March 2025

Guide to the Calculation of Tradeweb FTSE US Treasury Benchmark Closing Prices

v1.1

FTSE RUSSELL
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Section 1

Introduction

1. Introduction

1.1 Tradeweb FTSE US Treasury Benchmark Closing Prices

1.1.1 This guide describes the method by which Tradeweb FTSE US Treasury Benchmark Closing Prices for US Treasury notes and bonds, US Treasury bills; and US Treasury Inflation-Protected Securties (US TIPS) are derived. Three Tradeweb FTSE US Treasury Benchmark Closing prices are calculated for each security, reflecting a bid-, mid- and offer-side quote type.[1] Mid-side prices for US Treasury STRIPS are also produced. The process is the joint responsibility of Tradeweb and FTSE Russell.

1.1.2 FTSE Russell assumed benchmark administration responsibilities for Tradeweb FTSE US Treasury Benchmark Closing Prices, effective January 01, 2024. Prior to this time, Tradeweb acted as calculation agent for these prices under a separate benchmark administrator since 2019.

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

1.3 Tradeweb

1.3.1 Tradeweb Markets LLC and its subsidiaries (together, “Tradeweb”) build and operate electronic marketplaces for rates, credit, equities and money markets.

1.4 Publication

1.4.1 The benchmark closing prices are calculated at the end of each business day. Delivery is available through a variety of mechanisms, including the Tradeweb marks file service. Benchmark closing prices are not published on US bond market holidays.

[1] Prices that reflect bid-side and offer-side were introduced on June 10, 2024. Prior to this date, only mid-side prices were calculated.

Section 2

Management responsibilities

2. Management responsibilities

2.1 FTSE International Limited (FTSE)

2.1.1 FTSE is the administrator of the Tradeweb FTSE US Treasury Benchmark Closing Prices.[2]

2.2 Tradeweb

2.2.1 Tradeweb is responsible for calculating the Benchmark Closing prices based on quotes available on their electronic trading platform.

2.2.2 Tradeweb is the calculation agent of the Tradeweb FTSE US Treasury Benchmark Closing Prices as defined by the IOSCO Principles.

2.3 FTSE Russell Governance Framework

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 defense risk management framework and is designed to meet the requirements of the IOSCO Principles for Financial Benchmarks[3], the European benchmark regulation[4] and the UK benchmark regulation[5] . The FTSE Russell Governance Framework can be accessed using the following link:

FTSE_Russell_Governance_Framework.pdf

2.4 FTSE Global Fixed Income Index Advisory Committees

2.4.1 The FTSE global fixed income advisory committees, which have regional representation in the Americas, EMEA and APAC, has been established by FTSE Russell.

The committees provide external oversight of the methodology under by which Tradeweb calculates end-of-day benchmark closing prices for US Treasuries, in addition to other asset classes. The committees may also provide their feedback on changes to this methodology. The terms of reference of the FTSE global fixed income advisory committees are set out on the FTSE Russell website and can be accessed using the following links:

FTSE_US_Fixed_Income_Advisory_Committee

FTSE_EMEA_Fixed_Income_Advisory_Committee.pdf

FTSE_APAC_Fixed_Income_Advisory Committee

[2] The term administrator is used in this document in the same sense as it is defined in the IOSCO Principles for Financial Benchmarks and 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).

[3] IOSCO Principles for Financial Benchmarks Final Report, FR07/13 July 2013.

4 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.

5 The Benchmarks (Amendment and Transitional Provision) (EU Exit) Regulations 2019.

Section 3

Derivation of Tradeweb FTSE US Treasury Benchmark Closing prices

3. Benchmark closing prices

Tradeweb FTSE US Treasury Benchmark Closing Prices are calculated by Tradeweb using the methodology outlined below, with FTSE Russell responsible for governance and oversight of the calculation process. Benchmark closing prices are calculated reflecting a bid-, mid- and offer-side quote type for US Treasury nominal bonds and notes, US Treasury bills, and US Treasury Inflation-Protected Securities (US TIPS).[6] Mid-side prices for US Treasury STRIPS are also produced.

3.1 US Treasury Notes, Bonds, Bills and TIPS Pricing Methodology

Prices are derived from bid- and offer-side price quotes sourced from market makers on either (i) the Dealerweb Treasury Platform (for the purposes of calculating the Tradeweb FTSE US Treasury Benchmark Closing Price for On-the-Run notes and bonds); or (ii) the Tradeweb Institutional Platform (for the purposes of calculating the Tradeweb FTSE US Treasury Benchmark Closing Price for all other securities) in a pre-determined collection window centred around 3:00 p.m. (New York) and 4:00 p.m. (New York) and 1:00 p.m. (New York) and 2:00 p.m. (New York) on dates when the US bond market closes early.

Price quotes sourced from the Dealerweb Treasury Platform are firm and executable price quotes provided by liquidity providers to liquidity takers. Quotes sourced from the Tradeweb Institutional Platform are attributable to specific liquidity providers and are executable by the receiving liquidity takers, subject to the liquidity providers accepting the trade.

3.1.1 The collection window captures all observed price quotes that are submitted around 3:00 p.m. (New York) and 4:00 p.m. (New York). All non-zero prices are incorporated, regardless of size. For US Treasury notes and bonds, and US TIPS, the collection windows are defined as 2:59:55 p.m. – 3:00:20 p.m. (New York) and 3:59:55 p.m. – 4:00:20 p.m. (New York). For US Treasury bills, the collection windows are defined as 2:59:45 p.m. – 3:00:20 p.m. (New York) and 3:59:45 p.m. – 4:00:20 p.m. (New York).

3.1.2 The price collection windows are divided into one-second time intervals, where a value will be populated starting from when the first price quote submission occurs within the window.

3.1.3 For each On-the-Run (OTR) US Treasury note and bond, the median “top-of-book”[7] bid- and offer-side price submitted in the one-second time intervals from the Dealerweb Treasury Platform is selected. On any given pricing date, there will be a single OTR US Treasury note and bond for each tenor (2-, 3-, 5-, 7-, 10-, 20- and 30-year original maturity). The OTR US Treasury will change on the monthly Issue Date and represent the latest new or reopened security. For each On-the-Run (OTR) US Treasury note and bond, an average “top-of-book” bid- and offer-side price from the Dealerweb Treasury Platform is calculated across the collection window. The mid-side price is calculated as the mid-point from the closing bid- and offer-side prices.

[6] Prior to June 10, 2024, only mid-side prices were calculated.
[7] “Top-of-book” is defined as the best (highest) bid-side and best (lowest) offer-side price quote across all market makers.

3.1.4 For each Off-the-Run US Treasury notes and bonds, the mid-side price is derived from a spread against its respective OTR US Treasury. Tradeweb maintains a dynamic mapping between each Off-the-Run US Treasury note and bond and it's corresponding OTR US Treasury. The OTR US Treasury will change each month on the Issue Date of the new bond or reopening each month.

3.1.5 For each Off-the-Run US Treasury note and bond, the median bid- and offer-side price is taken from each market maker's contributions and measured as a spread to the OTR US Treasury benchmark quote. An average spread to the OTR benchmark is calculated across the collection window resulting in a single spread quote per instrument per market maker. The median spread of all market maker inputs is then applied to the OTR US Treasury closing price. The median bid-offer spreads of all bid-offer spreads from the collection window is calculated and applied to the benchmark closing mid-side price by adding one-half of the spread to benchmark closing mid-price (benchmark closing offer-side price) and subtracting one-half of the spread from the benchmark closing mid-side price (benchmark closing bid-side price).

3.1.6 For US Treasury bills and US TIPS, for each market maker, an average price is calculated for each instrument resulting in a single price per instrument per market maker. The Tradeweb FTSE US Treasury benchmark closing mid-side price is then derived as the median price of all market maker input prices. To calculate the closing bid- and offer-side price, the median bid-offer spread of all bid-offer spreads from the collection window is calculated and applied to the closing mid-side price by adding one-half of the spread to benchmark closing mid-price (benchmark closing offer-side price) and subtracting one-half of the spread from the benchmark closing mid-side price (benchmark bid-side closing price).

3.1.7 For each security, at least 3 market makers must contribute a price quote update during the collection window.

3.1.8 The benchmark closing bid-, mid- and offer-side prices are rounded to three decimal places for bonds with 10 years or less to maturity and two decimal places for bonds with more than ten years to maturity.

3.2 US Treasury STRIPS Pricing

3.2.1 Mid-side prices are calculated for all US Treasury Interest-Only and Principal-Only STRIPS sourced from market makers on the Tradeweb Institutional Platform in a pre-determined collection window centred around 3:00 p.m. (New York) and 4:00 p.m. (New York). Times may vary around public holidays, for example early market closes. Quotes sourced from the Tradeweb Institutional Platform are attributable to specific liquidity providers and are executable by the receiving liquidity takers, subject to the liquidity providers accepting the trade.

3.2.2 The collection window captures all observed price quotes that are submitted around 3:00 p.m. (New York) and 4:00 p.m. (New York). For US STRIPS, the collection windows are defined as 2:59:45 p.m. – 3:00:20 p.m. (New York) and 3:59:45 p.m. – 4:00:20 p.m. (New York).

3.2.3 The price collection windows are divided into one-second time intervals, where, for each market maker, a value will be populated starting from when the first price quote submission occurs within the window. For each US STRIP security, a single input price quote per instrument is derived reflecting the median mid-price. All non-zero prices are incorporated, regardless of size.

3.2.4 For each market maker, an average price is calculated for each instrument resulting in a single price per instrument per market maker. The Tradeweb FTSE US Treasury benchmark closing mid-side price for all US STRIPS is then derived as the median price of all market maker input prices.

3.2.5 The closing mid-side price is rounded are rounded to three decimal places for each STRIP security.

3.2.6 Mid-side prices for illiquid US Treasury STRIPS, where less than 3 market makers submit pricing quotes, are derived from a yield curve, which is fitted to the end-of-day US Treasury yields corresponding to the Tradeweb FTSE US Treasury Benchmark Closing Prices. Additional details on the derivation of this curve is provided in Section 4.

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. For each security, at

least 3 market makers must contribute prices during the collection window. 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

3.4.1 For OTR US Treasuries, if a benchmark closing price derived from the Dealerweb platform cannot be calculated based on Rule 3.2 or if a benchmark closing price has been calculated, but fails the verification process, then the benchmark closing price is derived from quotes sourced from the Tradeweb Institutional Platform based on the primary method.

3.4.2 For all other US Treasury instruments, if a benchmark closing price cannot be calculated based on Rule 3.2 (the primary method) or if a benchmark closing price has been calculated, but fails the verification process, then the following hierarchy is used. If a benchmark closing price is unavailable or fails verification using one layer of contingency, then the next layer on the hierarchy is triggered.

Contingency one: The primary method is used, but assumes the last price quote update prior to the start of the collection window and all valid price quotes during the window.

Contingency two: The primary method is used, but based on a window running five minutes earlier.

Contingency three: The primary method is used, but based on a window running ten minutes earlier.

Contingency four: The previous day's closing price is used.

3.5 Governance and oversight

On a periodic basis, Tradeweb provides reports to the FTSE Global Fixed Income Index Advisory Committees showing details of price contributions of all market makers for each US Treasury and the number of times contingency plans have been required. Also every quarter, FTSE Russell requests Tradeweb data from 10 randomly chosen business days in the past quarter to reproduce the calculations of primary and window-based contingency prices for all US Treasuries on those days. The US Treasury STRIPS curve is also reproduced.

Section 4

Methodology for pricing illiquid US Treasury STRIPS

4. Methodology for pricing of illiquid US Treasury STRIPS

4.1 Tradeweb derives yields for Illiquid US Treasury STRIPS from a zero-coupon yield curve calculated from the yields of liquid US Treasury STRIPS. US Treasury STRIPS are deemed illiquid if there are fewer than a specified minimum number of Market Snapshots with at least 3 market makers quoting the corresponding US Treasury security. A separate zero-coupon yield curve is derived for US Treasury Principal STRIPS and US Treasury Interest STRIPS.

The methodology uses cubic splines to model an instantaneous forward curve function $\mathbf{f_\beta(m)}$ where β is the vector of cubic spline parameters. The price of zero-coupon bonds with a par value of 1 can be written as a function of the instantaneous forward curve:

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

where $\boldsymbol{\tau}$ is the maturity of the bond.

The price of STRIPS with par of 100 can be written as:

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

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

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

where $P_i, D_i, \prod_i(\beta)$ are respectively the observed US Treasury STRIP 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 dated STRIPS.

The objective function has two terms:

1. The first is the sum of the squared US Treasury STRIPS price differences, weighted by modified duration.
2. The second is the Variable Roughness Penalty, defined as the integral of the forward curve curvature multiplied by a smoothing function $\lambda(m)$ which satisfies:

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

where L, S, μ are roughness penalty parameters maximized over the sampling set of liquid STRIPS.

Section 5

Price challenges

5. Price challenges

Tradeweb and FTSE Russell have established a means by which clients can query or challenge the price or other measures of value of any US Treasury security which has been calculated using the benchmark closing pricing methodology.

5.1.1 Users who wish to challenge a price or other measure of value can do so using the following link:

reports.tradeweb.com/closing-prices/challenge/

5.1.2 Clients contacting FTSE Russell with the intention of challenging a price or with a query that may reasonably be expected to result in a challenge, will be referred to Tradeweb and the above link. FTSE Russell will subsequently contact Tradeweb to check whether a challenge was made and the outcome.

5.1.3 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.

5.1.4 Details of challenges and ensuing actions will be tracked and reported on a quarterly basis to the FTSE global fixed income index 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

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

Website: www.lseg.com/en/ftse-russell/

For further information on the delivery mechanisms for the Tradeweb FTSE U.S. Treasury Benchmark Closing Prices, please e-mail Tradeweb at MarketData@tradeweb.com.

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