Ground Rules

FTSE Russell

Guide to the Calculation Methods of the FTSE Actuaries UK Gilts Index Series

v3.1

Contents

Section 1

Introduction

1.0 Introduction

1.1 Scope

This guide provides a deeper explanation of the calculation methods used in the FTSE Actuaries UK Gilts Index Series. It complements the document entitled “Ground Rules FTSE Actuaries UK Gilts Index Series” (Ground Rules). If a situation arises where this Guide and the Ground Rules can be interpreted differently, then the Ground Rules take priority.

The FTSE Actuaries UK Gilts Index Series cover separate calculations for conventional and index-linked gilts.

The aims of this Guide are:

A. To describe how gilt reference prices are calculated;

B. To describe how the gilt indexes and their associated statistics are calculated;

C. To make it easier for users to replicate the indexes in order to support their trading and investment strategies;

D. To assist users in understanding the component factors which influence the performance of the indexes.

The guiding principles behind the index calculation methods are:

A. The calculation methods should reflect reality wherever practical;

B. The indexes should be capable of being replicated by users;

C. Only historical data should be used in calculating the index statistics;

D. Continuity with the past should be maintained wherever possible;

E. The indexes should be transparent and predictable;

F. The primary purpose of the indexes has always been to indicate the current level of yields in the market. A secondary purpose is to reflect accurately movements in the underlying market.

In order to replicate the indexes, it is assumed that the investor is able to deal at closing middle market prices, without any expenses, and in any quantity. In addition, for the total return indexes, it is assumed that the investor is able to reinvest the full interest amount, on the ex-dividend day, without any tax or expense considerations.

1.2 **FTSE Russell**

FTSE Russell is a trading name of FTSE International Limited, Frank Russell Company, FTSE Global Debt Capital Markets Limited (and its subsidiaries FTSE Global Debt Capital Markets Inc. and MTSNext Limited), Mergent, Inc., FTSE Fixed Income LLC, The Yield Book Inc and Beyond Ratings.

Tradeweb

Tradeweb Europe Limited is incorporated in the UK and regulated by the Financial Conduct Authority. Tradeweb builds and operates electronic over-the-counter marketplaces including a Multi-Lateral Trading Facility (MTF) pursuant to the Markets in Financial Instruments Directive (MiFID) that was implemented in the UK in 2007.

1.3 **Overview of the origination of prices**

1.3.1 The UK Debt Management Office announced in January 2015 that it intended to withdraw from its role as the provider of daily end-of-day gilt and Treasury bill reference prices on behalf of the Gilt-edged Market Makers Association (GEMMA) and CREST respectively. In late 2015, an independent review into the successor arrangements for the reference prices was commissioned; Professor David Miles CBE was appointed as the Head of the Independent Reference Prices Review in January 2016.

1.3.2 Following a period of consultation with a wide variety of stakeholders, the Independent Reference Prices Review issued a Request for Proposals (RFP) in July 2016. A number of proposals were received. Tradeweb and FTSE collaborated to provide a joint proposal and were selected as the successor providers of gilt, strips and Treasury bill reference prices: the Tradeweb FTSE Gilt Closing Prices.

1.4 The Guide to the Calculation of the Tradeweb FTSE Gilt Closing Prices can be downloaded using the following link:

Guide_to_the_Calculation_of_Tradeweb_FTSE_Gilt_Closing_Prices.pdf

and a Statement of Principles with respect to the Calculation of the Tradeweb FTSE Gilt Closing Prices is available using the following link:

Statement_of_Principles_for_the_Administration_of_the_Tradeweb_FTSE_Gilt_Closing_Prices.pdf

1.4.1

1.5 **Overview of the index calculations**

Conventional Gilts

The following maturity sectors are calculated for conventional gilts:

Index Code	Index
BG01	FTSE Actuaries UK Conventional Gilts up to 5 Years Index
BG02	FTSE Actuaries UK Conventional Gilts 5-15 Years Index
BG03	FTSE Actuaries UK Conventional Gilts over 15 Years Index
BG05	FTSE Actuaries UK Conventional Gilts All Stocks Index
BG06	FTSE Actuaries UK Conventional Gilts 5-10 Years Index
BG07	FTSE Actuaries UK Conventional Gilts 10-15 Years Index
BG08	FTSE Actuaries UK Conventional Gilts up to 15 Years Index
BG09	FTSE Actuaries UK Conventional Gilts up to 20 Years Index
BG0A	FTSE Actuaries UK Conventional Gilts 15-25 Years Index

BG0B	FTSE Actuaries UK Conventional Gilts over 25 Years Index
BG0C	FTSE Actuaries UK Conventional Gilts over 5 Years Index
BG0D	FTSE Actuaries UK Conventional Gilts over 10 Years Index

In addition fitted yields are calculated for the following terms to maturity:

5, 10, 15, 20, 25, 30, 35, 40, 45, 50 years.

Index-linked Gilts

For index-linked gilts, indexes are calculated for the following sectors:

Index Code	Index
IL01	FTSE Actuaries UK Index-Linked Gilts All Stocks Index
IL02	FTSE Actuaries UK Index-Linked Gilts up to 5 Years Index
IL03	FTSE Actuaries UK Index-Linked Gilts over 5 Years Index
IL04	FTSE Actuaries UK Index-Linked Gilts 5-15 Years Index
IL05	FTSE Actuaries UK Index-Linked Gilts over 15 Years Index
IL06	FTSE Actuaries UK Index-Linked Gilts 15-25 Years Index
IL07	FTSE Actuaries UK Index-Linked Gilts 5-25 Years Index
IL08	FTSE Actuaries UK Index-Linked Gilts over 25 Years Index
IL09	FTSE Actuaries UK Index-Linked Gilts over 10 Years Index
IL10	FTSE Actuaries UK Index-Linked Gilts up to 15 Years Index

The yields for the index-linked sectors are calculated assuming future inflation rates of 0%, 3%, 5% and 10%.

1.6 Additional details for gilts maturity sector descriptions

The following details apply to both conventional and index-linked Gilts.

A maturity sector described in this Guide to Calculations as "up to XX years", is effectively defined and treated as "up to, *but not including,* XX years".

A maturity sector described in this Guide to Calculations as "over XX years", is effectively defined and treated as *"XX years and over"*.

A maturity sector described in this Guide to Calculations as a range of “XX years to YY years”, is effectively defined and treated as *"including XX years and up to, but not including, YY years"*.

These definitions will become important when we consider “shorteners” (covered in section 5) in the context of Gilts with *exactly* XX number of years to maturity. This is also necessary when clarifying FTSE’s treatment of shorteners when they occur on a non-business day (i.e. weekend or holiday).

1.7 Index Settlement Assumption/Dates

The index calculations assume a next business day settlement (T+1),

There are two relevant dates on each day: the “Calculation date”, which is the date, after the close of which, the calculations are done, and the “Settlement date”, which is the date when the deals are settled. Normally the settlement date is the next following working day after the calculation date, e.g. normally Tuesday after a Monday, etc, and Monday after a Friday, but with exceptions at public holidays. The calculation date is used to determine the outstanding term, and the settlement date is used for the calculation of accrued interest, redemption yields etc.

In this Guide “today” is used to mean the current Calculation date, “yesterday” to mean the previous Calculation date, and “tomorrow” to mean the next Calculation date.

1.8 Range of calculations

The main purpose of the indexes is to calculate the total returns and the level of yields in the market for Gilts of different outstanding terms[1]. These indexes are supported by a range of other associated statistics. Different calculations are performed for conventional gilts and for index-linked gilts.

Conventional Gilts

For each of the conventional sector indexes the following analytics are calculated:

Gross (or dirty) price index * ;
Accrued interest;
XD adjustment for the year to date;
Total return price index *;
Number of gilts in the index*;
Gross redemption yield;
Macaulay duration;
Modified duration;
Convexity;
Weight of the sector as a percentage of the total market
Day’s Change*
Month’s Change*
Year’s Change*

In addition, yield indexes are calculated which give the redemption yields for conventional gilts with outstanding terms of 5*, 10*, 15*, 20*, 25, 30, 35, 40, 45, 50 years

Index-linked Gilts

For each of the index-linked sector indexes the following analytics are calculated:

Gross (or dirty) price index *;
Accrued interest;
XD adjustment for the year to date;
Total return price index *;
Number of gilts in the index;
Weight of the sector as a percentage of the total market *
Day’s Change*
Month’s Change*
Year’s Change*

In addition for each sector, based on assumed future annual inflation rates of 0%*, 3%, 5%* and 10% of the UK Retail Price Index, the following information is calculated:

“Real” redemption yield *;
Macaulay duration;
Modified duration;
Convexity;

The “real” redemption yield of index-linked gilt is its calculated gross redemption yield, after grossing up the scheduled future payments at the assumed rate of inflation, and then discounting the resulting value by the same assumed rate of inflation. In other words it produces a return in excess of the

[1] See the paper introducing the indexes by G. M. Dobbie and A. D. Wilkie (Journal of the Institute of Actuaries Volume 105 Part 1 1978).
* These are displayed on a daily basis in the Financial Times.

assumed inflation rate. It will be seen in the calculations, which are described in Section 9, that this return is itself dependent on the assumed inflation rate.

The durations and convexity calculations above are based on the real yield calculations and hence are also dependent on the assumed inflation rate.

1.9 Publication

The indexes are calculated at the end of each business day. Delivery is available through a variety of mechanisms including the Tradeweb Marks file service. Index products are produced by FTSE Russell on a subscription basis. Some information is also published in the *Financial Times* and is available on the FTSE Russell web site www.ftserussell.com.

Section 2

Management Responsibilities

2.0 Management Responsibilities

2.1 **FTSE International Limited (FTSE)**

2.1.1 FTSE is the Administrator of the Tradeweb FTSE Closing Gilts Prices as defined by the IOSCO Principles for Financial Benchmarks published in July 2013.[3]

2.1.2 FTSE is the Administrator of the FTSE Actuaries UK Gilts Series as defined by Regulation of the European Parliament and of the Council on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds and amending Directives 2008/48/EC and 2014/17/EU and Regulation (EU) No 596/2014 (the European Benchmark Regulation).

2.2 **Tradeweb**

2.2.1 Tradeweb is the Calculation Agent of the Tradeweb FTSE Closing Gilts Prices as defined by the IOSCO Principles for Financial Benchmarks published in July 2013.

2.3 **FTSE EMEA Fixed Income Advisory Committee**

2.3.1 The FTSE EMEA Fixed Income Advisory Committee has been established by FTSE Russell.

The Committee provides external oversight of the process by which Tradeweb calculates end-of-day reference prices for all conventional and index-linked gilts and UK Treasury Bills. The Committee may also approve changes to the Ground Rules.

The Terms of Reference of the FTSE EMEA Fixed Income Advisory Committee are set out on the FTSE Russell website and can be accessed using the following link: FTSE_EMEA_Fixed_Income_Indexes_Advisory_Committee.pdf

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[3] The term administrator is used in this document in the same sense as it is defined in Regulation (EU) 2016/1011 of the European Parliament and of the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds (the European Benchmark Regulation).

Section 3

Gilts Included in the Indexes

3.0 Gilts Included in the Indexes

3.1 Types of Gilts

Over the years the British Government has issued a variety of different types of bonds, generally known as *gilts* (for “gilt-edged securities”). These have included conventional gilts with fixed or variable final redemption dates, gilts with two or four payments per annum, annuities, gilts with sinking funds, floating-rate notes and gilts linked to the retail price index.

The indexes and associated statistics contained in the FTSE Actuaries UK Gilts Index Series provide information on both conventional gilts and index-linked gilts.

UK Treasury Bills are not included in the indexes, nevertheless Tradeweb and FTSE Russell are jointly responsible for providing official end-of-day reference prices for these instruments as for conventional and index-linked gilts. Details of the derivation of the reference prices for all gilts and bills are given below.

3.2 Eligible Conventional Gilts

All sterling conventional gilts are potentially included in the conventional price indexes provided that:

- Gilts that are in the UK Debt Management Office’s “rump stock” list are excluded from the index.
- They do not have a variable interest rate, such as floating rate notes and index-linked gilts.
- They are not still in partly-paid form. Gilts have not been issued in partly-paid form for a number of years. (The last gilt to be issued in partly-paid form was 7% Treasury 2001 A, issued in February 1994.) Such gilts are not included since any change in interest rates has a disproportionate effect on their price. They are included in the indexes when they become fully paid, if they are otherwise eligible.
- Some, but not all, conventional gilts are “strippable”. That is each gilt may be broken down by a Gilt-Edged Market Maker (GEMM) into its separate interest and capital cash flows, and each of these cash flows may then be traded separately. In effect the gilt is broken down into a number of zero-coupon gilts.

Example

In July 2015, 8% Treasury 2021, which pays interest semi-annually on 7 June and 7 December, may be stripped into:

12 separate interest payments (payable 7 December 2015, 7 June 2016, …, 7 June 2021), and one capital payment on 7 June 2021.

After a gilt has been stripped, it is possible for a GEMM to re-combine the future cash flows again to make an unstripped gilt. This process is referred to as “reconstitution”.

The stripped components of gilts are not included in the indexes explicitly since the issue sizes of the unstripped original gilts have not been adjusted to allow for the fact that part of the issues have been stripped. This avoids any double counting. In any case, the stripped components are usually too small for there to be a liquid market in them.

Example

In February 2018, 5% Treasury 2018 had the largest amount of any gilt in stripped form, with £72m of nominal stripped, compared with its total amount in issue of £35,237m.

- Gilts issued by the Debt Management Office under their “special repo” arrangements are also not included in the indexes.
- Gilts issued with unusual conditions are not included in the indexes.
- Convertible and conversion gilt are included in the indexes. However, there are currently no such gilts, and the last convertible issue matured in 1997.

3.3 Yield Curve Exclusions

In addition to the above restrictions, the following gilts are excluded from the yield curve calculations:

- Gilts with less than 1 year to their assumed redemption date. This is because, at least in part, a very small change in the price of such gilts can cause the shape of the constructed yield curve to change considerably.

Example

Exclusion of 4% Treasury 2016 from the fitted yield curve

4% Treasury 2016 had a redemption date of 8 November 2016. FTSE announced that the gilt was removed from the calculation of the fitted yield curve, but not the price indexes, after close of business on Monday 7 September 2015 (i.e. with effect from start of trading on Tuesday, 8 September 2015). It was included in the calculation of the fitted yield curve on 7 September 2015.

- Convertible issues with outstanding conversion options, gilts with substantial sinking funds and gilts with special tax status (as defined by the FTSE EMEA Bond Indexes Advisory Committee) are excluded since their redemption yields are different to gilts of similar outstanding term.

Example

Most recently, only 5½% Treasury 2008-12, which had a special tax status, was excluded on these grounds from the calculation of the fitted yield curve. However in the past, 3½% Conversion was excluded, until it became a rump stock, because of its sinking fund.

3.4 Eligible Index-linked Gilts

All index-linked gilts are potentially included in the price indexes provided that:

- .Gilts that are in the UK Debt Management Office's "rump stock" list are excluded from the index.
- They are not convertible index-linked issues with outstanding conversion options. There are currently no index-linked convertible gilts – only one has ever been issued and this matured in 1999.
- Any other index-linked gilts would be excluded from the current indexes if they were to be issued with conditions which were significantly different from those of the existing index-linked gilts, e.g. linked to an index other than the RPI.

3.5 Maturity Sector Indexes

Gilts are grouped together in sectors according to their assumed remaining maturities. Gilts will be included in the relevant maturity sectors, provided they are eligible for inclusion in the "All-stock" indexes and their assumed redemption date meets the criterion for the sector.

The outstanding term of a gilt is from the calculation date to the assumed redemption date.

Example

A gilt moves from the 5 to 10 year sector to the under 5 years sector at the end of the day on which it is exactly 5 years from the calculation date to its assumed redemption date, or if this turns out not to be a business day at the beginning of the next business day.

Examples:

- On 7 September 2015 (a Monday), 3 ¾% Treasury 2020 will be exactly 5 years from its redemption date of 7 September 2020. The gilt will be included in the 5 -10 year and 5 -15 year sector indexes in the calculations for 7 September 2015. Immediately after the initial calculations for that date, it will be removed from the 5 -10 year and 5 -15 year sectors, and will be added to the up to 5 year sector, so that on 8 September 2015 it will appear in the new sector. Thus the change in price between the 7 and 8 September of 3 ¾% Treasury 2020 is reflected in the new sector.
- On 7 December 2013 (a Saturday), 6% Treasury 2028 was exactly 15 years from its redemption date of 7 December 2028. The gilt was included in the 15-25 years and the over 15 years sector indexes on the 6 December 2013 (a Friday). On the 9 December 2013 (a Monday), it was dropped from the 15-25 years and the over 15 years sectors, but added to the 5-15 years, the up to 15 years and the 10-15 years sectors. No indexes are calculated for Saturdays and Sundays.

3.6 Replication

One of the most important factors with any set of indexes is a requirement to make it possible for the indexes to be replicated. In the case of the FTSE Actuaries UK Gilts Index Series this is achieved by:

- Making available detailed guidelines of how the indexes are constructed.
- Producing lists of the constituent gilts together with rules for adding new issues and deleting existing issues.
- Using official end-of-day reference prices for their calculation, and similarly-sourced prices for mid-day valuations. From April 2020 reference prices are produced jointly by Tradeweb and FTSE Russell. Prior to this date reference prices were produced by the UK Debt Management Office (DMO).

Section 5

Price Index

4.0 Price Index

Fundamental to the FTSE Actuaries UK Gilts Index Series and other associated information, is the calculation of the actual gross price indexes and how they allow for changes in their constituent gilts.

Changes in the constituents of the sector indexes can occur for a variety of reasons. The following rules apply to both conventional and index-linked indexes, except where noted.

4.1 **Addition of constituents**

Gilts may be added to a sector as a result of:

- A new issue. Such gilts, unless they are partly paid, are added on the business day following the auction, syndication or placement.

Example

Auction of 1 ½% Treasury 2021

On 25 August 2015 the United Kingdom Debt Management Office announced the auction on a fully paid basis of £3,750 million nominal of 1 ½% Treasury 2021 on Wednesday, 2 September 2015 for settlement on Thursday, 3 September 2015. The auction resulted in the acceptance of bids between £100.185 and £100.215. The gilt was added to the FTSE Actuaries UK Gilts Index Series after close of business on 2 September 2015 (i.e. with effect from start of trading on 3 September 2015). The gilt was included in the indexes with a price of £100.274 (i.e. Wednesday's closing market price).

Example

Auction of 0 1/8% Index-linked Treasury 2026

On 15 July 2015 the United Kingdom Debt Management Office announced the results of the auction of 0 1/8% Index-linked Treasury 2026. It had been allocated at a uniform striking price of £108.121. The gilt was included in the FTSE Actuaries Gilt indexes on Tuesday, 16 July 2015 with a price of £108.307.

Example

Syndicated Offering of 2 ½% Treasury 2065

On 20 October 2015 the United Kingdom Debt Management Office announced the results of the syndicated offering of 2 ½% Treasury 2065. It had been priced at £98.403 and the closing market price for 20 October was £98.87. The announcement stated that the gilt would be issued and settled on 21 October 2015. The gilt was included in the FTSE Actuaries UK Gilts Index Series after the close of business on 20 October (i.e. with effect from the start of trading on 21 October 2015) at an initial price of £98.87 (i.e. the closing market price for 20 October).

- Gilts may also be added as a result of conversion from other gilts.
- Gilts may also be added to sectors as a result of the shortening outstanding term of existing gilt, which was previously in another sector.
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4.2 **Removal of constituents**

Gilts may be removed from the indexes or a sector as follows:

- Conventional and Index-linked gilts are removed from the indexes at the closing price when the settlement date is equal to the redemption date.
- Where the redemption date falls on a non-business date resulting in the settlement date being greater than the redemption date, the gilts are removed from the indexes at the close price on the last business day prior to the redemption date.
- Gilts are removed from the calculation of the fitted yields on the day they reach one year to redemption.

Example

Deletion 4 ¾%Treasury 2015

4 ¾% Treasury 2015 was redeemed on 7 September 2015. The gilt was removed from the FTSE Actuaries UK Gilts Index Series after close of business on Friday 4 September 2015 (i.e. with effect from the start of trading on 7 September 2015). The closing price on 4 September was £100.00.

Example

Deletion of 2 ½% Index-linked Treasury 2013

2½% Index-linked Treasury 2013 was redeemed on 16 August 2013. It was removed from the FTSE Actuaries UK Gilts Index Series after the close of business on Thursday, 15 August 2013 (i.e. with effect from start of trading on 16 August 2013) at its closing price of £276.68.

- If the gilt is added to the UK Debt Management Office's "rump stock" list.
- A gilt has been merged or funged into another gilt. This sometimes occurs when a new tranche of a gilt is issued. Its terms are identical to those of an existing gilt, except that the first interest payment is different. When the new gilt goes ex-dividend the first coupon payment, it becomes identical to the existing gilt. At this stage the two gilts are merged together, i.e. become fungible.

Example

One gilt to be re-opened with a tranche in this way was 8% Treasury 2015 A, which was issued in October 1995.

- A gilt has converted wholly into another gilt. It is removed from the indexes on the conversion date at the closing price on the previous day.

- The gilt now has a life that is too short for the sector. This is referred to as a “shortener”.

Example

A gilt is removed from the 5 -10 year sector after the close of business on the day when it is exactly 5 years to the assumed redemption date, e.g. if the redemption date is 31 March 2024, it will be included in the 5 -10 year sector closing calculations on 31 March 2019, but will be removed from this sector immediately afterwards.

4.3 Alteration to constituents

The amount in issue of a gilt can change from time to time. This can occur as a result of:

- The government buying back in the market some of the gilt, which it has then cancelled.

Example

Cancellation of the UK Debt Management Office’s Holdings

On 10 March 2006 the United Kingdom Debt Management Office (DMO) announced the cancellation of its holdings of £182.7 million nominal of 5½% Treasury Stock 2008-2012 and £317.1 million nominal of 7 ¾% Treasury Stock 2012-2015 to take effect from 13 March 2006. The DMO also announced an amendment to the size criterion for “rump” gilts to include gilts with nominal amounts that have been reduced to less than £850 million. Consequently the above gilts were declared “rump” stocks.

The effect on the FTSE Actuaries UK Gilts Index Series was that, after the close of business on Friday, 10 March 2006 (i.e. with effect from the start of trading on Monday 13 March 2006) the above “rump” stocks were deleted from the indexes. Please note, the above gilts would have remained in the indexes with a reduced nominal if the new outstanding was at least £850 million.

- Conversion or a switch auction into another gilt.

Example

Gilt-edged Conversion

On 5 August 2002 the United Kingdom Debt Management Office announced the result of its conversion offer from 9% Treasury 2008 into 5% Treasury 2008. 87.5% of holders accepted the offer. As a result of the conversion the nominal value of 9% Treasury 2008 decreased from £5,495 million to £686.7 million, and that of 5% Treasury 2008 increased from £3,050 million to £8,971 million. The DMO immediately declared 9% Treasury 2008 to be a “rump” stock, and hence not eligible for the indexes.

The effect on the FTSE Actuaries Gilt Index Series was that after the close of business on Monday, 5 August 2002 (i.e. with effect from the start of trading on 6 August 2002) the nominal amount 5% Treasury 2008 was increased to £8,971 million and 9% Treasury 2008 was deleted.

Example

Index-linked Switch Auction

On 19 July 2001 the United Kingdom Debt Management Office announced the results of a switch auction from 2% Index-linked Treasury 2006 into 2 ½% Index-linked Treasury 2016. As a result of this auction, the amount of nominal outstanding of 2% Index-linked Treasury 2006 decreased by £500 million to £2,000 million and that of 2 ½% Index-linked Treasury 2016 increased by £561 million to £5,526 million.

Both gilts remained in the FTSE Actuaries UK Gilts Index Series and their amounts in issue were adjusted after the close of business on Thursday, 19 July 2001 (i.e. with effect from the start of trading on 20 July 2001).

- The issuance of a new tranche of an existing gilt. New tranches are normally fungible from their issue date, although in the past they only became fungible after the new issue went ex-dividend for the first time.

Example

Increase in nominal of 2% Treasury 2025

The United Kingdom Debt Management Office announced the issue of a further tranche of £3,250 million nominal of 2% Treasury 2025 by auction on a fully-paid uniform price basis on Wednesday, 16 September 2015 and settlement on Thursday, 17 September 2015. The range of bids accepted was from £100.420 to £100.587.

The amount in issue of the gilt was increased from £12,274.874 million to £15,524.874 million after the close of business on 16 September 2015 (i.e. with effect from start of trading on 17 September). The closing price of the gilt on 16 September 2015, at which price the extra tranche was added to the indexes, was £100.500.

- The issue of a smaller amount of an existing gilt (“minitap”), or of very small amounts of all gilts in issue (which is done from time to time for technical reasons).
- Creation of collateral for cash management operations

Example

Creation of collateral for cash management operations

On 15 July 2014 the DMO created and issued an additional £15,000 million (cash) of collateral for use in the DMO's Exchequer cash management operations.

The nominal amounts were adjusted at the close of business on the day the UK Debt Management Office issued the gilts, and the increase in size of individual gilts ranged from £67 million to £509 million. The amounts had been chosen to have a negligible effect on indexes.

4.4 Price Index calculations

In order to ensure that the price index calculations reflect changes to their constituents, they are calculated on a chain-linked basis.

The basic principle used is:

$$Index(t) = Index(t-1) \times \frac{\sum_{i=1}^{n} N_i(t) \times P_i(t)}{\sum_{i=1}^{n} \sum_{i=1}^{n} N_i(t) \times P_i(t-1)}$$

where: $Index(t)$ =Price index on calculation date t;

$N_i(t-1)$ = Adjusted nominal value of gilt i on previous calculation date $t-1$.

$P_i(t)$ = Dirty price of gilt i on calculation date t.

The initial value of the index for each original index was 100, but where a sector has been divided into smaller sectors, the new sectors have started with the index value of the larger sector (e.g. the initial index for the 5-10 year and 10-15 year sectors was derived from the 5-15 year sector).

The basic structure of the index calculations ensures that the constituents of any index and their weights remain constant during the day, but they can change overnight. Throughout this document and in the "Ground Rules", there are references to changes that occur "at or after close of business". These changes do not change today's calculations in any way, but they do change the comparison information in the calculation of tomorrow's indexes, (i.e. they change the composition of the denominator in the above formula).

The calculations make use of the gross prices of the gilts, i.e. their quoted clean middle prices plus or minus the calculated accrued interest to the settlement date. The price index calculation in this way is analogous to the Total Return Index calculations.

The accrued interest calculations are described in Appendix A.

4.4.1 Price Index calculation examples

The following examples show how the methodology works and allows for changes in constituents. In all cases a selection of the following gilt data is used, and the prices include accrued interest:

Gilt	Nominal day 1	Price day 1	Nominal day 2	Price day 2	Nominal day 3	Price day 3
A	100	90	100	91	100	92
B	200	95	200	94	200	95
C	-	-	300	99	300	100
D	250	99	0	-	0	-
E	150	85	50	84	50	85
F	200	93	0	-	0	-

Gilt	Nominal day 1	Price day 1	Nominal day 2	Price day 2	Nominal day 3	Price day 3
G	300	94	500	92	500	94

In the following examples the price index on day 1, $I_s(1) = 120$.

Example

Normal case – no change in constituents or amounts in issue

The index for days 1, 2 and 3 consists of just two gilts A and B, as in the table above.

$$\boldsymbol{Index(day_1) = 120}$$

$$\boldsymbol{Index(day_2) = 120 \times \frac{100 \times 91 + 200 \times 94}{100 \times 90 + 200 \times 95} = 119.571}$$

$$\boldsymbol{Index(day_3) = 119.571 \times \frac{100 \times 92 + 200 \times 95}{100 \times 91 + 200 \times 94} = 120.857}$$

Example

New gilt issued on day 2

The index on day 1 consisted of two gilts A and B (see above). On day 2, a new issue C is added to the eligible gilts. The calculations are now:

$$Index(day_1) = 120$$

$$Index(day_2) = 120 \times \frac{100 \times 91 + 200 \times 94 + 0 \times 99}{100 \times 90 + 200 \times 95 + 0} = 119.571$$

$$Index(day_3) = 119.571 \times \frac{100 \times 92 + 200 \times 95 + 300 \times 100}{100 \times 91 + 200 \times 94 + 300 \times 99} = 120.817$$

Note in this case, the calculations on day 2 are identical to those in the previous example, as it was not possible to hold the new gilt on day 1. The new gilt C is included in the index calculations on day 2.

Example

Gilt is removed from the index

On day 1, the index consisted of three gilts A, B and D (see above). Gilt D is removed from the index on day 2. The calculations are now:

$$Index(day_1) = 120$$

$$Index(day_2) = 120 \times \frac{100 \times 91 + 200 \times 94 + 0}{100 \times 90 + 200 \times 95 + 0 \times 99} = 119.571$$

$$Index(day_3) = 119.571 \times \frac{100 \times 92 + 200 \times 95}{100 \times 91 + 200 \times 94} = 120.857$$

Gilt D does not influence day 2's index calculation, although it did those on day 1. Hence its weight in day 2's calculations must be reduced to 0.

Example

Size of gilt is reduced

On day 1, the index consisted of three gilts A, B and E (see above). On day 2, the size of gilt E was reduced to 50, possibly as the result of a conversion or the exercise of a sinking fund. The index calculations are now:

$$Index(day_1) = 120$$

$$Index(day_2) = 120 \times \frac{100 \times 91 + 200 \times 94 + 50 \times 84}{100 \times 90 + 200 \times 95 + 50 \times 85} = 119.442$$

$$Index(day_3) = 119.442 \times \frac{100 \times 92 + 200 \times 95 + 50 \times 85}{100 \times 91 + 200 \times 94 + 50 \times 84} = 120.744$$

N.B. only the reduced size of gilt E has been included in the indexes.

Example

Two existing gilts become fungible

On day 1, the index consisted of four gilts A, B, F and G (see above). *F* was a new tranche of gilt G, which became fungible with it on day 2, after they both went ex-dividend. On day 2 only the larger gilt G is quoted. The index calculations are now:

$$Index(day_1) = 120$$

$$Index(day_2) = 120 \times \frac{100 \times 91 + 200 \times 94 + 500 \times 92}{100 \times 90 + 200 \times 95 + 300 \times 94} = 118.556$$

$$Index(day_3) = 118.556 \times \frac{100 \times 92 + 200 \times 95 + 500 \times 94}{100 \times 91 + 200 \times 94 + 500 \times 92} = 120.642$$

N.B. on day 2, both gilts F and G are valued at their prices on day 1. They both went ex-dividend by different amounts on day 2, which is allowed for in the XD adjustment calculation.

4.4.2 Price Index calculations for a "Shortener"

As has been already described, indexes are calculated for gilts with specific assumed outstanding term ranges. As a result, over time, it will be necessary to remove gilts from one sector and to put them into a shorter sector. Such gilts are called "shorteners".

The following example describes the effect of a shortener on the calculations of both the longer sector (L) and the shorter sector (S) into which the gilt is placed.

The example uses the following gilt data:

Gilt	Nominal day 1	Price day 1	Nominal day 2	Price day 2	Nominal day 3	Price day 3
A	100	90	100	91	100	92
B	200	95	200	94	200	95
C	300	98	300	99	300	99
D	200	85	200	86	200	87
E	200	96	200	97	200	98

The shorter sector index on day 1, $Index(S, day_1)$ is 110, and the longer sector index $Index(L, day_1)$is 120.

Example

Effect of a "Shortener"

On day 1, $Index(L, day_1)$ consists of gilts A, B and E, and $Index(S, day_1)$ consists of gilts C and D. At the end of day 2, gilt E moves from the longer index band to the shorter one. The effects of this are as follows:

$$Index(S, day_1) = 110$$

$$Index(L, day_1) = 120$$

$$Index(S, day_2) = 110 \times \frac{300 \times 99 + 200 \times 86}{300 \times 98 + 200 \times 85} = 111.185$$

$$Index(L, day_2) = 120 \times \frac{100 \times 91 + 200 \times 94 + 200 \times 97}{100 \times 90 + 200 \times 95 + 200 \times 96} = 120.254$$

$$Index(S, day_3) = 111.185 \times \frac{300 \times 99 + 200 \times 87 + 200 \times 98}{300 \times 99 + 200 \times 86 + 200 \times 97} = 111.856$$

$$Index(L, day_3) = 120.254 \times \frac{100 \times 92 + 200 \times 95}{100 \times 91 + 200 \times 94} = 121.547$$

On Business Days

A gilt starting in an “over XX years” maturity sector will be moved from that maturity sector to the next-shortest maturity sector after the close of business on the day when its term to maturity is exactly equal to the number of years (XX) in that sector (when it is described as a “timeous shortener”). It will be moved at its closing price on that day. The next-shortest maturity sector may be an "up to XX years" sector or an “YY years to XX years” sector.

Another way of saying this is: If a gilt’s *term to maturity* (the exact number of years from the trade date to the gilt’s maturity date) falls on a *business day* (when trading is open), and it is currently a constituent in an “over XX years” maturity sector, it will remain in that sector until after the index’s value is calculated and disseminated for that day. The following day, when the gilt’s term to maturity is now one day shorter, it will become a constituent in the “up to XX years” sector. It may also then become a constituent in an “YY years to XX years” sector, if one exists.

Example

A gilt maturing on 23 August 2026 would be included in the calculation of the value of the "over 5 years" maturity sector on 23 August 2021 (when it had *exactly* 5 years remaining to maturity). After the close of business that day, the gilt would be moved to the "up to 5 years" maturity sector. In other words, it would become a constituent in the shorter maturity sector on the following business day.

A gilt starting in an “YY years to XX years” maturity sector will be moved from that maturity sector to the next-shortest maturity sector after the close of business on the day when its term to maturity is exactly equal to the minimum term (YY years) of that sector (when it is described as a “timeous shortener”). It will be moved at is closing price on that day. The shorter maturity sector may be an "up to XX years" sector or another “YY years to XX years” sector.

Example

A gilt maturing on 23 August 2048 would be included in the calculation of the value of the “15 - 25 years” maturity sector on 23 August 2023 (it had exactly 15 years remaining to maturity). After the close of business on that day, the gilt would be moved to the “up to 15 years” maturity sector. In other words, it would become a constituent in the shorter maturity sector on the following business day.

Example

A gilt maturing on 15 October 2028 would remain a constituent in the “over 5 years” maturity sector, the “5 - 10 years” sector, the “5 - 15 years” sector, the “up to 15 years” sector, the “up to 20 years” sector and the All-Stocks sector up until 15 October 2023.

Exactly on 15 October 2023, the gilt would remain a constituent in those maturity sectors and its values would be included in the closing values for those sectors that were calculated and disseminated to clients as of the close of business on 15 October 2023.

On 16 October 2023, when the gilt now has less than 5 years to maturity, it would be included in the “up to 5 years” sector, the “up to 15 years” sector, the “up to 20 years” sector and the All Stocks sector.

On Non-Business Days

If the gilt's term to maturity (the exact number of years from the trade date to the gilt's maturity date) falls on a *non-business day* (Saturday, Sunday or other market holiday), and it is a constituent in an "over XX years" maturity sector or an "XX years to YY years" maturity sector on the business day preceding the non-business day, it will remain in that sector on that preceding business day (since its term to maturity is over XX years as of that business day) until after the index's value is calculated and disseminated for that day. The following *business* day it will become a constituent in the next-shortest maturity sector, since its term to maturity will now be shorter (when it is described as a "late shortener").

Example

A gilt maturing on 15 October 2028 would remain a constituent in the "over 5 years" maturity sector, the "5 – 10 years" sector, the "5 – 15 years" sector, the "up to 15 years" sector, the "up to 20 years" sector and the All-Stocks sector up until 15 October 2023.

Exactly on 15 October 2023, the gilt would remain a constituent in those maturity sectors and its values would be included in the closing values for those sectors that were calculated and disseminated to clients as of the close of business on 15 October 2023.

Assuming 16 October was a Saturday, on that day the gilt now has less than 5 years to maturity, it would be included in the "up to 5 years" sector, the "up to 15 years" sector, the "up to 20 years" sector and the All Stocks sector beginning Monday, 18 October.

Assuming 15 October was a Saturday, and the gilt was a constituent in an "over XX years" maturity sector or an "XX years to YY years" maturity sector on the business day preceding that Saturday, it will remain in that sector on that preceding business day (since its term to maturity is over XX years as of that business day) until after the index's value is calculated and disseminated for that day. The following *business* day (i.e. Monday, 17 October) it will become a constituent in the next-shortest maturity sector, since its term to maturity will now be shorter than XX years.

4.4.3 Price Index methodology using a divisor

The Ground Rules for the Management of the FTSE Actuaries UK Gilts Index Series, on the other hand, describe the construction of the price indexes in terms of a divisor (see 'Ground Rules for the Management for the FTSE Actuaries UK Gilts Index Series'). With the divisor description, the price index $I_{s,t}$ for sector *s* for today, *t,* is given by:

$$I_s(t) = \frac{\sum_i N_i(t) \times P_i(t)}{Divisor_s(t)}$$

where:

where:	$I_s(t)$	=	today's index value
	$N_i(t)$	=	adjusted nominal value of gilt i today
	$P_i(t)$	=	gross price of gilt i today
	$Divisor_s(t)$	=	calculated divisor for sector s at time t

and where the summation is over all gilts in the sector *s* today, including those gilts yesterday which have been amalgamated with other gilts today.

The divisor in this formula started life as just the market value of the index at the base date divided by 100, (assuming that the index started with a base value of 100). This formulation of the index is easy to understand as long as the constituents of the index do not change in any way, as the index value is just the market value of the constituents now divided by their value at the base date. Unfortunately, whenever there is a change to the constituents, the divisor has to be changed to reflect this. These changes have to allow for constituents being removed from the index (they may have performed differently to that of the index as a whole), the size of constituents changing or new constituents being added. Thus after a while the divisor ceases to have any independent meaning.

The way the divisor changes are calculated is described fully in the Ground Rules (see 'Ground Rules for the Management for the FTSE Actuaries UK Gilts Index Series, Section 11.1.1).

The two methods of describing the construction of the price index: that is in terms of the change over the previous day and that of using a divisor, are equivalent.

Example

Consider an index I which commenced on date 0. This index has not had any changes to its constituents or changes to capital since its base date.

The index is calculated on dates $0, 1, 2, 3......t$.

Using the chain-linked method we get:

$$I(0) = 100$$

$$I(1) = 100 \times \frac{\sum_i N_i(1) \times P_i(1)}{\sum_i N_i(1) \times P_i(0)}$$

$$I(t) = 100 \times \frac{\sum_i N_i(1) \times P_i(1)}{\sum_i N_i(1) \times P_i(0)} \times \frac{\sum_i N_i(2) \times P_i(2)}{\sum_i N_i(2) \times P_i(1)} \times \ldots \times \frac{\sum_i N_i(t) \times P_i(t)}{\sum_i N_i(t) \times P_i(t-1)}$$

$$I(t) = 100 \times \frac{\sum_i N_i(t) \times P_i(t)}{\sum_i N_i(t) \times P_i(0)}$$

With the divisor method, as the constituents, and their weightings, have not changed since the base date, the divisor itself has not changed. It is given by:

$$Divisor(1) = \frac{\sum_i N_i(1) \times P_i(0)}{100}$$

Hence the index at time n is:

$$I(t) = \frac{\sum_i N_i(t) \times P_i(t)}{Divisor(t)} = 100 \times \frac{\sum_i N_i(t) \times P_i(t)}{\sum_i N_i(t) \times P_i(0)}$$

which is the same result as with the chain-linked method.

Section 6

Formulae – Applying to Both Conventional and Index-linked Gilts

5.0 Formulae – Applying to Both Conventional and Index-linked Gilts

5.1 Accrued Interest

All gilts in the indexes accrue interest at a daily rate for the period which would ensure that the total coupon payment would be accrued by the coupon payment date. This is not visible as all gilts go ex-dividend (XD) 7 business days before the coupon payment date. If a gilt is sold for settlement during the XD period, the seller retains the coupon.

The accrued interest calculations for securities are described in Appendix A.

The accrued interest for a sector *s* for day *t*, $AI_{s,t}$ is calculated as:

$$AI_s(t) = \frac{\sum_i N_i(t) \times AI_i(t)}{\sum_i N_i(t) \times P_i(t)} \times I_s(t)$$

where:	$I_s(t)$	=	gross price index of sector *s* at time *t*
	$N_i(t)$	=	nominal outstanding of gilt *i* at time *t*
	$AI_i(t)$	=	accrued interest of gilt *i* at time *t*
	$P_i(t)$	=	gross price of gilt *i* at time *t*

and where the summation is over all gilts in sector *s* at time *t*.

The price index adjustment is to make the calculation comparable with the price index which reflects all the changes in constituents since base date.

Example

Consider a sector which consists of two gilts A and B, which have the following current information:

Gilt	Nominal	Gross price	Accrued interest
A	100	95	2
B	200	90	3

The current price index is 150.

The accrued interest for the sector is then:

$$AccruedInterest(Sector) = \frac{100 \times 2 + 200 \times 3}{100 \times 95 + 200 \times 90} \times 150 = 4.364$$

5.2 **Gross or "Dirty" prices**

Gilts are quoted in the market with clean prices, i.e. at a price which excludes any accrued interest. This means that the price quotation does not have to be modified every day to allow for the daily effect of accrued interest. When a gilt is traded, the transaction is executed at a gross or "dirty" price, i.e. the clean price of the gilt plus/minus any accrued interest to the appropriate settlement date.

The settlement date for a gilt is usually the next business day. Thus normally on a Thursday, the accrued interest is calculated to the following day, the Friday, but on a Friday it is calculated to the following Monday (normally the next business day). In this case, a transaction executed on the Friday would include 3 days more accrued interest than one executed on the previous Thursday (instead of just 1 day more), assuming the gilt had not gone ex-dividend.

Gross prices are used in all the index calculations.

5.3 **XD Adjustment**

The effect of a gilt in an index going ex-dividend (XD) is to reduce the price index of the sector, since if the market quotation of the gilt is unchanged, its gross price will have decreased. Sometimes, as in the case of the Total Return Index, it is desirable to measure the effect of re-investing these coupons. This is achieved by calculating the XD adjustment factor.

The XD adjustment for sector s at time t, $XD_s(t)$ is calculated as:

$$XD_s(t) = \frac{\sum_i N_i(t-1) \times XD_i(t)}{\sum_i N_i(t-1) \times P_i(t-1)} \times I_s(t)$$

where: $I_s(t)$ = gross price index of sector $s$at time $t-1$

$N_i(t-1)$ = nominal outstanding of gilt i at time $(t-1)$

$XD_i(t)$ = quantum interest for gilt $i$that has gone ex-dividend between the last day on which the indexes were calculated, and the opening of today t

$P_i(t-1)$ = gross price of gilt $i$at time t

and where the summation is over all gilts in sector s at time t.

Note that the previous day's values are now used to weight the calculations, as for the ex-dividend to have an effect the gilts must have been held on the previous day.

$XD_i(t)$ for gilt i is 0 if the gilt has not gone ex-dividend between day $t-1$and day t, otherwise it is the percentage coupon payment that has gone XD.

Example

Consider a 5% gilt that goes XD on 4 April of a standard semi-annual coupon payment of 2.5%.

On 3rd April, the XD adjustment $XD_i = 0$

On 4th April, the XD adjustment $XD_i = 2.5$

On 5th April, the XD adjustment $XD_i = 0$

Example

Consider a sector which consists of two gilts A and B. On the previous calculation date A and B had respectively 100 and 200 of nominal in issue and gross prices of 95 and 90. Immediately prior to today gilt A goes XD with a payment of 2.5%, and the price index of the sector on the previous day is 140. The calculation of the XD adjustment for the sector today is:

$$XD\ adjustment(Sector) = \frac{100 \times 2.5 + 200 \times 0}{100 \times 95 + 200 \times 90} \times 140 = 1.273$$

The published figure for sector s for day t is the XD adjustment for the year to date. This figure is just the sum of all the daily figures for the current year up to date t.

5.4 Total Return Index

The Total Return Index for sector s for day t, $R_s(t)$, is calculated from the sector Price Index and XD adjustment by:

$$R_s(t) = R_s(t-1) \times \frac{I_s(t)}{I_s(t) - XD_s(t)}$$

where: $I_s(t)$ = sector s price index for day t

$XD_{s,t}$ = XD adjustment factor for sector s for day t.

As the XD adjustment factor for a sector is zero whenever there are no coupon payments on the day in the sector. Hence the percentage movement in the total return index is identical to that of the gross price index whenever there are no coupon payments in the sector.

Example

If 3 weeks ago the price index of a sector was 110 and its total return index was 140, and its price index is now 120, then provided there have been no gilts in the sector which have gone ex-dividend in the intervening period, the current total return index is:

$$140 \times \frac{120}{110} = 152.727$$

5.5 Number of securities

The number of securities is just the number of different securities today in the index sector.

5.6 **Sector weight**

The weight of a sector s is just its market value today $M_s(t)$divided by the market value of All-stocks sector. $M_A(t)$ That is:

$$M_s(t) = \sum_{i \in s} N_i(t) \times P_i(t)$$

$$M_A(t) = \sum_{i \in A} N_i(t) \times P_i(t)$$

where: $N_i(t)$ = nominal outstanding of gilt i at time t

$P_i(t)$ = gross price of gilt i at time t

and where the summations are over all gilts in sector s and the combined sector A respectively at time$t$.

Then:

$$W_s(t) = 100 \times \frac{M_s(t)}{M_A(t)}$$

where $W_s(t)$ is the percentage weight of sector s today.

Example

Assuming the All-stocks sector consists of two sectors *X* and *Y*. Both sectors consist of two gilts A and B, and C and D respectively. At the calculation date the gilts have the following data:

Sector	Gilt	Nominal outstanding	Clean price	Accrued interest
X	A	100	90	2
X	B	300	95	1
Y	C	200	80	0
Y	D	400	85	4

The market values M_X, M_Y of sectors *X* and *Y* are:

$$M_X = 100 \times (90 + 2) + 300 \times (95 + 1) = 38{,}000$$

$$M_Y = 200 \times (80 + 0) + 400 \times (85 + 4) = 51{,}600$$

Hence:

$$W_X = \frac{38{,}000}{38{,}000 + 51{,}600} \times 100 = 42.41\%$$

$$W_Y = \frac{51{,}600}{38{,}000 + 51{,}600} \times 100 = 57.59\%$$

where W_X and W_Y are the weights of the two sectors.

Section 7

Formulae – Applying to Conventional Gilts Only

6.0 Formulae – Applying to Conventional Gilts Only

6.1 Gross Redemption Yield

As all the gilts included in both the conventional and the index-linked indexes pay coupons twice a year, it is normal in the market place to quote redemption yields which are compounded on a six-monthly basis. This convention is adopted here.

The redemption yield of a conventional gilt with 2 semi-annual coupon payments, compounded annually can be determined from the following formula:

$$P = \sum_{t=1}^{T} \frac{CF_t}{\left(1+\frac{y}{2}\right)^{n_t}} = \sum_{t=1}^{T} CF_t \times v^{n_t}$$

where:

where:	P	=	gross price (i.e. clean price plus/minus accrued interest)
	T	=	number of future cash flows, i.e. future coupon payments and the final redemption amount
	CF_t	=	t^{th} cash flow, i.e. interest and capital payments
	n_t	=	time in periods (i.e. six-monthly coupon periods) to the t^{th} cash flow
	y	=	required redemption yield
	v	=	one-period discounting factor, i.e. $v = \frac{1}{1+\frac{y}{2}}$

This formula is used for gilts with more than one coupon payment remaining. The redemption yield for index-linked gilts is calculated in a similar way but with the following differences:

- In determining the standard equation, future cash flows may be grossed up by the assumed inflation rate;
- The resulting calculated discount factor has to be netted down by the assumed rate of inflation.

The discounting period n_t used for each cash flow CF_t is the number of interest periods and fraction of periods to the relevant payment date.

In the above equation, all the cash flows CF_t, other than the first one in the case of new issues and the last one, are normally equal to half the annual coupon of the security, as the gilts pay interest twice a year. The last cash flow is normally equal to the redemption amount plus half the annual coupon.

Example

If it is 7 August 2026 and a cash flow payment of 8 is due on 7 September 2027, then it is discounted for two and a bit periods in the calculations – a fractional period from 7 August 2026 to 7 September 2026, a whole period from 7 September 2011 to 7 March 2012 and another whole period from 7 March 2027 to 7 September 2027. The fractional period has a value 31/184 as there are 31 and 184 days from 7 August 2026 to 7 September 2026 and 7 March 2026 to 7 September 2026 respectively.

This cash flow will thus have a contribution of $8 \times v^{2.168}$ to the right hand side of yield equation, $\frac{31}{184} = 0.168$.

Example

Consider an 8% gilt which pays coupons semi-annually, which is priced at 104.284 on its coupon date 18 months before its redemption.

A holder of this gilt until redemption will receive the following interest and capital payments:

4 in 6 months' time (1 period n_t)

4 in 12 months time

104 in 18 months time (coupon plus the capital repayment).

To calculate the redemption yield y for this gilt, it is necessary to solve the equation:

$$102.284 = 4 \times v + 4 \times v^2 + 104 \times v^3$$

where: $y = 2 \times \frac{1}{v-1}$

This gives $v = 0.9756$ and $y = 0.05 = 5\%$

The gross redemption yield for a sector is calculated by discounting all the cash flows from the gilts in the sector at the same rate, i.e. it performs the redemption yield calculation as if the sector were just a single gilt. No distinction is made between cash flows emanating from different gilts.

Example

Consider a sector which consists of just two gilts. Gilt A has a 6% coupon and pays interest on 7 March and 7 September each year until it is redeemed on 7 September 2021. Gilt B has a 4% coupon and pays interest on 7 June and 7 December until it is redeemed on 7 December 2018. On 7 June 2015 gilt A has outstanding £200m of nominal value and a gross price, including accrued interest, of 105, whereas gilt B £100m outstanding and a gross price of 95.

Extending the formula given above, the following has to be solved to calculate the sector redemption yield:

$$\begin{aligned} 200 \times 105 + 100 \times 95 \\ &= 200 \times v^{0.5} \times (3 + 3 \times v + 3 \times v^2 + \cdots + 3 \times v^{13} + 100 \times v^{13}) + 100 \times (2 \times v + 2 \times v^2 \\ &+ \cdots + 2 \times v^7 + 100 \times v^7) \end{aligned}$$

where v is the one-period discount factor, i.e. $v = \frac{1}{1+\frac{y}{2}}$, and y is the required sector redemption yield.

However, when reporting yield, duration and convexity figures for individual gilts, FTSE follows market convention and uses different formulae for bonds in their final coupon period. A gilt enters the final coupon payment period only after the interest date has passed, at which point the yield, duration and convexity calculations switch to using simple interest.

The definition of simple interest during the last coupon payment of a gilt is as follows:

$$SimpleInterest_{annualised} = \frac{(\frac{FinalPayment}{DirtyPrice} - 1)}{YearstoMaturity}$$

Equivalently, the price of a bond as a function of simple interest during the last payment period is given by:

$$P = \frac{CF_T}{(1 + r \times f)}$$

where: P = gross price (i.e. clean price plus/minus accrued interest)

r = annualised simple interest rate

CF_T = final cash flow (coupon and principal)

f = fraction of a year to maturity

6.2 **Macaulay duration**

The Macaulay duration of a bond and hence by extension that of a sector, is just the time weighted average life of the future cash flows, expressed in years. It measures how long, on average, the will need to hold the gilt until the present value of the gilt equals the cash flows. The Macaulay duration is sometimes just referred to as the duration.

The duration D_{Mac} of a bond is derived by solving an equation of the form:

$$D_{Mac} = \frac{\frac{1}{P}\sum_{t=1}^{T} \frac{n_t \times CF_t}{\left(1 + \frac{y}{2}\right)^{n_t}}}{frequency} = \frac{\sum_{t=1}^{T} \frac{CF_t \times v^{n_t} \times n_t}{CF_t \times v^{n_t}}}{frequency}$$

where: D_{Mac} = Macaulay duration in years

P = gross price

T = number of future cash flows, i.e. future coupon payments and the final redemption amount

CF_t = t^{th} cash flow, i.e. interest and capital payments

n_t = time in periods (i.e. six-monthly coupon periods) to the t^{th} cash flow

$frequency$ = number of payments per year, i.e. 2 for gilts. This is required as the duration is normally expressed in years.

v = one-period discounting factor, i.e. $v = \frac{1}{1+\frac{y}{2}}$

y = redemption yield of the security or sector.

Example

Consider a sector that has a gross redemption yield y, and an associated discounting factor v, where $v = \frac{1}{1+\frac{y}{2}}$. It has anticipated future cash flows of 100, 200 and 300 in 1, 2 and 3 six-monthly periods respectively, then the duration D_{Mac} of the sector is:

$$D_{Mac} = \frac{\frac{100 \times v + 200 \times v^2 + 300 \times v^3}{100 + 200 + 300}}{2}$$

Example

Using, as an example, the same gilt as that used in the redemption yield calculation, i.e. an 8% gilt yielding 5% with exactly 18 months to go to redemption. As $v = 0.9756$ and $y = 0.05$, the duration D_{Mac} is given by:

$$D_{Mac} = \frac{\frac{4 \times 0.9756 \times 1 + 4 \times 0.9756^2 \times 2 + 104 \times 0.9756^3}{4 \times 0.9756 + 4 \times 0.9756^2 + 104 \times 0.9756^3}}{2} = 1.44\ years$$

When calculating the Macaulay duration of an individual bond in the final payment period, the following formula is used:

$$D_{Mac} = f$$

where f is the fraction of a year to maturity.

6.3 Modified duration

The modified duration of a bond or index measures how sensitive the yield is to a change in price and vice versa. It is defined as the percentage change in price for a unit change in yield. Hence, modified duration is a measure of volatility.

The modified duration D_{Mod} for a bond is approximately given by:

$$D_{Mod} = -\frac{dP}{dy} \times \frac{1}{P}$$

where: P = gross price

dP = small change in price

dy = corresponding small change in yield.

For a gilt paying semi-annual coupons, modified duration is:

$$D_{Mod} = \frac{D_{Mac}}{(1 + \frac{y}{2})} = D_{Mac} \times v$$

where: D_{Mac} = Macaulay duration of the bond or sector

v = one-period discounting factor, i.e. $v = \frac{1}{1+\frac{y}{2}}$

y = gross redemption yield of the bond or sector.

Whenever an index has a positive yield, the modified duration will be less than the Macaulay duration.

Example

If an index has a gross redemption yield of 4.5% and a Macaulay duration of 3 years, then it will have a modified duration of:

$$3 \times v = \frac{3}{(1+\frac{0.045}{2})} = 2.934$$

Example

If a gilt yielding 5% p.a. compounded semi-annually has a Macaulay duration of 1.44, then its modified duration D_{Mod} is given by:

$$D_{Mod} = \frac{1.44}{(1+\frac{0.05}{2})} = 1.405$$

The modified duration D_{Mod} for a bond in the final period is:

$$D_{Mod} = \frac{f}{(1 + r \times f)}$$

where: r = annualised single interest rate

f = fraction of a year to maturity

6.4 Convexity

The relationship between price and redemption yield is not linear, but curved. In a similar way to modified duration, which measures the slope of this relationship, convexity measures the degree of curvature: it is related to the second derivative $\frac{d^2P}{dy^2}$. The formula below is for Macaulay Convexity with semi-annual coupon payments:

$$C_{Mac} = \frac{\frac{1}{P}\sum_{t=1}^{T} \frac{{n_t}^2 \times CF_t}{\left(1+\frac{y}{2}\right)^{n_t}}}{frequency^2} = \frac{\frac{\sum_{t=1}^{T} CF_t \times v^{n_t} \times {n_t}^2}{\sum_{t=1}^{T} CF_t \times v^{n_t}}}{frequency^2}$$

where:

C_{Mac}	=	Macaulay Convexity
P	=	gross price
T	=	number of future cash flows, i.e. future coupon payments and the final redemption amount
CF_t	=	t^{th} cash flow, i.e. interest and capital payments
n_t	=	time in periods (i.e. six-monthly coupon periods) to the t^{th} cash flow
$frequency$	=	number of payments per year, i.e. 2. This is required if the convexity is to be expressed in years.
v	=	one-period discounting factor, i.e. $v = \frac{1}{1+\frac{y}{2}}$
y	=	redemption yield of the security or sector.

Example

Using, as an example, the same gilt as that used in the redemption yield calculation, i.e. an 8% gilt yielding 5% with exactly 18 months to go to redemption.

As $y = 0.05$, and $v = 0.9756$, the convexity C_{Mac} is given by:

$$C_{Mac} = \frac{\frac{4 \times 0.9756 \times 1 + 4 \times 0.9756^2 \times 2^2 + 104 \times 0.9756^3 \times 3^2}{4 \times 0.9756 + 4 \times 0.9756^2 + 104 \times 0.9756^3}}{4} = 2.130$$

The formula for Macaulay Convexity for a bond with a single remaining coupon payment is:

$$C_{Mac} = f^2$$

Where f is the fraction of a year to maturity or the Macaulay Duration of the gilt.

6.5 Fitted Yields for Conventional Gilts

Fitted yields give the theoretical yields for conventional gilts with outstanding terms of exactly 5, 10, 15, 20 and 25 years. A fitted yield is also calculated for undated securities.

This is achieved by calculating for all the acceptable dated conventional gilts, including the undated (irredeemable) issues but excluding all gilts with less than a year to maturity, the best fit curve of their gross redemption yields against their outstanding terms. The form of the yield curve, which allows for two changes of direction, is:

$$y(m) = b_0 + b_1 \times e^{-b_2 m} + b_3 \times e^{-b_4 m}$$

where b_0, b_1, b_2, b_3, b_4 are parameters derived by minimising the weighted sum of the price differences:

$$S(b_0, b_1, b_2, b_3, b_4) = \sum_k N_k \times \left(P_k - \widehat{P_k}\right)^2$$

where:

N_k	=	amount in issue of the gilt k
P_k	=	gross price of the gilt k
$\widehat{P_k}$	=	the gross price for the gilt k derived from the zero coupon yields $z(t)$

The zero coupon yields $z(t)$ are modelled with the following function:

$$z(t) = b_0 + \sum_{i=1}^{4} b_i \times \frac{(1 - e^{-c_i \times t})}{c_i \times t}$$

where:	c	=	(c_1, c_2, c_3, c_4) are constant fixed at $(0.04, 0.12, 0.20, 0.28)$
	t	=	is the time to maturity of the gilt

All the acceptable dated gilts in the price indexes which have an outstanding term of at least one year are included in the calculation of the fitted yields.

Fitted yields are published for terms of 5, 10, 15, 20, 25, 30, 35, 40, 45 and 50 years.

Section 8

Formulae – Applying to Index-linked Gilts Only

7.0 Formulae – Applying to Index-linked Gilts Only

7.1 Coupon and redemption amount calculations

Both coupon and redemption payments for all index-linked gilts currently in issue are linked to the UK retail prices index (RPI). Indexation for gilts issued prior to 22 September 2005 is based on an 8-month lag. New gilts issued on or after that date are based on a 3-month lag. Examples in the next section are based on 8-month lag. Examples for gilts with 3-month lag can be found in Section 9.

Example

Consider an index-linked gilt which is issued on 24 January 2020 with a 1% coupon, payable semi-annually, and which will be redeemed 10 years after issue on 24 January 2030 at par indexed by the RPI. If the RPI for May 2019 (i.e. 8 months prior to the issue date of January2020) is290, and the RPI values are as in the table below, the payments will be as shown.

	Payment Date	RPI Date	RPI Value	Payment
Interest	24-07-20	Nov-19	291	0.5 x 291/290 = 0.502
Interest	24-01-21	May-20	292	0.5 x 292/290 = 0.503
Interest	24-07-21	Nov-20	293	0.5 x 293/290 = 0.505
Interest	24-01-30	May-30	370	0.5 x 370/290 = 0.638
Capital	24-01-30	May-30	370	100 x 370/290 = 127.586

As has been mentioned before, the calculations are based on assumptions that in future the UK Retail Prices Index will rise by 0%, 3%, 5% and 10% per annum. However, if we are looking at a cash flow which is to be paid in one year's time, and we are assuming a future inflation rate of 10% p.a., this does not mean that this value will be 10% more than its value today because of the index lagging.

Example

In August 2018, for illustrative purposes assume that the recent RPI values have been:

Nov 2018	284.6
Dec 2018	285.6
Jan 2019	283.0
Feb 2019	285.0
Mar 2019	285.1
Apr 2019	288.2
May 2019	289.2
Jun 2019	289.6
Jul 2019	289.5
Aug 2019	291.7

Any payment due in September 2019, irrespective of whether it is an interest or capital payment, will be based on the January 2019 RPI, those due in October 2019 on the February 2019 RPI etc. Irrespective of what assumptions are assumed about future inflation rates, these payments are unchanged.

If an annual inflation rate of 10% is assumed, then the inflation for each future month is assumed to increase by the ratio r, where r is given by:

$$r = \left(1 + \frac{10}{100}\right)^{\frac{1}{12}} = 1.00797$$

Example

Using the above example, with 10% inflation the assumed future RPI figures are:

Sep 2019 $291.7 \times 1.00797^1 = 294.0$

Oct 2019 $291.7 \times 1.00797^2 = 296.4$

Nov 2019 $291.7 \times 1.00797^3 = 298.7$

Dec 2019 $291.7 \times 1.00797^4 = 301.1$

Jan 2019 $291.7 \times 1.00797^5 = 303.5$ etc.

Example

Again using the above example RPI, if a gilt which is issued with a 4% coupon, based on a base RPI of 198.0, pays standard six monthly interest payments in January and July, then the payments will be:

Jul2019 $2 \times \frac{Nov\ 18\ RPI}{198} = 2 \times \frac{284.6}{198} = 2.875\%$

Jan 2020 $2 \times \frac{May\ 19\ RPI}{198} = 2 \times \frac{289.2}{198} = 2.921\%$

July 2020 $2 \times \frac{Nov\ 19\ RPI}{198} = 2 \times \frac{291.7}{198} = 2.946\%$ assuming no future inflation

July 2021 $2 \times \frac{Est.Nov\ 20\ RPI}{198} = 2 \times \frac{315.8}{198} = 3.190\%$ assuming future inflation of 10%

7.2 Real redemption yield calculations

Real redemption yields for index-linked gilts are calculated in a similar way to those for conventional gilts, although there are two differences:

- In solving the standard equation, future cash flows may be grossed up by the assumed inflation rate as described in the previous section;
- The resulting calculated discount factor has to be netted down by the assumed rate of inflation.

The real redemption yield for index-linked gilts is derived by solving an equation of the form:

$$P = \sum_{i=1}^{T} CF_i \times v^{L_i}$$

where: P = gross price (i.e. clean price plus/minus accrued interest)

T = number of future cash flows, i.e. future coupon payments and the final redemption amount

CF_i = i^{th} cash flow, i.e. interest and capital payments, grossed up by the assumed future inflation rate as described in the previous section

L_i = time in periods (i.e. six-monthly coupon periods) to the i^{th} cash flow

v = one-period discounting factor with the future cash flows grossed up by the assumed inflation rate if necessary, i.e. $v = \frac{1}{((1+\frac{y}{2})\times r^6)}$

y = required real redemption yield

r = monthly inflation ratio, i.e. $r = (1 + j)^{\frac{1}{12}}$

j = assumed annual inflation rate, e.g. $j = 0.05$ for 5% inflation

Solving this equation gives a real redemption yield which has been compounded semi-annually.

In the above equation, the first cash flow amount CF_1 is known as it is based on an already known RPI.

Example

On 19 January 2016, consider an index-linked gilt with a coupon of 4%, payable semi-annually, based on a base RPI of 180, which will be redeemed in 18 months' time on 19 July 2017. The gilt will make interest payments on 19 July 2016, 19 January 2017 and 19 July 2017. The next interest payment will be based on the known RPI of 240.0 for November 2015 (i.e. 8 months before July 2016).

The latest published monthly RPI of 241.0 is for December 2015.

The scheduled cash flows for the gilt based on assumed future inflation rates of 0%, 5% and 10% are:

Assumed inflation rate	**0%**	**5%**	**10%**
Interest in 6 months	C	C	C
Interest in 12 months	A	$A \times r^5$	$A \times s^5$
Interest in 18 months	A	$A \times r^{11}$	$A \times s^{11}$
Capital in 18 months	B	$B \times r^{11}$	$B \times s^{11}$

where:

$$C = 2 \times \frac{240}{180} = 2.667\% A = 2 \times \frac{241}{180} = 2.678\%$$

$$B = 100 \times \frac{241}{180} = 133.889\%$$

$$r = (1 + 0.05)^{\frac{1}{12}}$$

$$s = (1 + 0.05)^{\frac{1}{12}}$$

The discount rates v_0, v_5 and v_{10} for assumed inflation rates of 0%, 5% and 10% respectively are calculated by solving the following equations:

$$P = C \times v_0 + A \times v_0^2 + (A + B) \times v_0^3$$
$$P = C \times v_5 + A \times r^5 \times v_5^2 + (A + B) \times r^{11} \times v_5^3$$
$$P = C \times v_{10} + A \times s^5 \times v_{10}^2 + (A + B) \times s^{11} \times v_{10}^3$$

where: $v_i = \frac{1}{((1+\frac{y_i}{2}) \times r^6)}$

and y_i is the real redemption yield at the relevant assumed inflation rate.

Real redemption yields for index-linked sectors are calculated, in a similar way to that for conventional sectors, from the projected combined future cash flows of the gilts in the sector in the same way as for a single security.

7.3 Other calculations

Macaulay Duration, Modified Duration and Convexity for index-linked gilts are calculated in the same way as for conventional gilts, but these calculations now use the one-period discounting factor $v = \frac{1}{((1+\frac{y}{2}) \times r^6)}$ from the calculation of the real redemption yield.

It is important to realize that the discounting factor v is NOT $\frac{1}{1+\frac{y}{2}}$ where y is the real yield.

The relationship between Macaulay's duration MD and modified duration D is still:

$$MD = D \times v$$

Section 9

Calculations for Index-linked Gilts with a 3-month lag

8.0 Calculations for Index-linked Gilts with a 3-month lag

8.1 Indexation methodology

The indexation methodology for the Index-linked gilts with a 3-month lag is as follows:

$$IndexRatio_{Date} = \frac{RefRPI_{Date}}{RefRPI_{FirstIssueDate}} \text{ (Rounded to 5 decimal places)}$$

Where $IndexRatio_{Date}$ refers to the Index Ratio for a given date

And $RefRPI_{Date} = RefRPI_M + (\frac{t-1}{D}) \times (RefRPI_{M+1} - RefRPI_M)$

Where

D = Number of days in calendar month in which the given date falls.

t = Calendar days corresponding to the given date.

RPI_M = Reference RPI for the first day of the calendar month in which the given date falls.

$RefRPI_{M+1}$= Reference RPI for the first day of the calendar month immediately following the given date.

$$RefRPI_{FirstIssueDate} = RefRPI_M + (\frac{t-1}{D}) \times (RefRPI_{M+1} - RefRPI_M)$$

This is similar to the $RefRPI\ Date$ Date formula except ‘M’ denotes the calendar month of the issue date.

The worked example below is based on a hypothetical 4% coupon gilt issued on the 26 January 2014 with a maturity date of 26 January 2024. Interest is payable semi-annually in January and July.

8.2 Calculating Coupon Payments

$$CouponPayment_{SemiAnnual} = \frac{C}{2} \times IndexRatio_{DivPaymentDate}$$ (Rounded to 6 decimal places)

Where:

$C = Annual\ Coupon\ Amount$

$IndexRatio_{DivPaymentDate} = \frac{RefRPI_{DivPaymentDate}}{RefRPI_{FirstIssueDate}}$

8.2.1 Calculating the Reference RPI for the Coupon Payment Date

$$RefRPI_{DivPaymentDate} = RefRPI_M + \left(\frac{t-1}{D}\right)[RefRPI_{M+1} - RefRPI_M]$$

Where:

D = Number of days in calendar month in which the coupon payment date falls.

t = Calendar days corresponding to the given date.

RPI_M = Reference RPI for the first day of the calendar month in which the given date falls.

$RefRPI_{M+1}$ = Reference RPI for the first day of the calendar month immediately following the given date.

Example

Assuming the RPI values for April 2019 and May 2019 are 288.2 and289.2 respectively, the reference RPI for 26 July 2014 is calculated as follows:

$$\begin{aligned} RefRPI_{26Jul2014} &= RefRPI_{1Jul2014} + \frac{26-1}{31}\left[RefRPI_{1Aug2014} - RefRPI_{1Jul2014}\right] \\ &= RPI_{Apr2014} + \frac{25}{31} \times \left[RPI_{May2014} - RPI_{Apr2014}\right] \\ &= 288.2 + \frac{25}{31} \times [289.2 - 288.2] \\ &= 289.00645 \end{aligned}$$

(Rounded to 5 decimal places)

8.2.2 Calculating the Reference RPI for the First Issue Date

$$RefRPI_{FirstIssueDate} = RefRPI_M + \left(\frac{t-1}{D}\right)[RefRPI_{M+1} - RefRPI_M]$$

Where:

D = Number of days in calendar month in which the issue date falls.

t = Calendar days corresponding to the given date.

RPI_M = Reference RPI for the first day of the calendar month in which the issue date falls.

$RefRPI_{M+1}$= Reference RPI for the first day of the calendar month immediately following the issue date.

Example

Assuming the RPI value of 290.4 for October 2019 and 291.0 for November2019, the reference RPI for 26 January 2020 (i.e. first issue date) is calculated as follows:

$$RefRPI_{26Jan2014} = RefRPI_{1Jan2014} + \frac{26-1}{31} \times \left[RefRPI_{1Feb2014} - RefRPI_{1Jan2014}\right]$$
$$= RPI_{Oct2013} + \frac{25}{31} \times [RPI_{Nov2013} - RPI_{Oct2013}]$$
$$= 290.4 + \frac{25}{31} \times [291.0 - 290.4]$$
$$= 290.88387$$

(Rounded to 5 decimal places)

8.2.3 Calculating the Index Ratio Coupon Payment Date

Recall $IndexRatio_{DivPaymentDate} = \frac{RefRPI_{DivPaymentDate}}{RefRPI_{FirstIssueDate}}$

Example

$IndexRatio_{DivPaymentDate} = \frac{203.40323}{202.40323} = 1.00494$ (Rounded to 5 decimal places)

8.2.4 Calculating the Coupon Payment Amount

Recall; $CouponPayment_{SemiAnnual} = \frac{AnnualCoupon}{2} \times IndexRatio_{DivPaymentDate}$

Example

$CouponPayment_{SemiAnnual} = \frac{4}{2} \times 1.00494 = £2.009880$ (Rounded to 6 decimal places)

8.2.5 Calculating the Redemption Payment

$$RedemptionPayment = 100 \times IndexRatio_{RedemptionDate}$$
$$IndexRatio_{RedemptionDate} = \frac{RefRPI_{RedemptionDate}}{RefRPI_{FirstIssueDate}}$$
$$RefRPI_{RedemptionDate} = RefRPI_{M} + [RefRPI_{M+1} - RefRPI_{M}]$$

Where:

D = Number of days in calendar month in which the redemption date falls.

t = Calendar days corresponding to the given date.

RPI_M = Reference RPI for the first day of the calendar month in which the redemption date falls.

$RefRPI_{M+1}$ = Reference RPI for the first day of the calendar month immediately following the redemption date.

Example

Assuming the RPI value of 280.0 for October 2023 and 280.5 for November 2023, the reference RPI for 26th January 2024 (i.e. redemption date) is calculated as follows:

$$
\begin{aligned}
RefRPI_{26Jan2024} &= RefRPI_{1Jan2024} + \frac{26-1}{31} \times [RefRPI_{1Feb2024} - RefRPI_{1Jan2024} \\
&= RPI_{Oct2023} + \frac{25}{31} \times [RPI_{Nov2023} - RPI_{Oct2023}] \\
&= 280.0 + \frac{25}{31} \times [280.5 - 280.0] \\
&= 280.40323
\end{aligned}
$$

(Rounded to 5 decimal places)
The $RefRPI_{FirstIssueDate}$ calculated as in previous examples, gives a value of 202.40323, hence

$IndexRatio_{RedemptionDate} = \frac{280.40323}{202.40323} = 1.38537$ (Rounded to 5 decimal places)

$RedemptionPayment = 100 \times 1.38537 = £138.537000$ (Rounded to 6 decimal places)

8.3 **Cashflows based on various inflation assumptions**

As has been mentioned before, yield, duration, modified duration and convexity calculations are based on assumptions that in future the UK Retail Prices Index will rise by 0%, 3%, 5% and 10% per annum. However, if we are looking at a cash flow which is to be paid in one year’s time, and we are assuming a future inflation rate of 10% p.a., this does not mean that this value will be 10% more than its value today because of the index lagging.

Example

In August 2014, for illustrative purposes assume that the recent RPI values have been:

Nov 2018	284.6
Dec 2018	285.6
Jan 2019	283.0
Feb 2019	285.0
Mar 2019	285.1
Apr 2019	288.2
May 2019	289.2
Jun 2019	289.6
Jul 2019	289.5
Aug 2019	291.7
Sep 2019	291.0
Oct 2019	290.4
Nov 2019	291.0

Any payment due in January2020, irrespective of whether it is an interest or capital payment, will be based on the RPI values for October 2019 and November 2019 since the Ref RPI for January is based on the RPIs for those months. Irrespective of what assumptions are assumed about future inflation rates, these payments are unchanged.

If an annual inflation rate of 10% is assumed, then the inflation for each future month is assumed to increase by the ratio r, where r is given by:

$$r = \left(1 + \frac{10}{100}\right)^{12} = 1.00797$$

Example

Using the above example, with 10% inflation the assumed future RPI figures are:

Sep 2019 $291.7 \times 100797^1 = 294.0$

Oct 2019 $291.7 \times 100797^2 = 296.4$

Nov 2019 $291.7 \times 100797^3 = 298.7$ etc.

Example

Again using the above example RPI, if a gilt which is issued with a 4% real coupon, then the payment on 26 January 2015 will be:

$$RefRPI_{DivPaymentDate} = RPI_{Oct2014} + \frac{25}{31} \times [RPI_{Nov2014} - RPI_{Oct2014}]$$

$$= 208.3 + \frac{25}{31} \times [209.09 - 208.3]$$

$$= 209.59032$$(Rounded to 5 decimal places)

The Ref RPI was calculated in previous example as 202.40323.

$$IndexRatio_{DivPaymentDate} = \frac{209.59032}{202.40323} = 1.03551$$

(Rounded to 5 decimal places)

$$CouponPayment_{SemiAnnual} = \frac{4}{2} \times 1.03551 = £2.071020$$

(Rounded to 6 decimal places).

Assuming no future inflation, an RPI value of 205.0 will be used for both October 2014 and November 2014. The calculation is shown below.

$$RefRPI_{DivPaymentDate} = 205.0 + \frac{25}{31} \times [205.0 - 205.0]$$

$$= 205.0 IndexRatio_{DivPaymentDate} = \frac{205.00000}{202.40323} = 1.01283$$

(Rounded to 5 decimal places)

$$CouponPayment_{SemiAnnual} = \frac{4}{2} \times 1.01283 = £2.025660$$ (Rounded to 6 decimal places)

8.4 Accrued Interest calculations

Interest accrued on an actual/actual basis and is calculated to the settlement date.

$$AccruedInterest = \frac{t}{s} \times \frac{C}{2} \times IndexRatio_{SettlementDate}$$

Where:

t is the number of calendar days from the previous quasi-coupon date to the settlement date

s is the number of calendar days in the quasi-coupon period

C is the annual coupon.

$IndexRatio_{SettlementDate} = \frac{RefRPI_{SettlementDate}}{RefRPI_{FirstIssueDate}}$

And $RefRPI_{SettlementDate} = RefRPI_M + \left(\frac{t'-1}{D}\right) \times [RefRPI_{M+1} - RefRPI_M]$

Where:

D = Number of days in calendar month in which the settlement date falls.

t' = Calendar days corresponding to the given date.

RPI_M = Reference RPI for the first day of the calendar month in which the settlement date falls.

$RefRPI_{M+1}$ = Reference RPI for the first day of the calendar month immediately following the settlement date.

Example

Assuming settlement date of 24th June 2014 and RPI of 201.5 for March 2014 and 203.0 for April 2014. Issue date of 26th January 2014

$$\begin{aligned} RefRPI_{SettlementDate} &= RPI_{Mar2014} + \frac{23}{30} \times \left[RPI_{Apr2014} - RPI_{Mar2014}\right] \\ &= 201.5 + \frac{23}{30} \times \left[RPI_{Apr2014} - RPI_{Mar2014}\right] \\ &= 201.5 + \frac{23}{30} \times [203.0 - 201.5] = 202.6499 \end{aligned}$$

(Rounded to 5 decimal places)

The Ref RPI was calculated in previous example as 202.40323.

$IndexRatio_{SettlementDate} = \frac{202.64999}{202.40323} = 1.00122$ (Rounded to 5 decimal places)

$AccruedInterest = \frac{150}{182} \times 1.00122 = £1.350363$ (Rounded to 6 decimal places)

Appendix A: Accrued Interest Calculations

Both conventional and index-linked gilts accrue interest daily on an actual/actual basis. The accrued interest, when purchasing a gilt, is calculated to the settlement date.

The basic principle used in the accrued interest calculation is that from one normal interest payment date to the next, the gilt accrues interest at the same amount for each calendar day at such a rate that it will have accrued exactly the payment amount by the coupon date.

Example

Consider a gilt with a 6% coupon, which pays 3% on 7 March and on 7 September.

The daily accrued interest per £100 nominal of the gilt between the 7 March and 7 September is $\frac{3}{184}\%$ as there are 184 days between 7 March and 7 September.

However, the daily accrued interest between 7 September and 7 March is either $\frac{3}{181}\% = 0.0166\%$ (181 days in a non-leap year), or $\frac{3}{182}\% = 0.0165\%$ (182 days in a leap year).

Example

2½% Treasury Index-Linked Stock 2013

The 2½% Treasury Index-linked Stock 2013 was issued on 21 February 1985. It pays semi-annual coupons on 16 February and 16 August, and the adjusted Retail Price Index (RPI) at the issue base date is 89.2014.

The calculation of accrued interest for this gilt for settlement on 2 June 2004 is as follows.

The gilt last paid a coupon on 16 February 2004 and the next coupon is expected on 16 August 2004. This coupon will be based on a RPI of 183.5 (i.e. the RPI 8 months before the payment). The coupon payment is adjusted by the ratio of the two RPIs. Hence the expected payment is:

1.25 x 183.5 / 89.2014 = 2.571428

As there are 107 days from 16 February 2004 to 2 June 2004 and 182 days from 16 February 2004 to 16 August 2004, the accrued interest on 2 June is:

2.571428 x 107 / 182 = 1.51177%

Sometimes gilts have either long or short coupon payment periods. When this occurs, “pseudo” or quasi-coupon payment dates are created so that the gilt accrues interest at the same daily rate as a gilt with the same coupon with the same normal interest payment dates.

Example

Consider a gilt with a 6% coupon, which will normally pay 3% interest on 7 March and on 7 September, which has been issued this year on 7 June.

Prior to the first coupon payment on 7 September, the gilt will accrue interest at the same daily rate as a gilt with a 6% coupon which last paid interest on 7 March, i.e. at a daily rate of $\frac{3}{184}\%$ (there being 184 days from 7 March to 7 September). The first coupon payment for such a gilt will be

$3 \times \frac{92}{184}\% = 1.5\%$ as there are 92 days from 7 June to 7 September.

The position in a gilt that has a long first coupon period is slightly more complicated.

Example

Consider a 6% conventional gilt, which will normally pay 3% interest on 7 March and on 7 September, which has been issued this year (not a leap year) on 7 February. It has been specified that the first coupon payment will be on 7 September, i.e. a period of 7 months.

From the 7 February to 7 March the gilt will accrue interest at daily rate of $\frac{3}{181}\%$as there are 181 days from the previous 7 September to the 7 March. From 7 March to 7 September it will then accrue at a daily rate of $\frac{3}{184}\%$.

The first interest payment on 7 September will be $\left(3 \times \frac{28}{184} + 3\right)\% = 3.4641\%$.

Gilts go ex-dividend (XD) 7 business days before the coupon payment date. This means that the seller as opposed to the buyer is entitled to the accrued interest associated with the gilt, when the settlement date is in the XD period. The accrued interest for such a transaction is now **negative**.

Example

Consider a 6% conventional gilt, which pays 3% on 7 March and on 7 September. It has been sold for settlement on 1 September, i.e. within the XD period, with a negative accrued interest.

The accrued interest per £100 nominal associated with the transaction is now $-3 \times \frac{6}{184}\% = -0.0978\%$, as the settlement date is 6 days before the coupon date in a 184 day period.

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Appendix B: Redemption Yield Compounding Frequency Adjustments

In some markets it is customary to calculate redemption yields with the interest being compounded annually, whereas in others it is compounded semi-annually. This appendix shows how it is possible to convert yields from one compounding basis to another.

Redemption yields for both conventional and index-linked gilts and sectors are calculated with interest being compounded on a semi-annual basis. This is historical because nearly all the gilts pay interest twice a year. It is normal to compound interest on a semi-annual basis in markets, such as USA and Canada, where coupons are normally paid semi-annually. However, in markets where coupons are normally paid annually, such as in continental Europe, yields are normally compounded annually.

Redemption yields compounded semi-annually appear to be less than those compounded annually. This is because the holder has use of half the annual coupon for an extra six months.

Example

Consider a 10% conventional gilt, which pays annually. If it is priced at par (100) and has exactly 10 years to redemption, then it has a redemption yield compounded annually of 10%.

However, if on the other hand it were to pay 5% interest every 6 months, in 6 months time one would get £5 for every £100 of nominal held which one could invest for the next extra 6 months at 10% p.a., assuming yields do not change. Thus on an annual compounding basis the redemption yield would now be:

$$100 \times \frac{10}{100} + 5 \times \frac{10}{2 \times 100} = 10.25\%$$

Generally the formula for converting semi-annually compounded yields to annually compounded ones and vice versa is:

$(1 + y_a) = \left(1 + \frac{y_s}{2}\right)^2$ where: y_a = yield compounded annually

y_s = yield compounded semi-annually.

Appendix C: Further Information

A Glossary of Terms used in FTSE Russell's methodology documents can be found using the following link: Fixed Income Glossary of Terms.pdf

Further information on the FTSE Actuaries UK Gilts Index Series Guide to Calculation is available from FTSE Russell.

For contact details please visit the FTSE Russell website or contact FTSE Russell client services at info@ftserussell.com.

Website: www.ftserussell.com

Further information on the delivery mechanisms for the Tradeweb FTSE Gilts Closing Prices please contact Tradeweb at ECS@Tradeweb.com.