

# FTSE Actuaries UK Gilts Index Series

v5.7



**FTSE  
RUSSELL**

An LSEG Business

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## Section 1

# Introduction

## 1. Introduction

1.1 This document sets out the Ground Rules for the construction and management of the FTSE Actuaries UK Gilts Index Series, as adopted by the FTSE Russell Policy Advisory Board. Copies of the Ground Rules are available from FTSE Russell. For further information on the indices please visit the FTSE Russell website at [www.lseg.com/en/ftse-russell/](http://www.lseg.com/en/ftse-russell/).

1.2 The FTSE Actuaries UK Gilts Index Series include the following:

### 1.2.1 Conventional Gilts – end of day

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
BG10	FTSE Actuaries UK Conventional Gilts up to 10 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
GBG05	FTSE Actuaries UK Conventional Gilts Green Index

### 1.2.2 Conventional Gilts – mid-day

Index Code	Index
MBG01	FTSE Actuaries UK Conventional Gilts up to 5 Years Index
MBG02	FTSE Actuaries UK Conventional Gilts 5-15 Years Index
MBG03	FTSE Actuaries UK Conventional Gilts over 15 Years Index
MBG05	FTSE Actuaries UK Conventional Gilts All Stocks Index
MBG06	FTSE Actuaries UK Conventional Gilts 5-10 Years Index
MBG07	FTSE Actuaries UK Conventional Gilts 10-15 Years Index

Index Code	Index
MBG08	FTSE Actuaries UK Conventional Gilts up to 15 Years Index
MBG09	FTSE Actuaries UK Conventional Gilts up to 20 Years Index
MBG10	FTSE Actuaries UK Conventional Gilts up to 10 Years Index
MBG0A	FTSE Actuaries UK Conventional Gilts 15-25 Years Index
MBG0B	FTSE Actuaries UK Conventional Gilts over 25 Years Index
MBG0C	FTSE Actuaries UK Conventional Gilts over 5 Years Index
MBG0D	FTSE Actuaries UK Conventional Gilts over 10 Years Index
MGBG05	FTSE Actuaries UK Conventional Gilts Green Index

### 1.2.3 Fitted Yields for the following terms to maturity:

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

### 1.2.4 Index-linked Gilts – end of day

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
IL11	FTSE Actuaries UK Index-Linked Gilts up to 10 Years Index
GIL01	FTSE Actuaries UK Index-Linked Gilts Green Index

### 1.2.5 Index-linked Gilts – mid-day

Index Code	Index
MIL01	FTSE Actuaries UK Index-Linked Gilts All Stocks Index
MIL02	FTSE Actuaries UK Index-Linked Gilts up to 5 Years Index
MIL03	FTSE Actuaries UK Index-Linked Gilts over 5 Years Index
MIL04	FTSE Actuaries UK Index-Linked Gilts 5-15 Years Index
MIL05	FTSE Actuaries UK Index-Linked Gilts over 15 Years Index
MIL06	FTSE Actuaries UK Index-Linked Gilts 15-25 Years Index
MIL07	FTSE Actuaries UK Index-Linked Gilts 5-25 Years Index
MIL08	FTSE Actuaries UK Index-Linked Gilts over 25 Years Index
MIL09	FTSE Actuaries UK Index-Linked Gilts over 10 Years Index
MIL10	FTSE Actuaries UK Index-Linked Gilts up to 15 Years Index
MIL11	FTSE Actuaries UK Index-Linked Gilts up to 10 Years Index
MGIL01	FTSE Actuaries UK Index-Linked Gilts Green Index

The yields are calculated assuming future inflation rates of 0%, 3%, 5% and 10%.

Please see Rules 4.3.2 and 4.3.4 for the detailed treatment of indices incorporating gilts within a fixed range of outstanding terms or with terms greater than a specified minimum period or up to a specified maximum period.

#### **1.2.6 Single Gilt Indices**

Single gilt indices are available for all gilts which are constituents of Conventional and Index-Linked Gilt Indices.

New single gilt indices are created each time a new gilt is issued and becomes a constituent of BG05 (FTSE Actuaries UK Conventional Gilts All Stocks Index) or IL01 (FTSE Actuaries UK Index-Linked Gilts All Stocks Index). Single gilt indices are calculated from issuance until the maturity of each security.

1.3 The FTSE Actuaries UK Gilts Index Series does not take account of ESG factors in its index design.

1.4 The base currency of the benchmark is GBP.

1.5 The unhedged index values and returns in EUR are also available for the conventional gilts' indices.

1.6 The indices are calculated at 12:00 UK time and at the end of each business day. The day on which they are calculated is referred to as the "calculation date". Some calculations make use of the "settlement date", which is normally the next working day, e.g. normally Tuesday after a Monday, etc, and Monday after a Friday, but with exceptions at public holidays.

#### **1.7 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 FTSE Fixed Income Europe Limited), FTSE Fixed Income LLC, FTSE (Beijing) Consulting Limited, Refinitiv Benchmark Services (UK) Limited, Refinitiv Limited and Beyond Ratings.

1.8 FTSE Russell hereby notifies users of the index series that it is possible that circumstances, including external events beyond the control of FTSE Russell, may necessitate changes to, or the cessation, of the index series and therefore, any financial contracts or other financial instruments that reference the index series or investment funds which use the index series to measure their performance should be able to withstand, or otherwise address the possibility of changes to, or cessation of, the index series.

1.9 Index users who choose to follow this index or to buy products that claim to follow this index should assess the merits of the index's rules-based methodology and take independent investment advice before investing their own or client funds. No liability whether as a result of negligence or otherwise is accepted by FTSE Russell for any losses, damages, claims and expenses suffered by any person as a result of:

- any reliance on these Ground Rules, and/or
- any inaccuracies in these Ground Rules, and/or
- any non-application or misapplication of the policies or procedures described in these Ground Rules, and/or
- any inaccuracies in the compilation of the Index or any constituent data.

## Section 2

# Management responsibilities

## 2. Management responsibilities

### 2.1 FTSE International Limited (FTSE)

2.1.1 FTSE is the benchmark administrator of the index series.<sup>1</sup>

2.1.2 FTSE Russell is responsible for the daily calculation, production and operation of the FTSE Actuaries UK Gilts Index Series and will:

- maintain records of all the constituents;
- be responsible for the addition and deletion of gilts and changes of nominal amounts, in accordance with the Ground Rules.

### 2.2 FTSE EMEA Fixed Income Advisory Committee

2.2.1 The FTSE EMEA Fixed Income Advisory Committee has been established by FTSE Russell. The Committee may recommend changes to the Ground Rules for approval by the FTSE Russell Index Governance Board.

### 2.3 Amendments to these Ground Rules

2.3.1 These Ground Rules shall be subject to regular review by FTSE Russell to ensure that they continue to best reflect the aims of the index series. Any proposals for significant amendments to these Ground Rules will be subject to consultation with FTSE Russell advisory committees and other stakeholders if appropriate. The feedback from these consultations will be considered by the FTSE Russell Index Governance Board before approval is granted.

2.3.2 In the event that the FTSE EMEA Fixed Income Advisory Committee or any Committee responsible for the operation and administration of the FTSE Actuaries UK Gilts Index Series consider that a change of principle or exceptions should be made to any of the Ground Rules, market participants will be provided with clear and significant notice. The issue will subsequently be discussed at the FTSE EMEA Fixed Income Advisory Committee and FTSE Russell will decide if a change to these Grounds Rules is warranted. If a change is required this will be authorised by the FTSE Russell Index Governance Board.

<sup>1</sup> 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) and [The Benchmarks \(Amendment and Transitional Provision\) \(EU Exit\) Regulations 2019](#) (the UK Benchmark Regulation).

## Section 3

# FTSE Russell index policies

### 3. FTSE Russell index policies

These Ground Rules should be read in conjunction with the following policy documents which can be accessed using the links below:

#### 3.1 Statement of Principles for FTSE Fixed Income Indices (the Statement of Principles)

Indices need to keep abreast of changing markets and the Ground Rules cannot anticipate every eventuality. Where the Rules do not fully cover a specific event or development, FTSE Russell will determine the appropriate treatment by reference to the Statement of Principles for FTSE Fixed Income Indices which summarises the ethos underlying FTSE Russell's approach to index construction. The Statement of Principles is reviewed annually and any changes proposed by FTSE Russell are presented to the FTSE Russell Policy Advisory Board for discussion before approval by the FTSE Russell Index Governance Board.

The Statement of Principles for Fixed Income Indices can be accessed using the following link:

[Statement of Principles Fixed Income Indices.pdf](#)

#### 3.2 Queries and Complaints

FTSE Russell's complaints procedure can be accessed using the following link:

[Benchmark Determination Complaints Handling Policy.pdf](#)

#### 3.3 Recalculation Policy and Guidelines

The Recalculation Policy and Guidelines for Fixed Income Indices document is available from the FTSE Russell website using the link below or by contacting [info@ftserussell.com](mailto:info@ftserussell.com).

[Fixed Income Recalculation Policy and Guidelines.pdf](#)

#### 3.4 Policy for Benchmark Methodology Changes

3.4.1 Details of FTSE Russell's policy for making benchmark methodology changes can be accessed using the following link:

[Policy for Benchmark Methodology Changes.pdf](#)

#### 3.5 Index Policy in the Event Clients are Unable to Trade a Market or a Security

3.5.1 Details of FTSE Russell's treatment can be accessed using the following link:

[Index Policy in the Event Clients are Unable to Trade a Market or a Security.pdf](#)

### **3.6 FTSE Russell Governance Framework**

3.6.1 To oversee its indices, FTSE Russell employs a governance framework that encompasses product, service and technology governance. The framework incorporates the London Stock Exchange Group's three lines of defence risk management framework and is designed to meet the requirements of the IOSCO Principles for Financial Benchmarks<sup>2</sup>, the European benchmark regulation<sup>3</sup> and the UK benchmark regulation<sup>4</sup>. The FTSE Russell Governance Framework can be accessed using the following link:

[FTSE Russell Governance Framework.pdf](#)

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<sup>2</sup> IOSCO Principles for Financial Benchmarks Final Report, FR07/13 July 2013.

<sup>3</sup> 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.

<sup>4</sup> The Benchmarks (Amendment and Transitional Provision) (EU Exit) Regulations 2019.



## Section 4

# Conventional gilts

## 4. Conventional gilts

### 4.1 Gilts

- 4.1.1 All Conventional Gilts (i.e. those gilts that are not index-linked – see Section 5), denominated in GBP and quoted on the Stock Exchange, are considered for inclusion in the price indices.
- 4.1.2 Gilts which are regarded by the Debt Management Office as “rump stocks” (i.e. too small an amount is in issue for an effective market) and are listed as such by the Debt Management Office are excluded from the indices.
- 4.1.3 Partly-paid gilts are excluded from the indices until they become fully paid.
- 4.1.4 The total market issuance of strippable gilts is included in the indices as if the gilts had not been stripped.
- 4.1.5 Gilts issued by the Debt Management Office under their “special repo” or “standing repo” arrangements are not included in the indices.
- 4.2 There are no liquidity requirements for entry to the FTSE Actuaries UK Gilts Index Series.

### 4.3 Sectors

- 4.3.1 The sector in which each gilt is placed depends on the term from the date of calculation to the date of redemption of the gilt. See Rule 1.2 for a full list of sectors.
- 4.3.2 “Shorteners”: effective 01-June 2021, a gilt is moved, at its closing price, from one sector to a shorter sector after the close of business on the day when its redemption date is less than or equal to 5, 10, 15, 20 or 25 years from the settlement date (T+1).
- 4.3.3 Prior to the above change the term to maturity for the move to shorter sector was based on the trade date.
- 4.3.4 If a gilt is due to be included in or excluded from an index defined under Rule 4.3.2 on a day when the market is closed, the stock will be included or excluded after the close on the last trading day before the appropriate anniversary so that it will be included in an index from the beginning of the first trading day for which it becomes eligible and excluded from an index from the beginning of the first trading day for which it becomes ineligible.

### 4.4 Price Indices

- 4.4.1 Each of the Price Indices is an arithmetically weighted index based on the gross or dirty price (see Rule 8.2.2), and weighted by the nominal amount outstanding (see Rule 8.3).
- 4.4.2 In addition to the Price Index for each sector other values are calculated.

- 4.4.3 The gilts that are used for the calculation of the number of gilts and the weight of the sector on any day include those gilts that have been in the sector during the course of that day, and exclude those gilts that are entering the sector after close of business on that day (see Rule 11.2.2).

The gilts that are used for the calculation of gross redemption yield, duration, convexity and modified duration include those gilts that have been in the sector during the course of that day. It excludes those gilts that are entering the sector after the close of business on that day (see Rule 11.2.2).

#### **4.5 Fitted Conventional Yield Indices**

- 4.5.1 All conventional gilts in the indices are considered for inclusion in the yield curve calculation from which the fitted yields for specific terms to maturity are derived.
- 4.5.2 Convertibles with outstanding conversion options, gilts with substantial sinking funds, gilts with special tax status and gilts with less than one year to redemption are excluded from the yield indices.
- 4.5.3 The gilts that are used for the calculation of the yield curve on any day include those gilts that have been in the Indices during the course of that day, and exclude those gilts that are entering the Indices after the close of business on that day (see Rule 11.2.2). Gilts with less than one year to maturity are excluded from the calculation.
- 4.5.4 Yields are calculated by fitting a curve to the zero coupon yields for all eligible gilts (see Rule 9.8).
- 4.5.5 In addition to the zero coupon yield, the par and the forward yields are also calculated.
- 4.5.6 The redemption yield for each gilt is calculated using the gross price (see Rule 9.1). The redemption yields are gross yields, calculated taking account of the coupon frequency (currently always half-yearly) and then quoted convertible half-yearly.
- 4.5.7 Yields for terms of 5, 10, 15, 20, 25, 30, 35, 40, 45 and 50 years are calculated.

## Section 5

# Index-linked gilts

## 5. Index-linked gilts

### 5.1 Gilts

- 5.1.1 All Index-linked Gilts, denominated in GBP and quoted on the Stock Exchange are considered for inclusion in the price indices. This comprises index-linked gilts with either an 8-month or 3-month indexation lag to the Retail Price Index (RPI) or to the Consumer Price Index (CPI).
- 5.1.2 Gilts which are regarded by the Debt Management Office as “rump stocks” (i.e. too small an amount is in issue for an effective market) and are listed as such by the Debt Management Office are excluded from the indices.
- 5.1.3 Convertible index-linked gilts with outstanding conversion options are excluded from the indices.
- 5.1.4 If any other index-linked gilts were to be issued with conditions which were significantly different from those of the existing index-linked gilts (e.g. linked to an Earnings Index or to a Limited Price Indexation index), they would be excluded from the indices.
- 5.1.5 Gilts issued by the Debt Management Office under their “special repo” or “standing repo” arrangements are not included in the indices.

### 5.2 Sectors

- 5.2.1 The sector in which each gilt is placed depends on the term from the date of calculation to the date of redemption of the gilt. See Rule 1.2 for a full list of sectors.
- 5.2.2 “Shorteners”: a gilt is moved, at its closing price, from one sector to a shorter sector after the close of business on the day when its redemption date is less than equal to 5, 10, 15 or 25 years from the settlement date.  
Please see Rules 4.3.2 and 4.3.4 for the treatment of “Shorteners”.

### 5.3 Price Indices

- 5.3.1 Each of the Price Indices is an arithmetically weighted index based on the gross or dirty price (see Rule 8.2.2), and weighted by the nominal amount outstanding (see Rule 8.3).
- 5.3.2 In addition to the Price Index for each sector other values are calculated.
- 5.3.3 The gilts that are used for the calculation of the number of gilts and the weight of the sector on any day include those gilts that have been in the sector during the course of that day, and exclude those gilts that are entering the sector after the close of business on that day (see Rule 11.2.2).

## **5.4 Yields Indices**

- 5.4.1 All gilts in the Price Indices are included in the yield calculations.
- 5.4.2 “Real yields” are calculated for each sector (see Rule 10.2). Since the real yield on index-linked gilts depends on the future rate of inflation assumed, four yields are calculated for each sector, assuming future annual inflation rates of 0%, 3%, 5% and 10% uniformly from the date of the last published value of the Retail Prices Index.
- 5.4.3 In addition the duration, and modified duration (see Rule 10.4) and convexity (see Rule 10.6) for each sector on each inflation assumption are calculated.
- 5.4.4 The gilts that are used for the calculation of the number of gilts and the weight of the sector on any day include those gilts that have been in the sector during the course of that day, and exclude those gilts that are entering the sector after close of business on that day (see Rule 11.2.2).
- The gilts that are used for the calculation of gross redemption yield, duration, convexity and modified duration include those gilts that have been in the sector during the course of that day. It excludes those gilts that are entering the sector after the close of business on that day (see Rule 11.2.2).
- 5.4.5 No yield curve is calculated for the index-linked indices.

## Section 6

# Prices

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### 6. Prices

- 6.1 From 24 July 2017, the prices used in the calculation of the end-of-day indices are the Tradeweb FTSE Gilt Closing prices. These prices are administered by FTSE International Limited with Tradeweb Europe Limited acting as calculation agent.
- 6.2 The Tradeweb FTSE Gilt Closing Prices were selected as reference prices for gilts, strips and Treasury bills following the announcement by the UK Debt Management Office that it intended to withdraw from its role as the provider of reference prices in January 2015. A review - the Independent Reference Price Review chaired by Professor Miles CBE - was commissioned to recommend the successor arrangements and the proposal jointly submitted by Tradeweb and FTSE was selected.
- 6.3 The mid-day indices are based on prices received from Tradeweb. These prices are not considered to be reference prices.
- 6.4 The Guide to the Calculation of the Tradeweb FTSE UK Gilt Benchmark Closing Prices can be downloaded using the following link:  
[Guide to the Calculation of Tradeweb FTSE Gilt Benchmark Closing Prices.pdf](#)  
and a guide to the Principles with respect to the Calculation of the Tradeweb FTSE Gilt Closing Prices is available using the following link:  
[Principles for the Administration of the Tradeweb FTSE Gilt Closing Prices.pdf](#)
- 6.5 Prior to 24 July 2017 the prices used for the calculation of the end of day indices were the GEMMA prices compiled and distributed by the Debt Management Office each day on behalf of GEMMA. The midday indices were based on the composite intra-day prices compiled by the DMO.
- 6.6 The indices are calculated using gross or “dirty” prices, i.e. these prices include accrued interest for all gilts (see Rule 8.2.2).

## Section 7

# Addition, removal and alterations to constituents

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## 7. Addition, removal and alterations to constituents

The following Rules apply to both conventional gilts and index-linked gilts as appropriate except where noted.

### 7.1 Addition of constituents

- 7.1.1 New issues that are issued fully paid by auction are included in full in the indices at the close of the day when the auction takes place. New issues that are issued partly paid are included at the market price at the close of the day when they become fully paid, at the closing market price.
- 7.1.2 New issues that are issued by syndicated offering are included in the indices at the close of business on the day of pricing (i.e. with effect from start of trading on the following business day), at the closing market price.
- 7.1.3 Conversion and switch auction gilts are added at their market price at the close of business on the day on which the operation takes place (see Rule 7.3.1)
- 7.1.4 New issues not issued through an auction process or additional issues of existing gilt, “taps”, are added to the indices at the closing price at the close of business on the day the tap issue takes place.

### 7.2 Removal of constituents

- 7.2.1 Gilts are removed from the indices when their redemption dates equals settlement date at the closing price.
- 7.2.2 Gilts are removed from the indices at the close of business on the day they join the Debt Management Office’s list of rump gilts.

### 7.3 Alterations to constituents

- 7.3.1 Alterations to nominal amounts outstanding are adjusted at the close of business on the day the Debt Management Office announces the change in nominal, or the day that FTSE Russell becomes aware of the change.

## Section 8

# Formulae and calculation methods applying to both conventional and index-linked gilts

## 8. Formulae and calculation methods applying to both conventional and index-linked gilts

The Rules in this Section and in Section 9 (Conventional) and 10 (Index-linked) show the normal formulae, when there are no complications. Section 11 gives details of what happens when there are capital changes, “shorteners”, etc.

### 8.1 Notation

$i$	=	Individual Gilt
$s$	=	Gilts sector
$t$	=	Calculation day
$t - 1$	=	Previous calculation day
$p_i(t)$	=	Dirty price of Gilt $i$ on $t$
$ai_i(t)$	=	Accrued interest of Gilt $i$ on $t$
$cp_i(t)$	=	Clean price of Gilt $i$ on $t$
$xd_i(t)$	=	Ex-dividend period of Gilt $i$ on $t$
$sd(t)$	=	Settlement date on $t$
$ld_i(t)$	=	Last/previous coupon date of Gilt $i$ on $t$
$nd_i(t)$	=	Next coupon date of Gilt $i$ on $t$
$ad_i(t)$	=	Interest accrual/issue date of Gilt $i$ on $t$
$qd_i(t)$	=	Quasi-interest date of Gilt $i$ on $t$

$c_i$	=	Annual coupon of Gilt $i$
$f_i$	=	Coupon frequency of Gilt $i$ , i.e. number of coupon payments per year
$ao_i(t)$	=	Amount outstanding/Nominal of Gilt $i$ on $t$
$I_s(t)$	=	Index value of Sector $s$ on $t$
$D_s(t)$	=	Divisor of Sector $s$ on $t$
$R_s(t)$	=	Day change/Day return of Sector $s$ on $t$ in percentage terms

## 8.2 Formulae

### 8.2.1 Accrued interest

The “Clean” Price (i.e. excluding Accrued Interest) is collected for each Gilt  $i$  for each Day  $t$  (see Section 6). Accrued Interest  $ai_i(t)$  per cent nominal for each Gilt  $i$  for each Day  $t$ , is calculated in accordance with current market conventions, which are denoted “actual/actual”, or more precisely, in the normal case, as:

If the gilt is not  $xd_i(t)$ :

$$ai_i(t) = \frac{c_i(t)}{f_i} \times \frac{(sd_i(t) - ld_i(t))}{(nd_i(t) - ld_i(t))}$$

and if the gilt is  $xd_i(t)$ :

$$ai_i(t) = \frac{c_i(t)}{f_i} \times \frac{(nd_i(t) - sd_i(t))}{(nd_i(t) - ld_i(t))}$$

### 8.2.2 Dirty price

Accrued Interest  $ai_i(t)$  is added to the “Clean” Price  $cp_i(t)$  to give the “Dirty” Price,  $p_i(t)$ , which is used hereafter.

$$p_i(t) = cp_i(t) + ai_i(t)$$

Special calculations apply during the initial irregular interest period of a Gilt, as follows.

(1) If the gilt has a short first interest period (less than half a year):

If the gilt is not  $xd_i(t)$ :

$$ai_i(t) = \frac{c_i(t)}{f_i} \times \frac{(sd_i(t) - ad_i(t))}{(nd_i(t) - ld_i(t))}$$

and if the gilt is  $xd_i(t)$ :

$$ai_i(t) = \frac{c_i(t)}{f_i} \times \frac{(nd_i(t) - sd_i(t))}{(nd_i(t) - ld_i(t))}$$

Note that the actual first interest payable is calculated by the Debt Management Office as:

$$actual\ first\ interest_i(t) = \frac{c_i(t)}{f_i} \times \frac{(sd_i(t) - ad_i(t))}{(nd_i(t) - ld_i(t))}$$

rounded in accordance with current conventions

(2) If the gilt has a long first interest period (more than half a year):



In the period up to the quasi-interest date, i.e. the interest date during the long first period on which interest is not paid, and during which the gilt cannot be xd:

$$ai_i(t) = \frac{c_i(t)}{f_i} \times \frac{(sd_i(t) - ad_i(t))}{(qd_i(t) - ld_i(t))}$$

In the period after the quasi-interest date:

If the gilt is not 'xd':

$$ai_i(t) = \frac{c_i(t)}{f_i} \times \left( \frac{(qd_i(t) - ad_i(t))}{(qd_i(t) - ld_i(t))} + \frac{(sd_i(t) - qd_i(t))}{(nd_i(t) - qd_i(t))} \right)$$

and if the gilt is 'xd':

$$ai_i(t) = \frac{c_i(t)}{f_i} \times \frac{(nd_i(t) - qd_i(t))}{(nd_i(t) - qd_i(t))}$$

Note that the actual first interest payable is calculated as:

$$actual\ first\ interest_i(t) = \frac{c_i(t)}{f_i} \times \left( \frac{(qd_i(t) - ad_i(t))}{(qd_i(t) - ld_i(t))} + 1 \right)$$

rounded in accordance with current conventions

### 8.3 Index Value for a Sector

8.3.1 The Index Value for Sector  $s$  for day  $t$ ,  $I_{s,t}$ , is calculated as

$$I_s(t) = \frac{\sum_{i=1}^N (ao_i(t) \times p_i(t))}{D_s(t)}$$

where

$D_s(t)$  (also called the "base value") = a figure which was originally set equal to the total market value of Sector  $s$  at the base date divided by the starting Index Value at that date (often 100.00), but which has subsequently been adjusted to allow for changes in the constituents of the Sector and the nominal amounts of the constituent Gilts, so as keep the Index Value "chain-linked" (see Section 11).

The numerator of the expression for the Index Value is equal to the market value of the Gilts in Sector  $s$  on Day  $t$ .

### 8.4 Days change %

8.4.1 The "Day's change %" is calculated as:

$$R_s(t) = \left( \frac{I_s(t)}{I_s(t-1)} - 1 \right) \times 100$$

### 8.5 Accrued Interest for a Sector

8.5.1 The Accrued Interest for Sector  $s$  for Day  $t$ ,  $AI_{s,t}$ , is calculated as

$$AI_s(t) = \frac{\sum_{i=1}^N (ao_i(t) \times ai_i(t))}{D_s(t)}$$

### 8.6 XD Adjustment

8.6.1 The XD Adjustment for Sector  $s$  for Day  $t$ ,  $XD_{s,t}$ , is calculated as

$$XD_s(t) = \frac{\sum_{i=1}^N \left( ao_i(t) \times \frac{c_i(t)}{f_i} \right)}{D_s(t-1)}$$

## XD Year to Date

The published figure for Sector  $s$  for Day  $t$  is the XD Adjustment for the year to date,  $XD ytd_{s,t}$ , which is calculated as:

$$XDytd_s(t) = \sum_{t=1}^T XD_s(t)$$

## 8.7 Total Return Index for a Sector

8.7.1 The Total Return Index for Sector  $s$  for Day  $t$ ,  $R_{s,t}$ , is calculated from the Sector Index Value and the XD Adjustment:

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

Note: when calculating Total Return Index for a Gilt, it would be calculated in a similar way, with  $I_s(t)$  for the Sector replaced by  $p_i(t)$  for the Gilt.

## 8.8 Weight % of a Sector

8.8.1 The Weight % for Sector  $s$  for Day  $t$ ,  $W_s(t)$ , is calculated from the Total Market Value for the Gilts in the Sector,  $MV_s(t)$ , and the Total Market Value for the Gilts in the All Gilts Sector,  $MV_a(t)$ , where:

$$MV_s(t) = \sum_{i=1}^N (ao_i(t) \times p_i(t))$$

summed over the Gilts in Sector  $s$

$$MV_a(t) = \sum_{i=1}^N (ao_i(t) \times p_i(t))$$

summed over the Gilts in the All Gilts Sector

Then,

$$W_s(t) = \frac{MV_s(t)}{MV_a(t)} \times 100$$

## Section 9

# Formulae and calculation methods: conventional gilts

## 9. Formulae and calculation methods: conventional gilts

### 9.1 Redemption Yield

9.1.1 The Redemption Yield for Gilt  $i$  for Day  $t$ ,  $y_i(t)$ , is calculated by solving an equation of value.

$$dp_i(t) = \sum_{k=\frac{v}{d}}^{m+\frac{v}{d}} \frac{cf_i(t)}{\left(1 + \frac{y_i(t)}{f_i}\right)^k}$$

Where,

- $p_i(t)$  = Dirty price of the Gilt  $i$  on day  $t$
- $m$  = The number of payment periods until maturity
- $v$  = Number of calendar days to next cash flow according the day count convention of the Gilt  $i$
- $d$  = Number of calendar days between the previous cash flow and the next cash flow according the day count convention of the Gilt  $i$
- $a$  = Time in cash flow periods of the Gilt  $i$
- $cf_i(t)$  = Cash flows at the end of each cash flow period of the Gilt  $i$  on day  $t$
- $y_i(t)$  = Redemption yield of the Gilt  $i$  on day  $t$
- $f_i(t)$  = Number of cash flows per year of the Gilt  $i$  on day  $t$

9.1.2 The above formulae apply to gilts with more than one coupon payment left. When a gilt is in its final coupon payment period, a simple interest formula is used:

$$y_i(t) = \frac{\left(\frac{cf_i(l)}{p_i(t)} - 1\right)}{ttm_i(t) \times f_i(t)}$$

where:

- $p_i(t)$  = Dirty price of the Gilt  $i$  on day  $t$
- $cf_i(t)$  = Cash flows at the end of each cash flow period of the Gilt  $i$  on day  $t$
- $y_i(t)$  = Redemption yield to maturity of the Gilt  $i$  on day  $t$
- $ttm_i(t)$  = Term to maturity of the Gilt  $i$  on day  $t$

$f_i(t)$  = Number of cash flows per year of the Gilt  $i$  on day  $t$

## 9.2 Redemption Yield for a Sector

### 9.2.1 Cash Flow methodology:

$$v_s(t) = \sum_{k=\frac{v}{d}}^{m+\frac{v}{d}} \frac{cf_i(t)}{\left(1 + \frac{YTM_{s,cf}(t)}{f_i}\right)^k}$$

$$MV_s(t) = \sum_{i=1}^N (v_s(t) \times ao_i(t))$$

Where

$v_s(t)$  = Is the sum of discounted cash flows using of the Gilt  $i$  on day  $t$  using the Sector redemption yield

$cf_i(t)$  = Cash flows at the end of each cash flow period of the Gilt  $i$  on day  $t$

$YTM_{s,cf}(t)$  = Redemption yield of the Sector  $s$  on day  $t$ , using cash flow methodology

$MV_s(t)$  = Market value of the Sector  $s$  on day  $t$

$f_i(t)$  = Number of cash flows per year of the Gilt  $i$  on day  $t$

Note that at the sector level, no distinction is made between cash flows emanating from different gilts.

## 9.3 Macaulay Duration for a Gilt

### 9.3.1 The (Macaulay) Duration for Gilt $i$ for Day $t$ , $D_{i,t}$ , is calculated as:

$$macdur_i(t) = \frac{1}{p_i(t)} \sum_{k=\frac{v}{d}}^{m+\frac{v}{d}} \frac{k_i \times cf_i(t)}{\left(1 + \frac{ym_i(t)}{f_i}\right)^k}$$

where:

### 9.3.2 The Modified Duration for Gilt $i$ for Day $t$ , $ModD_{i,t}$ , is calculated as:

$$moddur_i(t) = \frac{macdur_i(t)}{\left(1 + \frac{ym_i(t)}{f_i}\right)}$$

### 9.3.3 The Macaulay Duration and Modified Duration for a gilt within its last coupon payment period are calculated as:

$$D_{i,t} = f_{i,t}^{last}$$

$$ModD_{i,t} = f_{i,t}^{last} / (1 + y_{i,t}^{last} \times f_{i,t}^{last})$$

where  $f_{i,t}^{last}$  is the fraction of a year to maturity.

## 9.4 Duration for a Sector

### 9.4.1 The Duration for Sector $s$ for Day $t$ , $D_{s,t}$ , is calculated as:

$$macdur_{s,i}(t) = \frac{1}{v_s(t)} \times \sum_{k=\frac{v}{d}}^{m+\frac{v}{d}} \frac{k_i \times cf_i(t)}{\left(1 + \frac{YTM_{s,cf}(t)}{f_i}\right)^k}$$

$$MacDur_{s,cf}(t) = \frac{\sum_{i=1}^N (macdur_{s,i}(t) \times mv_i(t))}{MV_s(t)}$$

where

9.4.2 The Modified Duration for Sector  $s$  for Day  $t$ ,  $ModD_{st}$ , is calculated as:

$$ModD_{s,t} = D_{s,t} \times v_s$$

$$moddur_{s,i}(t) = \frac{macdur_{s,i}(t)}{\left(1 + \frac{YTM_{s,cf}(t)}{f_i}\right)}$$

$$ModDur_{s,cf}(t) = \frac{\sum_{i=1}^N (macdur_{s,i}(t) \times mv_i(t)) \times mv_i(t)}{MV_s(t)}$$

## 9.5 Convexity for a Gilt

### 9.5.1 Macaulay Convexity

A. The Convexity for Gilt  $i$  for Day  $t$ ,  $C_{i,t}$ , is calculated as:

$$maccnvx_i(t) = \frac{1}{p_i(t)} \sum_{k=\frac{v}{d}}^{m+\frac{v}{d}} \frac{k_i^2 \times cf_i(t)}{\left(1 + \frac{ytm_i(t)}{f_i}\right)^k}$$

where

B. The Convexity for a gilt within its last coupon payment period is calculated as:

$$C_{i,t} = (flasti,t)^2$$

where  $flasti,t$  is the fraction of a year to maturity.

### 9.5.2 Modified Convexity

A. The Modified Convexity for Gilt  $i$  for Day  $t$ ,  $ModC_{i,t}$ , is calculated as:

$$ModC_{i,t} = \frac{C_{i,t}}{\left(1 + \frac{y_{i,t}}{frequency}\right)^2} + \frac{ModD_{i,t}}{frequency \times \left(1 + \frac{YTM_{s,cf}(t)}{f_i}\right)}$$

Where:

$ModC_{i,t}$	=	Modified Convexity of the Gilt
$C_{i,t}$	=	Macaulay Convexity of the Gilt, which is currently calculated
$ModD_{i,t}$	=	Modified Duration of the Gilt, which is currently calculated
$y_{i,t}$	=	Redemption Yield of the Gilt

## 9.6 Convexity for a Sector

9.6.1 The Macaulay Convexity (either Macaulay or modified) for Sector  $s$  for Day  $t$ ,  $C_{s,t}$ , is calculated as:

$$maccnvx_{s,i}(t) = \frac{1}{v_s(t)} \sum_{k=\frac{v}{d}}^{m+\frac{v}{d}} \frac{k_i^2 \times cf_i(t)}{\left(1 + \frac{YTM_{s,cf}(t)}{f_i}\right)^k}$$

$$MacCnvx_{s,cf}(t) = \frac{\sum_{i=1}^N (maccnvx_{s,i}(t) \times mv_i(t))}{MV_s(t)}$$

where

9.6.2 Modified convexity

$$modcnvx_{s,i}(t) = \frac{maccnvx_{s,i}(t)}{\left(1 + \frac{YTM_{s,cf}(t)}{f_i}\right)^2} + \frac{moddur_{s,i}(t)}{f_i \times \left(1 + \frac{YTM_{s,cf}(t)}{f_i}\right)}$$

$$ModCnvx_{s,cf}(t) = \frac{\sum_{i=1}^N (modcnvx_{s,i}(t) \times mv_i(t))}{MV_s(t)}$$

## 9.7 Market value weighting

9.7.1 The redemption yield (rule 9.2), duration (rule 9.4) and convexity (rule 9.6) are aggregated at the sector level using the portfolio cash flow (PCF) method. FTSE also calculates sector yields, duration and convexity which are aggregated using the market value weighting (MVW) method. The MVW method weights the relevant metric of every bond in the sector based on its gross price, the modified duration (for redemption yield only) and the notional outstanding amount.

The MVW Redemption Yield for sector  $s$  for day  $t$ ,  $y_{s,t}$ , is calculated as:

$$y_{s,t} = \frac{\sum_i N_{i,t} * P_{i,t} * D_{i,t} * y_{i,t}}{\sum_i N_{i,t} * P_{i,t} * D_{i,t}}$$

Where:

$y_{s,t}$	=	Redemption Yield of the index $s$ at time $t$
$y_{i,t}$	=	Redemption Yield of gilt $i$ at time $t$
$N_{i,t}$	=	Adjusted nominal value of gilt $i$ today at time $t$
$P_{i,t}$	=	Gross price of gilt $i$ at time $t$
$D_{i,t}$	=	Modified Duration of Gilt $i$ at time $t$

Similarly, the MVW duration or convexity for sector  $S$  on day  $t$ ,  $M_{s,t}$ , is calculated as:

$$M_{s,t} = \frac{\sum_i N_{i,t} * P_{i,t} * M_{i,t}}{\sum_i N_{i,t} * P_{i,t}}$$

Where:

$M_{s,t}$	=	Index duration or convexity (Macaulay or Modified) at time $t$
$M_{i,t}$	=	Duration or convexity (Macaulay or Modified) of gilt $i$ at time $t$
$N_{i,t}$	=	Adjusted nominal value of gilt $i$ at time $t$
$P_{i,t}$	=	Gross price of gilt $i$ at time $t$

## 9.8 Fitted Yields for Conventional Gilts

9.8.1 This section describes the methodology for the construction of the zero coupon yield curve, which is calculated daily, in order to produce a set of zero coupon, par and forward yields for conventional gilts.

The “zero coupon yield curve” for gilts of term  $m$  to maturity is defined:

$$z(m) = b_0 + \sum_{x=1}^4 b_x \times \frac{(1 - e^{-c_x \times m})}{c_x \times m}$$

Where:

$z(m)$	=	Zero-Coupon Yield for the term $t$
$b_0$	=	Parameter produced by the optimisation routine
$b_x$	=	Parameter produced by the optimisation routine where $x = 1, 2, 3$ and $4$
$c_x$	=	Constant value where $x = 1, 2, 3$ and $4$
$m$	=	Term to Maturity

The parameters of this yield curve,  $b_0$ ,  $b_1$ ,  $b_2$ ,  $b_3$ , and  $b_4$  are found by minimising the sum of squares function:

$$SS(b) = \sum_{i=1}^i N_i \times (P_i - \hat{P}_i)^2$$

Where:

$SS(b)$	=	Weighted sum of the squares of the price differences
$N_i$	=	Nominal Amount in Issue Gilt $i$
$P_i$	=	Actual Gross Price for Gilt $i$
$\hat{P}_i$	=	Gross Price of Gilt $i$ derived from Zero Coupon Yield

that is, the sum of the squares of the differences between the actual gross price for each gilt minus the gross price derived from the zero coupon curve, weighted by the market value of the gilt.

The derived gross price of each gilt in the index must be calculated using the following formula:

$$\hat{P}_K = \sum_{t=1}^T \frac{C}{freq} \times e^{-z(t) \times t} + PAR \times e^{-z(T) \times T}$$

Where,

$\hat{P}_K$	=	Derived gross price of the Gilt $k$
$T$	=	Term to Maturity
$T$	=	Term to remaining coupon payments
$C$	=	Coupon Rate of the Gilt $k$
$PAR$	=	Par value of the Gilt $k$ which is always 100.
$freq$	=	Frequency of Coupon payments
$z(T)$	=	Zero-Coupon yield for term to Maturity

Then Fitted Yields, using the formula for  $y(m)$ , for terms  $m = 5, 10, 15, 20, 25, 30, 35, 40, 45$  and  $50$  are published.

## 9.9 Technical Note on Duration, Modified Duration and Convexity

9.9.1 Duration and modified duration can be defined in terms of differential calculus. Consider a zero-coupon gilt of unit face value of term  $n$  years. Its present value, discounted at the continuously compounded rate (or “force”) of interest  $r$  is:

$$V(r) = \exp(-nr).$$

The derivative of  $V$  with respect to  $r$  is:

$$dV/dr = -n (\exp(-nr)).$$

The proportionate sensitivity, or “volatility”, of  $V$  to changes in  $r$  is:

$$-1/V \times dV/dr = -(-n (\exp(-nr))/\exp(-nr)) = n.$$

This is also the Macaulay Duration (or just Duration) of the gilt, first defined by F. R. Macaulay in *Some theoretical problems suggested by the movements of interest rates, bond yields and gilt prices in the United States since 1856*, published by the New York National Bureau of Economic Research, 1938 and reprinted by UMI Books on Demand, Ann Arbor, Michigan, 2000. The sensitivity with respect to the continuously compounded rate  $r$  is seen to equal the term of the zero-coupon gilt.

9.9.2 If the gilt is discounted at a rate of interest convertible half-yearly,  $i$ , then its present value is

$$V(i) = (1 + i/2)^{-2n}.$$

The derivative of  $V$  with respect to  $i$  is:

$$dV/di = -2n (1 + i/2)^{-2n-1}/2 = -n (1 + i/2)^{-2n-1}$$

The proportionate sensitivity of  $V$  to changes in  $i$  is:

$$-1/V \times dV/di = -(-n (1 + i/2)^{-2n-1})/(1 + i/2)^{-2n} = n (1 + i/2)^{-1} = n/(1 + i/2)$$

This is the Modified Duration of the zero-coupon gilt, which is the sensitivity with respect to changes in the rate compounded half-yearly,  $i$ .

Putting  $v$ , the half-yearly discount factor,  $= 1/(1 + i/2)$ , we see that

$$\text{Modified Duration} = n/(1 + i/2) = nv = \text{Duration} \times v.$$

9.9.3 For a coupon gilt, all the calculations are similar, with the numerators and denominators containing sums of the zero-coupon gilts that are the equivalent of the coupon gilts. Suppose that the coupon gilt is equivalent to a series of  $N$  zero-coupon gilts, with amounts  $A_j$  due at terms  $n_j$ , for  $j=1$  to  $N$ . Then the present value of the gilt is, discounted at the continuously compounded rate of interest  $r$  is:

$$V(r) = \sum_j A_j \exp(-n_j r).$$

The derivative of  $V$  with respect to  $r$  is:

$$dV/dr = -\sum_j A_j n_j \exp(-n_j r).$$

The proportionate sensitivity, or “volatility”, of  $V$  to changes in  $r$  is:

$$-1/V \times dV/dr = (\sum_j A_j n_j \exp(-n_j r))/\sum_j A_j \exp(-n_j r).$$

This is the (Macaulay) Duration of the coupon gilt. The sensitivity of the coupon gilt is seen to be the average value of the terms of the constituent zero-coupon gilts, weighted by the discounted present values of the constituent parts. It is therefore also known as the “discounted mean term” (see Redington, F. M. “Review of the principles of life office valuations”, *Journal of the Institute of Actuaries*, **78**, 286, 1952). The duration of a coupon gilt varies with the discount rate  $r$ , whereas the duration of a zero-coupon gilt of term  $n$  is always equal to  $n$ . However, the Modified Duration of a zero-coupon gilt varies with  $r$ .



9.9.4 As for the zero-coupon gilt, for the coupon gilt we have:

Modified Duration = Duration  $\times$   $v$ .

9.9.5 Convexity is equal to:

Convexity =  $(\sum_j A_j n_j^2 \exp(-n_j r))/V = 1/V \times d^2 V/dr^2$

Convexity is therefore equivalent to the second moment of the terms about zero.

## Section 10

# Formulae and calculation methods: index-linked gilts

## 10. Formulae and calculation methods: index-linked gilts

### 10.1 “Real” Redemption Yield for an Index-linked Gilt

10.1.1 The Real Redemption Yield for Index-linked Gilt  $i$  for Day  $t$ ,  $ry_{i,t}$ , is found as follows:

First, the rate of inflation assumed is denoted  $i$ , e.g.  $i = 0.05$  for 5% inflation.

Then we put  $r = (1 + i)^{1/12}$ , the monthly ratio for inflation.

Then values of the Retail Prices Index for each past month  $m$  are denoted  $Q(m)$ , and the most recent month for which the value of the Retail Prices Index is available is denoted  $M$ .

Then projected values of the Retail Prices Index, using the rate of inflation assumed, for month  $m$  from month  $M + 1$  onwards, are calculated as  $Q^l(m) = Q(M) \times r^{(m-M)}$ .

Then the projected nominal amount of each future payment of interest and redemption amount, indexed according to the rules for the Gilt, is calculated, using the past values of the RPI,  $Q(m)$ , up to month  $M$  and the future projected values,  $Q^l(m)$ , from month  $M + 1$  onwards. The indexed interest payments are denoted  $C_0^l, C_1^l, C_2^l, \dots$  and the indexed redemption amount is denoted  $R^l$ . In each case the projected amount, say  $I^l$ , payable in month  $m$  is calculated by multiplying the corresponding nominal amount  $X$  by  $Q(m - 8)$  or  $Q^l(m - 8)$ , as appropriate, and dividing by  $Q(B - 8)$  (assuming an 8-month lag, and a base month  $B$ ).

Then the root  $v_i$  is found of the equation

$$F_i(v) = V_i(v) - P_i = 0$$

where

$$V_i(v) = v^f \times \{C_0^l + C_1^l \times v + C_2^l \times v^2 + \dots + C_n^l \times v^n + R^l \times v^n\}$$

and other terms are as defined in Rule 9.1 for UK gilts.

Then the Real Redemption Yield  $ry_{i,t}$  is calculated as:

$$ry_{i,t} = 200 \{1/(v_i \times r^6) - 1\} \text{ (for half-yearly Gilts as all Index-linked Gilts are).}$$

### 10.2 “Real” Redemption Yield for an Index-linked Sector

10.2.1 The Real Redemption Yield for Index-linked Sector  $s$  for Day  $t$ ,  $ry_{s,t}$ , is calculated using the methodology for Gilts described in Rule 10.1 and the methodology for Sectors described in Rule 9.2.

Thus for Sector  $s$  the Real Redemption Yield is calculated from the root,  $v_s$ , of the equation:

$$F_s(v) = \sum_i N_i \times F_i(v) = 0$$

where

$F_i(v)$  for Gilt  $i$  is as defined in Rule 10.1, but calculated at the same discount factor for all Gilts in Sector  $s$ .

and the Real Redemption Yield is calculated as:

$ry_{s,t} = 200 \{1/(v_s \times r^6) - 1\}$  (all Index-linked Gilts being payable half-yearly).

### 10.3 Duration for an Index-linked Gilt

10.3.1 The Duration for Index-linked Gilt  $i$  for Day  $t$ ,  $D_{i,t}$ , is calculated as:

$$D_{i,t} = A_i(v_i)/V_i(v_i)$$

where

$$A_i(v) = [v^f \times \{C_0^1 \times f + C_1^1 \times (f+1) \times v + C_2^1 \times (f+2) \times v^2 + \dots + C_n^1 \times (f+n) \times v^n + R^1 \times (f+n) \times v^n\}]/frequency_i$$

$V_i(v)$  is as defined in Rule 10.1.

$v_i$  is the root of the equation  $F_i(v) = 0$  for Gilt  $i$  found previously.

10.3.2 The Modified Duration for Gilt  $i$  for Day  $t$ ,  $ModD_{i,t}$ , is calculated as:

$$ModD_{i,t} = D_{i,t} \times v_i$$

### 10.4 Duration for an Index-linked Sector

10.4.1 The Duration for Index-linked Sector  $s$  for Day  $t$ ,  $D_{s,t}$ , is calculated as:

$$D_{s,t} = A_s(v_s)/V_s(v_s)$$

where

$$A_s(v) = \sum_i N_i \times A_i(v)$$

$$V_s(v) = \sum_i N_i \times V_i(v)$$

$A_i(v)$  and  $V_i(v)$  for Gilt  $i$  are calculated using the discount factor  $v_s$  for Sector  $s$

$v_s$  for Sector  $s$  is the root of the equation  $F_s(v) = 0$  found previously in the calculation of the Real Redemption Yield for Index-linked Sector  $s$ .

10.4.2 The Modified Duration for Sector  $s$  for Day  $t$ ,  $ModD_{s,t}$ , is calculated as:

$$ModD_{s,t} = D_{s,t} \times v_s$$

### 10.5 Convexity for an Index-linked Gilt

10.5.1 The Convexity for Index-linked Gilt  $i$  for Day  $t$ ,  $C_{i,t}$ , is calculated as:

$$C_{i,t} = B_i(v_i)/V_i(v_i)$$

where

$$B_i(v) = [v^f \times \{C_0^1 \times f^2 + C_1^1 \times (f+1)^2 \times v + C_2^1 \times (f+2)^2 \times v^2 + \dots + C_n^1 \times (f+n)^2 \times v^n + R^1 \times (f+n)^2 \times v^n\}]/frequency_i^2$$

$V_i(v)$  is as defined in Rule 10.1

$v_i$  is the root of the equation  $F_i(v) = 0$  for Gilt  $i$  found previously.

## **10.6 Convexity for an Index-linked Sector**

10.6.1 The Convexity for Index-linked Sector  $s$  for Day  $t$ ,  $C_{s,t}$  is calculated as:

$$C_{s,t} = B_s(v_s)/V_s(v_s) \times \text{frequency}^2$$

where

$$B_s(v) = \sum_i N_i \times B_i(v)$$

$V_s(v)$  is as defined in Rule 10.4

$B_i(v)$  and  $V_i(v)$  for Gilt  $i$  are calculated using the discount factor  $v_s$  for Sector  $s$

$v_s$  for Sector  $s$  is the root of the equation  $F_s(v) = 0$  found previously in the calculation of the Real Redemption Yield for Index-linked Sector  $s$ .

## Section 11

# Formulae and calculation methods: capital changes

## 11. Formulae and calculation methods: capital changes

### 11.1 Changes to constituents

11.1.1 There are changes in the constituents of the indices from time to time and for each Sector the divisor in the expression in Rule 8.3 (the “base value”) must be adjusted so as to “chain-link” the indices appropriately. The possible types of change that are considered for the price indices are:

- A. New issues, brought in on the day of issue at the closing price on the day of issue.
- B. Late entrants, such as partly-paid new issues, which are brought in at the closing price when fully paid, and conversion gilts, brought in at or near an appropriate conversion date at the closing price.
- C. Amalgamations of further tranches of an existing gilt (A or B gilts), which take place normally on the first ex-dividend date of the A or B gilt, after which the gilts are identical.
- D. Alterations of nominal amount outstanding, such as: for gilts with a sinking fund, brought in from time to time as the information is available; for taps (small additional issues of an existing gilt, brought in at the close of business on the day the tap issue takes place at the closing price); for reductions of the amount outstanding for convertible gilts and increases of the amount outstanding for conversion gilts, where the nominal amounts are altered in accordance with the conversion terms, but the prices are the closing prices on the day the alteration is made (and not based on the conversion ratio).
- E. Redemptions, taken out on the redemption date at the closing price on the previous day, which always in practice equals the redemption amount.
- F. Early leavers, such as various gilts which have been almost wholly repurchased by the Government in exchange for a different gilt from time to time, and were deleted from the indices; and convertible gilts, once it is estimated that almost all the outstanding issue has been converted; also any gilts whose outstanding amount becomes so small that it gets onto the Debt Management Office’s list of rump gilts.

11.1.2 The above changes can apply to any gilts in any of the price indices. In addition a gilt may be transferred from one of the sectors to another depending on the time from the date of calculation to the date of redemption of this gilt. The possible further changes are:

- G. “Shorteners”: a gilt is moved, at its closing price, from one sector to a shorter sector after the close of business on the day when its redemption date less than or equal to 5, 10, 15, 20 or 25 years from the settlement date.
- H. If a gilt is due to be included in or excluded from an index defined under Rule 4.3.2 on a day when the market is closed, the stock will be included or excluded after the close on the last trading day before the appropriate anniversary so that it will be included in an index from the beginning of the first trading day for which it becomes eligible and excluded from an index from the beginning of the first trading day for which it becomes ineligible.

## 11.2 Adjustments to base values

- 11.2.1 On any one day there may be up to three adjustments to the “base value”, i.e. the denominator of the expression in Rule 8.3:
1. Redemptions are taken out at “yesterday’s” prices. Thus the base value is multiplied by (total market value yesterday of all gilts except redemptions) and divided by (total market value yesterday of all gilts).
  2. All remaining changes are allowed for at today’s closing prices. Thus the third adjustment factor is (total market value at today’s prices of gilts after changes, i.e. including new issues etc) divided by (total market value at today’s prices of gilts before changes).
- 11.2.2 In all calculations that relate to those gilts in a sector or in the indices as at the close of business on any day, such as calculations of yields, durations, etc, the gilts that are used include those gilts that have been in the sector during the course of that day, including those gilts that are leaving the sector after the close and excluding those gilts that are entering the sector after the close of business on that day. Thus redemptions and “shorteners”, which have been allowed for in adjustments (1) and (2) above, are assumed to have happened before the relevant calculations, whereas all other changes, those which are allowed for in adjustment (3) above, are assumed to take place after the closing calculations have been done (see Rules 4.4.3, 4.5.3, 5.3.3 and 5.4.4).

## 11.3 Normal calculations

- 11.3.1 The above description in words will now be repeated in a precise mathematical formulation. The same notation as defined in Rule 8.1 is used. The nominal amounts (in suitable units) for Gilt  $i$  in issue on the previous calculation date, denoted “yesterday”,  $y$ , and the current calculation date, “today”,  $t$ , are denoted by  $N_{i,y}$  and  $N_{i,t}$  respectively. Usually these are the same. “Capital changes” occur when these are different for any gilt.
- 11.3.2 On a day when there are no capital changes,  $N_{i,t} = N_{i,y}$  for all gilts. The market value of all gilts in the sector index yesterday was calculated as  $M_y = \sum_i N_{i,y} \times P_{i,y}$ . The market value of these same gilts today is calculated as  $M_t = \sum_i N_{i,t} \times P_{i,t}$ . The “base value” for the index yesterday is denoted by  $B_y$  and the index yesterday was calculated as  $I_y = M_y/B_y$ .
- 11.3.3 Since it is being assumed that there are no capital changes today, the base value for the index today is unchanged from yesterday, so  $B_t = B_y$ , and the index value today is calculated as  $I_t = M_t/B_t = M_t/B_y$ .
- 11.3.4 But  $B_y = M_y/I_y$ , so  $I_t = I_y M_t/M_y$ , showing that the change in the index from yesterday to today is proportional to the change in the market value of the gilts that are constituents of the index.

## 11.4 Capital changes

- 11.4.1 On a day when there are capital changes the calculations are more complicated. The base value needs to be adjusted, and this is done in three stages. Three ratios are calculated. These are denoted  $r_1$ ,  $r_2$  and  $r_3$ , and the new base value is calculated from the old as  $B_t = B_y \times r_1 \times r_2 \times r_3$ .
- 11.4.2 Each ratio is the quotient of a numerator and a denominator. Thus  $r_1 = N_1/D_1$ ,  $r_2 = N_2/D_2$  and  $r_3 = N_3/D_3$ .
- 11.4.3 The denominator,  $D_1$ , of the first ratio is the same as  $M_y$ , the market value of all gilts in the index yesterday.
- 11.4.4 The numerator,  $N_1$ , of the first ratio is the same as  $D_1$ , but with the exclusion of gilts that have just gone out of the index entirely (redemptions and “early leavers”).
- 11.4.5 Thus the ratio  $r_1 = N_1/D_1$  reflects the first adjustment described in Rule 11.2.1 above, under (1). Adjustment (2) is dealt with similarly.
- 11.4.6 The contributions made to the numerators and denominators for different types of change are shown in Table A. The numerators and denominators used in the calculation of the ratios are the totals for all relevant gilts of the appropriate contributions. The subscript  $i$  denoting the Gilt is omitted.
- 11.4.7 In Table A “Replacements” refer to cases where the recorded gilt details are to be changed, perhaps to correct an error; where the nominal amount is unchanged the effect of lines (c) and (d) combined is the same as line (a), no change.

- 11.4.8 For the amalgamation of an A gilt with the main gilt, where the nominal for the combined gilt is the sum of the previous nominals, the effect of lines (d) and (e) combined is also the same as line (a), no change.
- 11.4.9 It is possible, at least theoretically, though very seldom in practice, for multiple changes to apply to one gilt on one day. A gilt might “shorten” between sectors on the same day as the nominal amount is changed or an amalgamation occurs.
- 11.4.10 The mean prices,  $P_{i,m}$ , used for the calculations for “shorteners”, are calculated as

$$P_{i,m} = (1 - k)(P_{y,i} - XD_{i,t}) + kP_{i,t}$$

where the interpolation factor,  $k$ , is calculated as

$$k = \{\Sigma(N_{i,y} \times E_{i,t}) - \Sigma N_{i,y} \times (P_{i,y} - XD_{i,t})\} / \{\Sigma(N_{i,y} \times P_{i,t}) - \Sigma(N_{i,y} \times (P_{i,y} - XD_{i,t}))\}$$

where the summations are for all shorteners in the sector today, and  $XD_{i,t}$  is the ex-dividend interest amount (if any), defined Rule 8.6.

**Table A**

Contributions to the numerators and denominators of the adjustment factors made by gilts subject to different types of change.

$D_1$	$N_1$	$D_2$	$N_2$	$D_3$	$N_3$
(a) Gilts not changing today ( $N_t = N_y$ , so numerators equal corresponding denominators)					
$N_y \times P_y$	$N_y \times P_y$	$N_y \times P_m$	$N_y \times P_m$	$N_y \times P_t$	$N_t \times P_t$
(b) Redemptions and early leavers and shorteners out					
$N_y \times P_y$	0	0	0	0	0
(c) Late shorteners in					
0	$N_y \times P_y$	$N_y \times P_m$	$N_y \times P_m$	$N_y \times P_t$	$N_t \times P_t$
(d) New issues, entrants, replacements in and shorteners in					
0	0	0	0	0	$N_t \times P_t$
(e) Amalgamations (A gilt), replacements out and shorteners out					
$N_y \times P_y$	$N_y \times P_y$	$N_y \times P_m$	$N_y \times P_m$	$N_y \times P_t$	0
(f) Changes of nominal amount, amalgamations (combined gilt) ( $N_t \neq N_y$ )					
$N_y \times P_y$	$N_y \times P_y$	$N_y \times P_m$	$N_y \times P_m$	$N_y \times P_t$	$N_t \times N_t$

## Appendix A

# Further information

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A Glossary of Terms used in FTSE Russell's Ground Rule documents can be found using the following link:

[Fixed Income Glossary of Terms.pdf](#)

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

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