
Guide to the Calculation of Tradeweb FTSE Gilt Closing Prices

v1.5

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Section 1

Introduction

1.0 Introduction

1.1 Scope

1.1.1 This guide describes the method by which Tradeweb FTSE Gilt Closing Prices for UK gilts are derived. The process is jointly the responsibility of Tradeweb and FTSE Russell. The reference prices of conventional and index-linked gilts are used in the calculation of the FTSE Actuaries UK Gilts Index Series. Prices for gilt strips and UK Treasury Bills are also produced.

1.2 FTSE Russell

1.2.1 FTSE Russell is a trading name of FTSE International Limited, Frank Russell Company, and FTSE TMX Global Debt Capital Markets Limited and its subsidiaries (including MTSNext Limited). FTSE International Limited is the administrator of all FTSE Russell indexes.

1.3 Tradeweb

1.3.1 Tradeweb Europe Limited is incorporated in the UK and regulated by the Financial Conduct Authority. Tradeweb builds and operates electronic 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.

1.4 Overview of the origination of the reference prices

1.4.1 Since 1998, end-of-day gilt reference prices have been published by the UK Debt Management Office (DMO) on behalf of the Gilt-Edged Market Makers Association (GEMMA) based on aggregating prices submitted by Gilt-Edged Market Makers (GEMMs).

1.4.2 In 2015, the DMO announced its intention to withdraw from providing end-of-day GEMMA reference gilt and Treasury bill prices and the publication of its intra-day prices.

1.4.3 Following a review of alternative sources of reference prices by the Independent Reference Prices Review Team appointed by HM Treasury, Tradeweb and FTSE Russell were selected to provide reference prices following a transition period agreed in conjunction with the DMO.

1.4.4 The DMO ceased publishing end-of-day reference prices on 21 July 2017. From 24 July the responsibility for publishing the prices has resided with Tradeweb and FTSE Russell.

1.5 **IOSCO Principles for Financial Benchmarks**

1.5.1 In accordance with the requirements set out in the Request for Proposals issued by the Independent Reference Prices Review in July 2016, FTSE Russell will administer the Tradeweb FTSE Gilt Closing Prices in accordance with the IOSCO final report on Principles for Financial Benchmarks published in July 2013 (the “IOSCO Principles”).

1.6 **Publication**

1.6.1 The reference prices are calculated at the end of each business day. Delivery is available through a variety of mechanisms including the Tradeweb Marks file service.

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 Gilt Prices for the purposes of the IOSCO Principles.

2.2 Tradeweb

2.2.1 Tradeweb is responsible for calculating the reference prices based on executable price quotes available on their electronic trading platform.

2.2.2 Tradeweb is the Calculation Agent of the Tradeweb FTSE Gilt Closing Prices as defined by the IOSCO Principles

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, gilt strips and UK Treasury Bills. The Committee may also approve changes to this methodology. 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 Advisory Committee.pdf](#)

Section 3

Derivation of Tradeweb FTSE Gilt Closing Prices

3.0 Reference Prices

3.1 Prior to the transition in July 2017 end-of-day gilt reference prices will be provided by the UK Debt Management Office. After the transition the provision of reference prices will jointly be the responsibility of Tradeweb and FTSE Russell. The prices are calculated by Tradeweb using the methodology outlined below, with FTSE Russell responsible for governance and oversight of the calculation process.

3.2 Prices for conventional and index-linked gilts

Prices are based on executable bid and offer prices supplied by Gilt-Edged Market Makers (GEMMs) to Tradeweb's electronic trading platform in a two-minute collection window centred around the notional market "closing" time of 4.15pm. (Times may vary around public holidays, for example early closing on Christmas Eve.)

The two minute collection window is broken down into 24 5-second intervals for each security. Prices are sampled at a random time within the first 5-second interval. Prices are then sampled a further 23 times at regular 5-second intervals from the first interval.

For each conventional or index-linked gilt, prices are sampled this way from all GEMMs quoting prices for that bond. If, for example, twenty GEMMs are quoting bid-offer prices for a bond, then that gives 480 mid prices for the bond over the two-minute window, where each mid price is the arithmetic mean of associated bid and offer prices.

The prices are subject to two layers of filtering: firstly by standard deviation (SD) to eliminate outlying GEMMs, then a number of GEMMs are also randomly eliminated. The filtering process is applied separately to each of the 24 intervals.

For each security, in the first layer of filtering the mean mid price for each GEMM is calculated from its 24 prices within the sample window. The mean and population standard deviation of these GEMM mean prices is then calculated. Where an individual GEMM's mean price lies outside of a +/- one standard deviation range about the overall mean across all GEMMs then the prices from that GEMM are dropped from further calculations.

In the second layer of filtering, prices from a number of randomly-chosen remaining GEMMs are then also dropped from further calculations.

The number chosen is given in the table below.

No. of remaining GEMMs quoting prices, post SD-filter	No. of GEMMs removed
13 or more	3
12	2
11	1
10 or less	0

The reference price for the bond is then taken as the mean of all remaining mid prices, rounded to three decimal places for bonds with ten years or less to maturity, and two decimal places for bonds with more than ten years to maturity.

3.3 Price verification

Tradeweb compares derived prices against the Tradeweb composite prices, the previous day's price in the context of yield curve movements and prices from transactions on the Tradeweb system. Deviations outside of pre-set tolerances will result in a price failing the verification process and the triggering of a contingency plan.

3.4 Contingency plans

If a price cannot be calculated using the primary method, or if a price has been calculated but fails the verification process, then contingency plans are implemented according to the hierarchy below. If a price is unavailable or fails verification using one layer of contingency then the next layer on the hierarchy is triggered.

Contingency 1: Tradeweb's composite mid price based on non-executable dealer prices as at 4.15pm is used.

Contingency 2: The primary method is used, but based on a window running from 4.09 to 4.11pm.

Contingency 3: The primary method is used, but based on a window running from 4.04 to 4.06pm.

Contingency 4: The mid-day price, calculated using the primary method based on a window running from 11.59 to 12.01, is used.

Contingency 5: The previous day's reference price is used.

3.5 Prices for strips

Tradeweb derives prices for all UK gilt strips from a yield curve which is effectively fitted to the end-of-day gilt yields corresponding to the reference prices. More details on the derivation of this curve are provided in the next section.

3.6 Prices for bills

Tradeweb derives prices for UK Treasury Bills from a daily closing yield curve which is based on client sell transactions over the preceding five business days that were conducted through Tradeweb's electronic platform. The window runs from 4.15pm on date T-5 to 4.15pm on date T (where T = trade date). Prices from "outright" transactions only are used. The curve is fitted using a similar method as for pricing UK strips: see the next section.

The contingency price for a bill is the previous day's reference price.

3.7 Governance and Oversight

Every quarter Tradeweb provides reports to the FTSE Russell EMEA Fixed Income Advisory Committee showing details of price contributions of all GEMMs for each gilt; the number of times contingency plans have been required; and the number of times each GEMM has been dropped from the reference price calculations as a result of each of the standard deviation and randomness filters. Also every quarter FTSE Russell requests Tradeweb data from ten randomly-chosen business days in the past quarter to reproduce the calculations of primary and window-based contingency prices for all gilts on those days. Bill and strip curves are also reproduced.

Section 4

Methodologies for Pricing of Strips and Bills

4.0 Methodologies for pricing of strips and bills

- 4.1 Tradeweb derives end-of-day UK gilt strip prices from a zero-coupon yield curve calculated from the reference prices of conventional gilts. This approach follows the practice of the DMO and is in accordance with Bank of England publications^{1,2}. The methodology uses cubic splines to model an instantaneous forward curve function $f_{\beta}(m)$ where β is the vector of cubic spline parameters. The price of zero-coupon strips can be written as a function of the instantaneous forward curve:

$$B(\tau) = \exp \left[- \int_0^{\tau} f_{\beta}(m) dm \right]$$

where τ is the maturity of the bond.

The price of a coupon-paying bond can be written as:

$$P(c, \tau) = \sum_{i=1}^n cB(\tau_i) + 100B(\tau)$$

where c is the coupon payment each period, and n is the number of payments.

By minimising the following objective function the values of the cubic spline parameters β are found:

$$X_s = \sum_{i=1}^N \left[\frac{P_i - \Pi_i(\beta)}{D_i} \right]^2 + \int_0^M \lambda(m) [f_{\beta}''(m)]^2 dm$$

where $P_i, D_i, \Pi_i(\beta)$ are respectively the observed price, the modified duration and the fitted price of bond i . $f_{\beta}''(m)$ is the second derivative of the fitted forward curve and M is the maturity of the longest bond.

The objective function has two terms: the first is the sum of the squared bond price differences, weighted by modified durations. The second term is the Variable Roughness Penalty, which is the integral of the forward curve curvature multiplied by a smoothing function $\lambda(m)$ which satisfies:

¹ Nicola Anderson and John Sleath (1999), "New estimates of the UK real and nominal yield curves", Bank of England Quarterly Bulletin, November, pp384-392

² Nicola Anderson and John Sleath (2001), "New estimates of the UK real and nominal yield curves", Bank of England working paper, no. 126

$$\log \lambda(m) = L - (L - S) \exp\left(\frac{-m}{\mu}\right)$$

where L, S, μ are three parameters.

- 4.2 Tradeweb derives end-of-day UK Treasury Bill prices using a similar methodology to that used to price strips. The methodology uses a piecewise constant spline to model an instantaneous forward curve function $f_{\beta}(m)$ where β is the vector of spline parameters and, analogously to strips, the price of a bill can be written as a function of the instantaneous forward curve:

$$B(\tau) = \exp\left[-\int_0^{\tau} f_{\beta}(m) dm\right]$$

where τ is the maturity of the bill.

The price of a bill can also be written as:

$$P(\tau) = 100B(\tau)$$

By minimising the following objective function the values of the spline parameters β are found:

$$X_s = \sum_{i=1}^N \frac{e^{-(Today-TrdDate[i])/5}}{\sum_{j=1}^N e^{-(Today-TrdDate[j])/5}} * \left[\frac{P_i - \Pi_i(\beta)}{D_i} \right]^2$$

where $P_i, D_i, \Pi_i(\beta)$ are respectively the observed price, the modified duration and the fitted price of trade i . $TrdDate[i]$ is the date of trade i , N is the total number of bill trades. This objective function is the sum of the squared differences between fitted and observed prices, weighted by modified durations and exponential weights. The division of each date range by 5 within the exponential weights arises from the fact that transaction data from a collection window of 5 business days are used to arrive at the observed prices.

Constant yield extrapolation is used where maturities lie outside of the range of available data.

Based on the derived curve the yield of individual bills can be obtained (rounded to 6 decimal places) and the corresponding price (also rounded to 6 dp).

Section 5

Pricing of Illiquid Gilts

5.0 Pricing of Illiquid Gilts

5.1 An illiquid gilt is one for which there are consistently insufficient GEMM prices available to calculate a reliable and transparent end-of-day reference price. If for any gilt there are fewer than 5 GEMMs contributing prices during the end-of-day pricing window for 5 consecutive business days then that gilt will be deemed illiquid and on the fifth day and thereafter the gilt is priced according to the methodologies set out below. Note that by this definition a “rump” gilt need not be illiquid unless it also meets these criteria.

5.1.1 **Illiquid conventional gilts.** These are priced using the same yield curve used to calculate the reference price for gilt strips. As described previously this curve is created each day using liquid conventional gilt prices. The price of the illiquid gilt is calculated by discounting each cashflow according to the zero-coupon curve output from this process. In order to be as transparent as possible, no spreads are assumed.

5.1.2 **Illiquid index-linked gilts.** These are priced from a yield curve based on linearly interpolating the real yields of all liquid 3 month-lag index linked gilts. From the real yield thus obtained the corresponding price is calculated. In order to be as transparent as possible no spreads are assumed.

5.1.3 Once a gilt becomes illiquid and is priced according to the appropriate illiquid gilt pricing methodology above it will continue to be priced using this methodology unless and until it regains consistent liquidity. The gilt will be regarded as liquid once again if there are at least 5 contributing GEMMs during the end-of-day pricing window for 10 consecutive business days.

Section 6

Price Challenges

6.0 Price Challenges

- 6.1 Tradeweb and FTSE Russell have established a means by which clients can query or challenge the price or other measures of value of any gilt which has been calculated using the reference pricing methodology.
 - 6.1.1 Users who wish to challenge a price or other measure of value can do so using the following link:
<http://www.tradeweb.com/Institutional/Services/Gilt-Closing-Prices/>
 - 6.1.2 Clients submitting a query will receive an email acknowledgement. Details of the resolution of the issue will be further communicated to the client in a timely manner. Where files are republished all clients using the price service will be notified by email.
 - 6.1.3 Details of challenges and ensuing actions will be tracked and reported on a quarterly basis to the FTSE Russell EMEA Fixed Income Advisory Committee.

Appendix A: Further Information

A Glossary of Terms used in FTSE Russell's methodology documents can be found at:
[Fixed Income Glossary of Terms.pdf](#)

Further information on the FTSE Actuaries UK Gilts Series 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

For further information on the delivery mechanisms for the Tradeweb FTSE Gilt Closing Prices please contact Tradeweb at ECS@Tradeweb.com.

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