)	March 2007	UK	5 Years	17-26bps	Swap spreads
Copper and Scholtes (2001)	2000	UK, US and euro market	10 Years	60-70bps (UK, US) 30 bps (euro market)	Swap spreads
Copper and Scholtes (2001)	2000	UK and US	10 Years	60bps (Bias in UK and US gov't bond markets relative to euro market)	International evidence on spreads of supranational bond yields
NERA (2007)	June 2003	Australia	5 Years	15bps	Corporate Bonds and CDS
NERA (2007)	January 2007	Australia	5 Years	42-44bps	Corporate Bonds and CDS

We note our analysis and the results reported by Copper and Scholtes (2001) and NERA (2007) of the implied bias of government bond yields is measured relative to *nominal* government bond yields. It is important to note that the bias is larger if one measures the real risk free rate using indexed linked securities, as it is standard practice for UK regulators. As discussed in Section 3, demand side distortions prevalent in the market for indexed-linked securities are more exacerbated than in the market for nominal government bonds.

We have not undertaken a full scale study of the bias in UK ILGs relative to the real risk free rate across all maturities. However, our analysis shows that the difference between real yields implied by nominal gilts and ILG yields (bps) has recently been around 30bp for 5 year bonds; 70bps for 10 and 20 year maturities; and 90bps for 30 year maturities.

Adding this difference to our estimate of the bias in nominal gilts as a measure of the real risk free rate shows that UK ILGs have been downwardly biased as a measure of the "true" real risk free at that time by at least 50-60bp.

In summary, our analysis shows that recent spot rates on UK ILGs have been downwardly biased as a measure of the "true" real risk free at that time by at least 50bp.

Appendix A. UK Gilts – Supplementary Information

A.1. Commentary on ILG Yields

This Section sets out supplementary commentary on UK gilt yields.

A.1.1. Competition Commission

Competition Commission (2000)

> *"T(t)here appears little doubt that gilt yields have been affected by liquidity factors, including the increasing maturity of UK pension funds and the MFR for mature pension funds, which was introduced in April 1997 just before the decline in longer term gilt yields started. The Bank of England referred in its May 1999 Inflation Report to strong demand for bonds, both from pension funds due to the MFR and from insurance companies, leading to upwards pressure on the price of both conventional and index-linked government securities. Low UK Government borrowing in recent years is another factor that may have contributed to this upwards pressure on gilts prices. During the period that gilt yields have fallen, yields on corporate bonds have widened (relative to conventional gilts), again supporting the contention that specific institutional factors have affected gilt yields."*[76]

Competition Commission (2003)

> "*There appears to be widespread recognition that gilt yields have been affected by special factors, including an increased demand from pension funds as a result of the introduction of the minimum funding requirements (MFR) in 1997, just before the decline in gilt yields started"* [77]

Competition Commission (2006)

> *"Other relevant factors for the downward trend in yields in recent years include the minimum funding requirement for pension schemes, which increased the demand for both conventional and index-linked government securities and thereby placing upward pressure on their prices."*[78]

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[76] Competition Commission (2000) "*Mid Kent Water Plc: A report on the references under sections 12 and 14 of the Water Industry Act 1991"*, para 8.13.

[77] Competition Commission (2003).p188, Competition Commission (2003) "*Reports on references under Section 13 of the Telecommunications Act 1984 on the charges made by Vodafone, O_2, Orange and T-Mobile for terminating calls from fixed and mobile networks"*

[78] Competition Commission (2006) *"Cost of capital for UK home credit providers"*

A.1.2. Bank of England

BoE Quarterly Bulletin Spring 2006[79]

> *"Another factor, frequently cited by market contacts, is that increased demand from defined benefit pension funds may have pushed up prices of long-dated government bonds, thereby reducing their yields"*

> *"To the extent that yields on government bonds influence the discount rates that pension funds use to assess their future liabilities, the recent falls in real interest rates could have further widened deficits between the value of their assets and liabilities. In turn, this may have reinforced the demand for long-dated assets."*

> *"At long horizons, both real and nominal sterling forward rates fell over the review period such that the impact on implied inflation was fairly small. This suggests inflation expectations remained stable. It may also be consistent with pension funds being primarily concerned with matching the duration of their assets and liabilities, rather than hedging their inflation exposure, or with dealers and other market participants being prepared to take on the long-dated inflation risk."*

BoE Quarterly Bulletin Summer 2006[80]

> *"Despite the rise in long real forward rates, the sterling curve remained inverted. As discussed in previous Bulletins, the inversion may indicate continued robust demand, relative to available supply, for long-maturity index-linked bonds from defined-benefit pension funds."*

A.1.3. Financial Times

Financial Times (24/01/06) *"Make the most of low bond yields".*

> *"While a substantial switch towards long-dated bonds would generate net new demand that was very large relative to supply from the UK government for several years, it would not do so indefinitely. Once a portfolio switch is made, with new inflows falling to very low levels in the relatively near term, the balance between net new demand and supply will look very different. When that occurs, yields are likely to be much higher. The anticipation of that happening should affect yields on long-dated bonds far sooner."*

Financial Times (25/01/06) "Yields on 50-year gilts hit auction low *Prices fail to deter strong demand by pension funds *Calls to increase supply of long-dated bonds"

> *"Demand is being fuelled in part by company pension funds trying to match assets with their liabilities to current and future pensioners. However,*

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[79] Bank of England (2006) "Quarterly Bulletin Spring 2006".

[80] Bank of England (2006) "Quarterly Bulletin Summer 2006".

> *pension fund deficits are calculated using long-dated bond yields so, as real yields fall, deficits grow larger. Pension funds are thus forced to buy more bonds, creating a vicious cycle. The yield on the 50-year linked has fallen dramatically in recent trading sessions. Last week, a surge of demand sent its real yield to a record low of 0.38 percent".*

Financial Times (16/02/06) "Gilts sale highlights pressure on rates."

> *"The UK government on Thursday sold 50-year bonds at a yield below 4 per cent, the first sale of long-dated paper below that level for more than 50 years, emphasising the continued downward pressure on long-term interest rates. The slide in yields is being fuelled by an increase in pension fund demand after new regulations that provide strong incentives for corporate pension funds to match liabilities - or payments to current and future pensioners - to the assets they hold."* [81]

Financial Times (17/02/06) "Pressure on pension funds set to remain."

> *"The result of the auction underlines a point made in a report yesterday from pension consultants Watson Wyatt. While real yields on inflation-linked bonds have been squeezed - and have been the subject of most comment - nominal yields on conventional gilts have also collapsed. Indeed, across a range of maturities, the gap between nominal and real yields - so-called break-even inflation - has not changed much since the start of last year. Both nominal and real yields have fallen by more than 0.5 per cent on average in the 12 months to the end of January."*

Financial Times (9/12/2006) "Treasury's nod to nuclear bonds helps fuel the market."

> *The FT recently noted the government's implicit acknowledgement of distortions to the market: "But there is a bigger problem. Roger Brown, strategist at UBS, says the government's decision to sell BNFL's linkers into the market only confirms what most people believe to be unhealthy distortions in the bond market. Demand for long-dated assets has been so strong that long-dated yields are being compressed to unhealthily low levels. "There could be no clearer signal than this sale that the Treasury believes long-dated real yields are too low," says Mr Brown. "They do not want to own such low yielding assets themselves and are therefore selling them.""*

[81] Financial Times (16/02/06) "Gilts sale highlights pressure on rates."

A.1.4. Other

Reuters News (28/11/06) "Strong demand for UK's 2027 index-linked gilt sale"

> *"This auction was boosted liability-driven demand rather than anything to do with inflation expectations"*

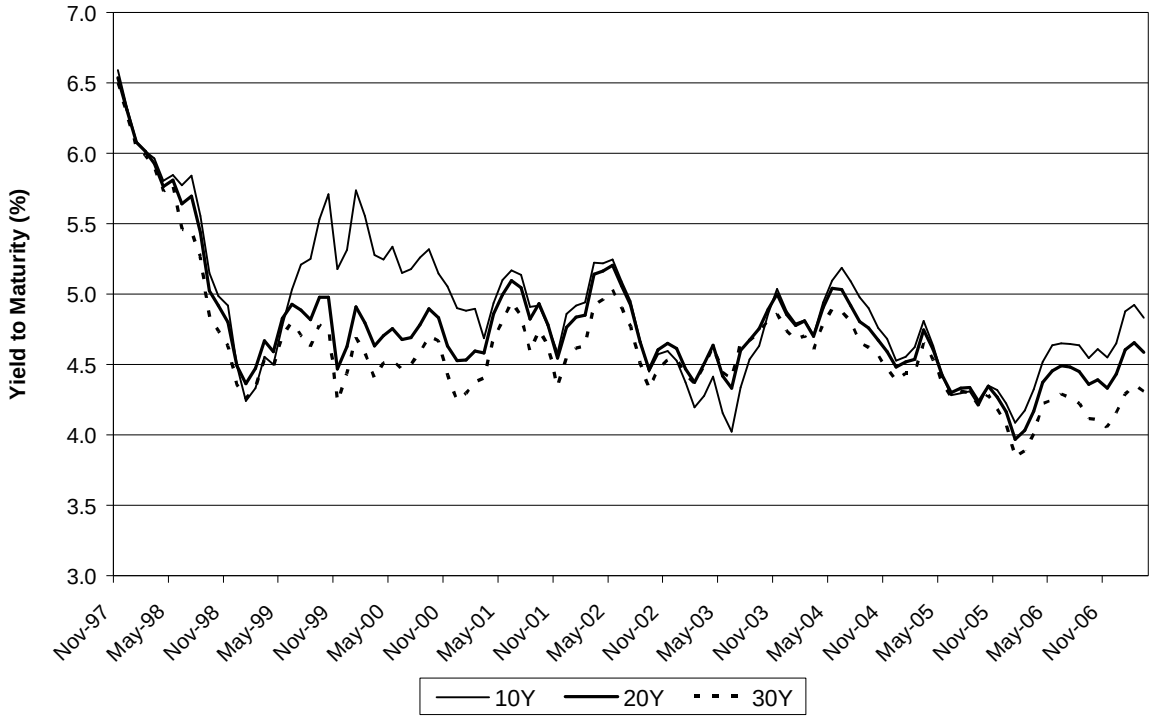
The Business (10/02/07) "Resounding answer to the riddle of the bond yield curve".

> *"In the UK gilts market, the yield curve has long been inverted. Much of this has been caused by rampant demand from pensions funds for long-dated bonds, which they need to match against their lengthening liabilities caused by an ageing population. The strong demand for these long-term gilts has pushed up their price, and hence cut their yield"*

A.2. Nominal Bonds

Figure A.1 shows historical yields on nominal UK government bond indices for maturities of 10, 20 and 30 years.

Figure A.1
Time Series of UK Government Bond Yields (Nominal)
(Nov 1997 – April 2007)

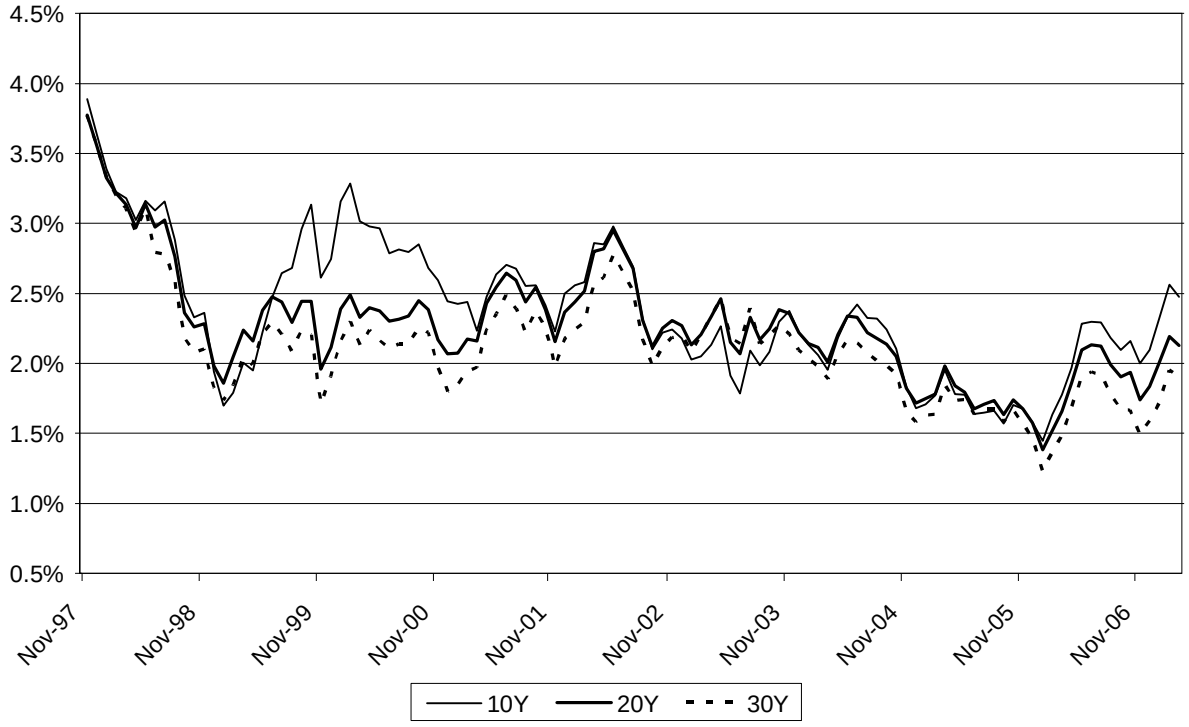


Source: Bloomberg
Note: Yields based on Bloomberg's generic Bond Price Index for the UK (GGR)

We deflate these yields using consensus forecasts of RPI-X reported in HM-Treasury's quarterly "Forecasts for the UK Economy" series. These forecasts run out to five years. We extend the fifth year forecast as a proxy for longer run forecasts up to the thirty year maturity on the longest index presented.[82]

Deflated yields are presented in the Figure below.

Figure A.2
Time Series of UK Government Bond Yields (Real)
(Nov 1997 – April 2007)

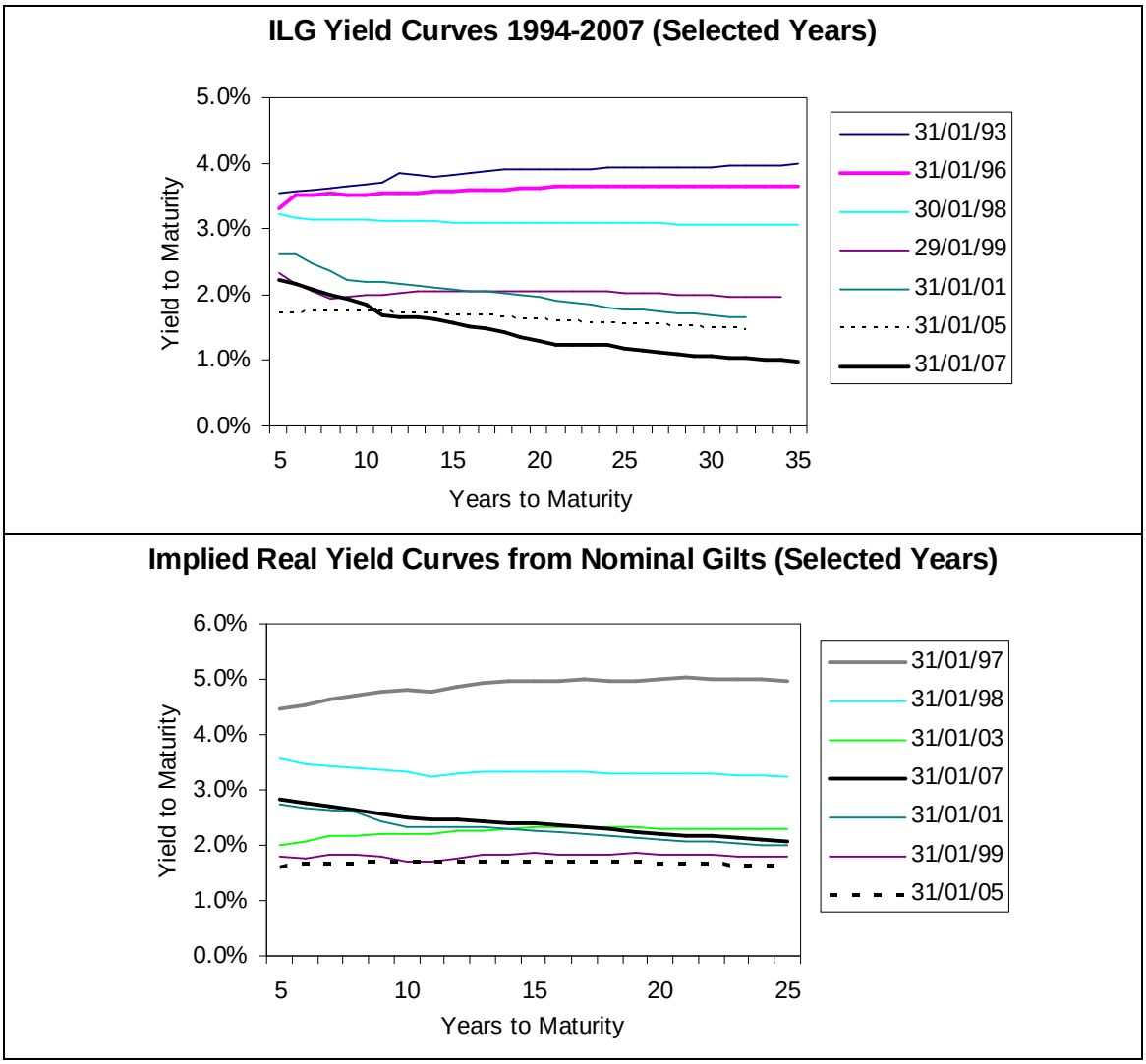


Source: Bloomberg
Note: Yields based on Bloomberg's generic Bond Price Index for the UK (GGR); Nominal yields have been deflated using expected inflation from Consensus Forecast (HM Treasury)

[82] www.hm-treasury.gov.uk/forecasts

A.3. UK Gilt Yield Curves

Figure A.3
Gilt Yield Curves



Source: NERA analysis of Bloomberg data. Yields curves constructed by linear interpolation between monthly average mid yield to maturity on UK ILGs and nominal gilts in issuance. For years prior to 2005 when the 50 year bond was issued, for some years we extrapolated (by no more than two years) out from maximum maturity in order to derive long maturity yields. Nominal yields deflated by RPIX forecasts as discussed in Appendix Figure A.2.

A.4. Bid to Cover Ratios at DMO Auctions

Table A.1
Nominal and ILG Bid:Cover Ratios: Five Most Recent According to Maturity

	ILG			Nominal	
Month of Issue	**Maturity**	**Bid:Cover**		**Maturity**	**Bid:Cover**
<10Y					
Nov-05	2013	**3.3**	Mar-07	2012	1.9
Feb-05	2013	**3.0**	Feb-07	2016	**2.2**
Jul-04	2013	**2.0**	Nov-06	2011	**2.2**
Oct-03	2011	1.8	Sep-06	2011	**2.7**
Apr-03	2009	**2.2**	Jun-06	2011	**2.2**
10-30Y					
Apr-07	2037	1.8	Mar-07	2027	1.5
Apr-07	2017	**2.1**	Jan-07	2027	**2.3**
Mar-07	2027	**2.5**	Dec-06	2027	1.5
Feb-07	2037	**2.0**	Nov-06	2016	**2.2**
Jan-07	2017	**2.4**	Oct-06	2027	1.9
>30Y					
Jan-07	2055	**2.4**	Apr-07	2046	1.4
Oct-06	2055	**3.0**	Feb-07	2046	1.6
May-06	2055	1.2	Nov-06	2046	1.7
Jan-06	2055	1.8	Jul-06	2046	**2.3**
Oct-06	2055	1.7	Jun-06	2046	1.4

Source: DMO

The Table shows that bid:cover ratios have typically been higher for ILG auctions, but that nominal auctions have also been significantly oversubscribed: up to over two times for the 2027 and 2016 issues. Whilst bid:cover ratios may not be a fully accurate guide to excess demand (as they are themselves a function of the auction price), relatively inelastic demand from pension funds means that these ratios provide an idea of relative subscription rates.

Appendix B. The MFR

The key impact of the MFR on the market was to distort the relationship between the holding of equities and gilts by pension funds. Whilst the MFR did not directly advocate the form of asset holding, gilt holding over equity holdings are encouraged in three main ways.

Firstly, the discount rate applied to the future pension liabilities of pensions not yet retired is defined by the assumed long-term rate of return of equities. This is adjusted by the MVA to reflect current dividend expectations. Since the use of the long-term rate of return on equities was assumed, and then partially adjusted by the set MVA (prevailing dividend expectations adjustment), periods of stock market turbulence meant that previously set long-term rates of return on equities, and the MVA, lagged behind the market discount rate based on equity returns. Given the short periods allowed for catch-up to MFR target levels and the recent trend of falling expected dividend payments, this provided pension funds with an incentive to move out of equities, since equities that were expected to underperform the MVA (in terms of future dividend payouts) imposed a greater risk to the reliability of asset valuation than gilts. Gilts were therefore used as a hedge against short-run MFR fluctuations in asset valuation.[83]

Secondly, given that the gilt rate was used to ultimately value all the pensions upon-payment liabilities, and given the more reliable stream of income accruing from these assets, many pension funds operated a gilt-matching policy – and chose to hold gilts as opposed to equities, such that the discount rate used to value their assets matched the discount rate used to value the liabilities.

Thirdly, it has been argued[84] that the MFR effectively valued equity assets on the basis of long term dividend payouts. Certain key companies, such as Microsoft, operate no-dividend policies. Applying a dividend-based discount rate for valuation purposes thus meant that holding these equities represented gaps in asset provision. This could have also encouraged offloading of large equity positions.

In an attempt to alleviate the problems caused by the MFR, key modifications were implemented as of March 2002. Firstly, allowed periods of "catch-up" of pension funds to target levels were extended. By extending the "catch-up" period it was intended that the rush for gilts occurring during shorter term periods of market volatility and falls would be eased, as funds could afford to take a longer term view regarding the discounted value of equity assets.

Secondly, the 'market valuation adjustment', MVA, factor was reduced to 3%, to reflect the lower dividend payouts by companies prevailing in the early '00s. The MVA factor was adjusted downwards such that assets held to cover non-retired pension liabilities were valued at a lower discount rate. This reduced the risk to pension funds holding riskier assets such as equities, as it allowed for lower future dividend payouts.

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[83] Bank of England Quarterly Bulletin, November 2000.

[84] "Is the MFR doing more harm than good?" PriceWaterhouseCoopers – Pensions April/May 2000

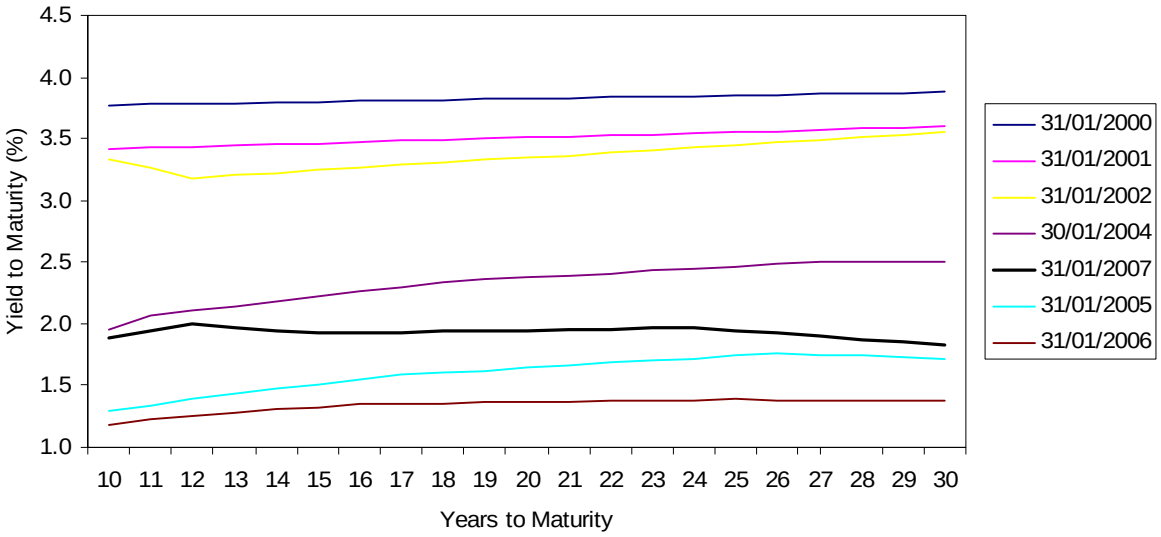
The key gilt maturities affected by the MFR were the medium-term nominal gilts or short-term index-linked gilts (either could be used[85]). For pensions currently in payment, as the discount rate for liabilities was calculated as the prevailing market yield on a basket of nominal gilts with a maturity of 15 years, or index-linked gilts of 5 years. However, other maturities are likely to have been affected, as other non-pension fund investors are likely to have bought into gilts of differing maturities, as medium term maturity gilts became more expensive.

[85] Given the existence of index-linked pension liabilities LPI (limited price indexation) which guarantees that annuities are indexed to 5% or RPI, whichever is lower. When inflation expectations fell below 5%, it was appropriate for pension funds operating LPI pensions to use the yield on IL bonds as a discount factor. There was also a strong incentive to hold the 5 year IL gilts such that assets matched RPI-varying liabilities.

Appendix C. Evidence on French ILGs

The Figure below shows the yield curve on French IL government bonds constructed for selected years between 2000 and 2007.

Figure C.1
Constructed Yield Curve for French IL Government Bonds – 2000-2007



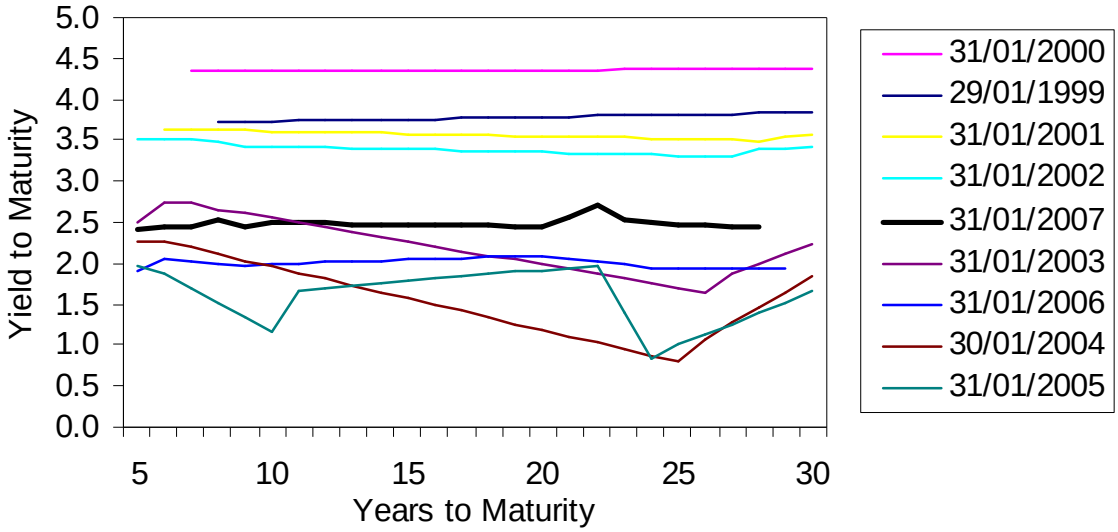
Source: NERA analysis of Bloomberg data. Yields curves constructed by linear interpolation between monthly average mid yield to maturity on French IL government bonds in issuance. For some years we extrapolated (by no more than two years) out from maximum maturity in order to derive long maturity yields.

The yield curves for 2000-2006 inclusive are all upward sloping. However, the 2007 curve is slightly inverted.

Appendix D. Evidence on US TIPS

The Figure below shows the yield curve on US IL government bonds constructed for 1999 to 2007.

Figure D.1
Constructed Yield Curve for US IL Government Bonds – 1999-2007

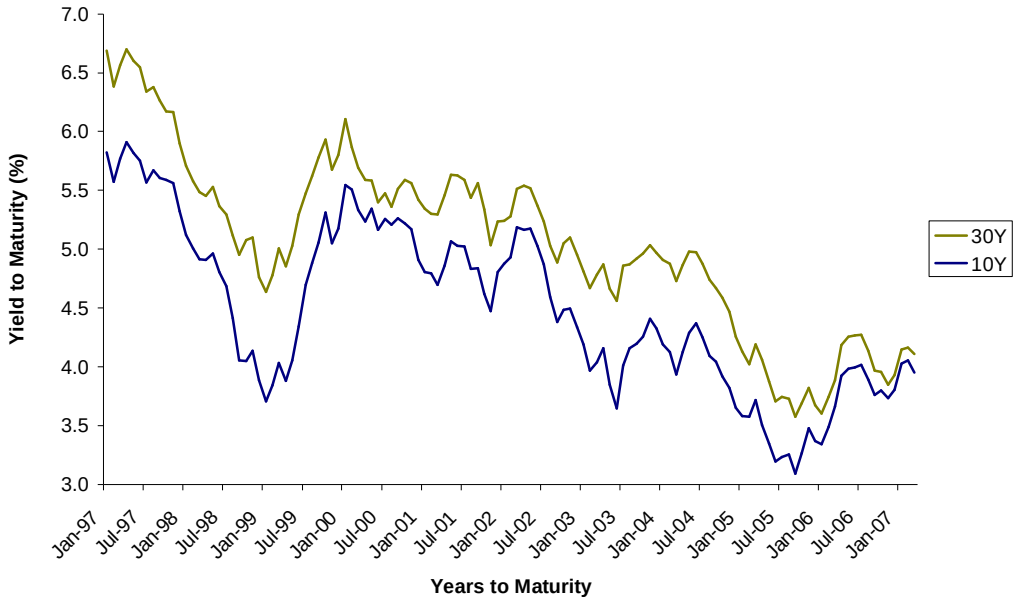


Source: NERA analysis of Bloomberg data. Yields curves constructed by linear interpolation between monthly average mid yield to maturity on French IL government bonds in issuance. For some years we extrapolated (by no more than two years) out from maximum maturity in order to derive long maturity yields.

Appendix E. Evidence on German Nominal Bunds

E.1. Time Series Evidence

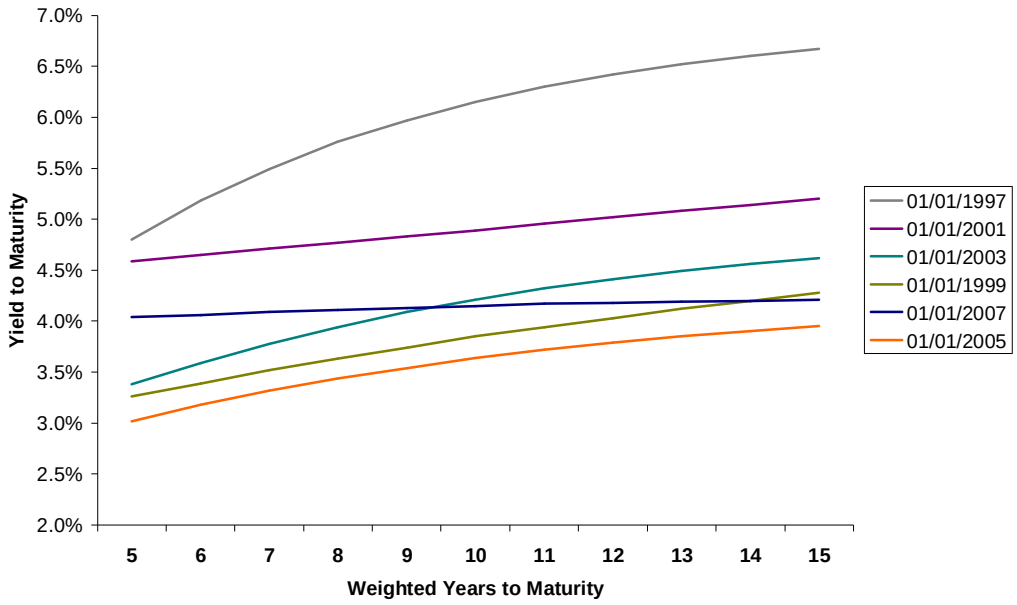
Figure E.1
Time Series of German Government Bond Yields (Nominal)
(1997 – 2007)



Source: Bloomberg
Note: Yields based on Bloomberg's generic Bond Price Index for Germany (GGR);

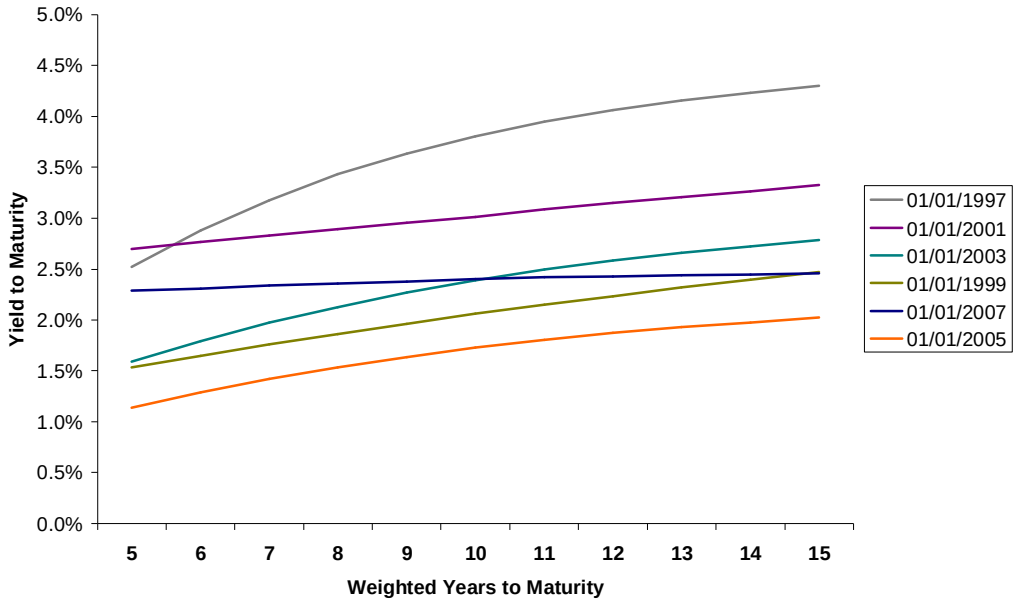
E.2. Yield Curves

Figure E.2
Nominal Yield Curves for German Government Bonds



Source: Deutsche Bundesbank
Note: Deutsche Bundesbank weighs years until final redemption of the security by the present value of the corresponding cash flow by the time it is received divided by the total price of the security; the sum of the weights is equal to one. Yields are derived from quoted German Government Bonds using the Svensson-Method

Figure E.3
Implied Real German Government Yield Curves



Source: Deutsche Bundesbank
Note: Deutsche Bundesbank weighs years until final redemption of the security by the present value of the corresponding cash flow by the time it is received divided by the total price of the security; the sum of the weights is equal to one. Yields are derived from quoted German Government Bonds using the Svensson-Method; Nominal yields have been deflated using expected inflation over the period of maturity at the time of yield measurement from Consensus Forecasts.

Appendix F. Implied Bias of Government Bond Yields Using Swap Rates and CDS Premiums

Table F.1
Implied Bias of Nominal Government Bond Yields Using Swap Rates and CDS Premiums

	Swap rate (5Y Maturity)	CDS premium	Implied RFR	Gov't Yield 5Y Maturity))	Implied Bias
31/01/2005	4.85%	na	na	4.51%	na
28/02/2005	4.95%	18	4.76%	4.62%	15
31/03/2005	5.12%	18	4.94%	4.80%	14
29/04/2005	4.95%	18	4.76%	4.60%	16
31/05/2005	4.72%	18	4.54%	4.37%	17
30/06/2005	4.55%	18	4.37%	4.21%	16
29/07/2005	4.50%	18	4.32%	4.18%	14
31/08/2005	4.56%	18	4.37%	4.24%	13
30/09/2005	4.48%	18	4.30%	4.15%	14
31/10/2005	4.63%	19	4.44%	4.30%	14
30/11/2005	4.72%	17	4.55%	4.33%	22
30/12/2005	4.66%	15	4.51%	4.25%	26
Average 2005	**4.71%**	**18**	**4.53%**	**4.37%**	**17**
31/01/2006	4.57%	13	4.44%	4.15%	29
28/02/2006	4.63%	12	4.51%	4.26%	25
31/03/2006	4.76%	12	4.64%	4.39%	25
28/04/2006	4.92%	13	4.79%	4.56%	24
31/05/2006	5.12%	12	5.00%	4.77%	23
30/06/2006	5.12%	15	4.98%	4.78%	20
31/07/2006	5.11%	14	4.97%	4.77%	20
31/08/2006	5.16%	12	5.05%	4.81%	24
29/09/2006	5.11%	10	5.01%	4.77%	24
31/10/2006	5.21%	10	5.12%	4.87%	24
30/11/2006	5.19%	na	na	4.84%	na
29/12/2006	5.28%	na	na	4.94%	na
Average 2006	**5.02%**	**12**	**4.85%**	**4.66%**	**24**
31/01/2007	5.54%	8	5.46%	5.20%	26
28/02/2007	5.58%	8	5.50%	5.25%	26
30/03/2007	5.48%	8	5.39%	5.13%	26
Average (Jan 07 - Mar 07)	**5.53%**	**8**	**5.45%**	**5.19%**	**26**

Source: NERA analysis
Note: Data on Swap rates and government bond yields are provided from Bloomberg; data on CDS premiums are provided from iTraxx database for Senior Financials, Series 4-7; no data available for Nov 2006 and Dec 2006.

NERA
Economic Consulting

NERA Economic Consulting
15 Stratford Place
London W1C 1BE
United Kingdom
Tel: +44 20 7659 8500
Fax: +44 20 7659 8501
www.nera.com

NERA UK Limited, registered in England and Wales, No 3974527
Registered Office: 15 Stratford Place, London W1C 1BE