



# **TRADEWEB ICE U.S. TREASURY CLOSING PRICES**

## **CALCULATION METHODOLOGY**

September 2019

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### Overview

The “Tradeweb ICE U.S. Treasury Closing Prices” have been designed to represent the market mid-price for U.S. Treasury Securities around 3:00pm Eastern Time (or 1:00pm on an early close) on days when the U.S. Treasury Securities market is open for trading in the United States (the “Underlying Interest”).

Each Tradeweb ICE U.S. Treasury Closing Price for a U.S. Treasury Security is calculated in accordance with this Methodology document based upon executable bid and offer quotes for the relevant U.S. Treasury Security from dealers on the Tradeweb Platform.

The “U.S. Treasury Securities” in respect of which the Tradeweb ICE U.S. Treasury Closing Prices are determined and published are (i) securities issued by the U.S. Treasury and (ii) separate trading of registered interest and principal securities (hereafter called “STRIPS”) created from securities issued by the U.S. Treasury. The Introduction and Key Terms section contains details of the types of the U.S. Treasury Securities in respect of which the Tradeweb ICE U.S. Treasury Closing Prices are calculated.

The executable bid and offer quotes that are used to calculate and determine the Tradeweb ICE U.S. Treasury Closing Prices (“Input Data”) are provided by dealers on Tradeweb’s Institutional Platform for trading U.S. Treasury Securities (the “Tradeweb Platform”, as further described in the Introduction and Key Terms section) which satisfy the detailed specifications and eligibility criteria regarding the different types and sources of, and the priority of use of the different types of, the Input Data (the “Input Data Specification”, as set out in the Introduction and Key Terms section).

This document is the “Methodology” that sets out the methodology used to calculate and determine the published values for each Tradeweb ICE U.S. Treasury Closing Price, and is reviewed at least annually by the Oversight Committee for the Tradeweb ICE U.S. Treasury Closing Prices (the “Oversight Committee”), as documented in the Oversight Committee’s Terms of Reference.

The Tradeweb ICE U.S. Treasury Closing Prices are administered by ICE Benchmark Administration Limited (“IBA”), which is authorised and regulated by the Financial Conduct Authority for the regulated activity of administering a benchmark, and is authorised as a benchmark administrator under the EU Benchmarks Regulation (Regulation (EU) 2016/1011 of 8 June 2016).

IBA has outsourced the calculation, publication and licensing of the Tradeweb ICE U.S. Treasury Closing Prices to Tradeweb Markets LLC (“Tradeweb”).

## INTRODUCTION AND KEY TERMS

### Key Features of the Methodology

- **Multiple, Random Snapshots:** Multiple, randomized market snapshots of executable bid and offer quotes for a given U.S. Treasury Security from dealers on the Tradeweb Platform taken during a short window before calculation. This enhances the benchmark's robustness and reliability by protecting against attempted manipulation and temporary aberrations in the underlying market.
- **Outlier Exclusion:** To protect against unrepresentative dealer quotes within a market snapshot influencing the benchmark, dealer mid-prices that are more than one standard deviation from the mean are excluded from the calculation.
- **Random Dealer Quote Removal:** To protect against the possibility of predicting the impact that a particular quote (or quotes) may have on the benchmark calculation, a number of dealer mid-prices are randomly eliminated from the calculation.
- **Special Cases:** There are certain special cases where the published price for a U.S. Treasury Security is not derived using bid and offer quotes from the Tradeweb Platform. For example, U.S. Treasury Securities that are close to maturity will be priced at par.

### U.S. Treasury Security Types and Quoting Convention

The Tradeweb ICE U.S. Treasury Closing Prices are calculated and published in respect of the following types of U.S. Treasury Security, as described in the table below.

Each type of U.S. Treasury Security has a quoting convention that dictates whether the economic value of the Tradeweb ICE U.S. Treasury Closing Price for such U.S. Treasury Security is expressed as a "Price", a "Rate" or a "Yield", which is also set out in the table below.

U.S. Treasury Security Type	Description	Quoting Convention for Tradeweb ICE U.S. Treasury Closing Price
REGNOTE	U.S. Treasury Note/Bond	Mid-Price
REGTIPS	U.S. Treasury Inflation Protected Note/Bond	
WIANOTE	When Issued After Auction U.S. Treasury Note/Bond	
WIATIPS	When Issued After Auction U.S. Treasury Inflation Protected Note/Bond	
REGBILL	U.S. Treasury Bill	Mid-Rate
WIABILL	When Issued After Auction U.S. Treasury Bill	
WIBBILL	When Issued Before Auction U.S. Treasury Bill	
STRIPINT	U.S. Treasury Interest Strip	Mid-Yield
STRIPPRIN	U.S. Treasury Principal Strip	
WIBNOTE	When Issued Before Auction U.S. Treasury Note/Bond	
WIBTIPS	When Issued Before Auction U.S. Treasury Inflation Protected Note/Bond	

The descriptions within this document use the generic term “mid-price” but the calculation and the Tradeweb ICE U.S. Treasury Closing Price will always use the correct convention (mid-price, mid-rate or mid-yield) for each U.S. Treasury Security Type.

For certain U.S. Treasury Security Types, a mid-price and/or mid-yield will be published as part of the Derived Prices and Associated Information (as defined below) alongside the mid-price, mid-rate or mid-yield that constitutes the Tradeweb ICE U.S. Treasury Closing Price.

Please see below and Appendix 2 for further information on the Derived Prices and Associated Information.

### The Tradeweb Platform

The Tradeweb Platform is a global, institutional platform for trading U.S. Treasury Securities (as well as other fixed income asset types). The Tradeweb Platform is either regulated or exempt from regulation in the various jurisdictions where institutional users can access the platform and trade U.S. Treasury Securities.

For further details about the Tradeweb Platform, visit: <https://www.tradeweb.com/our-markets/institutional/>.

### Input Data Specification

The Tradeweb ICE U.S. Treasury Closing Price for each U.S. Treasury Security is calculated based on Input Data that are:

- Executable bid and offer quotes expressed as a price, a rate or a yield (as applicable);

- For that U.S. Treasury Security;
- From dealers on the Tradeweb Platform;
- Offered to institutional clients of that dealer on the Tradeweb Platform;
- During the relevant Collection Window,

in accordance with this Methodology (the “Input Data Specification”).

The Input Data sourcing and collection process is subject to a Tradeweb validation procedure to ensure that the Input Data Specification is satisfied in respect of the Input Data used to calculate and determine each Tradeweb ICE U.S. Treasury Closing Price.

### **Publication Days, Early Closing Days and Holiday Schedules**

The days when the U.S. Treasury Securities market is open for trading in the United States and on which the Tradeweb ICE U.S. Treasury Closing Prices will be published (“Publication Days”) follow the U.S. holiday schedule recommended by SIFMA.

This can be found at the following link: <https://www.sifma.org/resources/general/holiday-schedule/>.

The Tradeweb Platform will be closed on U.S. holidays, so the Tradeweb ICE U.S. Treasury Closing Price will not be calculated and published on these days.

For certain U.S. holidays, as recommended by SIFMA, the Tradeweb Platform closes early on the preceding Publication Day (“Early Closing Days”). Users should check the holiday schedule listed above to confirm the Early Closing Days.

The time of publication (“Publication Time”) for the Tradeweb ICE U.S. Treasury Closing Prices on a Publication Day is:

- 3:45pm ET, where the Publication Day is not an Early Closing Day; or
- 1:45pm ET, where the Publication Day is an Early Closing Day.

### **Errors and Republication**

IBA has published an [Error and Republication Policy](#) which addresses situations where an error in Input Data or in the determination of a Tradeweb ICE U.S. Treasury Closing Price is identified after the publication of the relevant price, including when a re-publication of a corrected Tradeweb ICE U.S. Treasury Closing Price is required.

A record of all replications and errors in any quarter, and any complaint that results in a determination of a Tradeweb ICE U.S. Treasury Closing Price being changed in any quarter, will be published as part of a quarterly update by IBA at [IBA Reports Center](#).

### **Derived Prices and Associated Information**

Tradeweb will, alongside each Tradeweb ICE U.S. Treasury Closing Price, publish certain prices, yields and other information in respect of each U.S. Treasury Security that are derived from or related to the published Tradeweb ICE U.S. Treasury Closing Price for that U.S. Treasury Security (the “Derived Prices and Associated Information”).

The list of such Derived Prices and Associated Information and a description of how certain of these are calculated from the relevant Tradeweb ICE U.S. Treasury Closing Price is included in Appendix 2.

### High Level Calculation Overview

The Tradeweb ICE U.S. Treasury Closing Price calculation for each of U.S. Treasury Security has the following steps, subject to certain “Special Cases” as described below:

- **Step 1** - During a 2-minute Collection Window, 24 Market Snapshots are taken for each U.S. Treasury Security and a Dealer Mid-Price is calculated for each dealer in each snapshot.
- **Step 2** - Dealer Mid-Prices for dealers that are outliers and a set of randomly selected Dealer Mid-Prices are removed from the calculation.
- **Step 3** - The arithmetic mean of the remaining Dealer Mid-Prices is calculated for each Market Snapshot to produce a Market Snapshot Price.
- **Step 4** - The Tradeweb ICE U.S. Treasury Closing Price for each U.S Treasury Security is calculated as the arithmetic mean of the 24 Market Snapshot Prices.
- **Step 5** - The Tradeweb ICE U.S. Treasury Closing Price for each U.S. Treasury Security is subject to a verification process to determine whether this or an alternative Tradeweb ICE U.S. Treasury Closing Price using Market Snapshots from an earlier Collection Window is published for that U.S. Treasury Security.

## DETAILED CALCULATION METHODOLOGY STEPS

### Step 1 - Market Snapshots

On each Publication Day and for each U.S. Treasury Security executable bid and offer quotes that satisfy the Input Data Specification, supplied by dealers on the Tradeweb Platform, are gathered during a two-minute window (a “Collection Window”) centered around 3:00pm ET (i.e. between 2:59pm and 3:01pm).

On Early Closing Days the two-minute Collection Window is centered around 1:00pm ET (i.e. between 12:59pm and 1:01pm) instead.

Where a verification check is failed as per Step 5 below, then an alternative, earlier Collection Window may be utilized.

The two minute Collection Window is broken down into 24 separate 5-second intervals. A random time is chosen within the first 5-second interval.

A record of all executable bids and offers from all applicable dealers on the Tradeweb Platform for that interval for each U.S. Treasury Security (a “Market Snapshot”) is then taken. The remaining 23 Market Snapshots for each U.S. Treasury Security are taken at regular 5-second intervals following the first Market Snapshot.

Each dealer has several categories of clients (“Tiers”) on the Tradeweb Platform. Each Tier represents the price available to a different category of client. Within each Market Snapshot for a U.S. Treasury Security, a “Mid-Price” is calculated for each dealer for each Tier as the volume-weighted mid-price of that dealer’s executable bid prices and offer prices within that Tier (such prices being a “Ladder”).

The resulting Mid-Prices for each dealer Tier within a Market Snapshot are then arithmetically averaged to derive an overall “Dealer Mid-Price” for each Market Snapshot in respect of each dealer quoting the relevant U.S. Treasury Security.

### Step 2 - Filtering of Dealer Quotes

The Dealer Mid-Prices for each Market Snapshot are subject to two layers of filtering: first by standard deviation to eliminate outlying Dealer Mid-Prices; and secondly by randomly eliminating a number of Dealer Mid-Prices. The filtering process is applied separately to each of the 24 Market Snapshots for each U.S. Treasury Security.

#### Outlier Filtering

The filtering of outliers only applies within a Market Snapshot if there are at least 4 dealers quoting the relevant U.S. Treasury Security. If there are 3 or fewer dealers, then there is no outlier filtering. The arithmetic mean and population standard deviation of the Dealer Mid-Prices for a Market Snapshot are calculated. If an individual Dealer Mid-Price lies outside of a +/- 1 standard deviation range about the mean, then that Dealer Mid-Price is removed from the benchmark calculation.

#### Random Dealer Filtering

This filtering only occurs if there are at least 11 Dealer Mid-Prices remaining after the outlier filtering has been applied. A number of the Dealer Mid-Prices for a Market Snapshot are randomly selected for removal from the benchmark calculation. The number of Dealer Mid-Prices that are randomly removed is dependent upon the number of Dealer Mid-Prices remaining after the outlying filtering has taken place.

The number of Dealer Mid-Prices removed is given in the table below:

Number of Remaining Dealer Mid-Prices	Number of Dealer Mid-Prices Randomly Removed
13 or more	3
12	2
11	1
10 or less	0

### Step 3 - Market Snapshot Price

The price for each Market Snapshot for each U.S. Treasury Security (the “Market Snapshot Price”) is then calculated as the arithmetic mean of the Dealer Mid-Prices that remain after all filtering has been applied.

### Step 4 - Closing Price Calculation

The Tradeweb ICE U.S. Treasury Closing Price for each U.S. Treasury Security is then calculated as the arithmetic mean of the 24 Market Snapshot Prices for that U.S. Treasury Security. This price is rounded to the nearest whole tick unit for the type of U.S. Treasury Security, as detailed in the table below.

U.S. Treasury Security Type	Tick Unit
REGNOTE REGTIPS WIANOTE WIATIPS	1/8 of 1/32 (1/256)
REGBILL WIABILL WIBBILL	0.0005
STRIPINT STRIPPRIN	0.0005
WIBNOTE WIBTIPS	0.0001

Each Tradeweb ICE U.S. Treasury Closing Price is then subject to a verification process prior to publication to determine whether this or price or an alternative Tradeweb ICE U.S. Treasury Closing Price using Market Snapshots from an alternative, earlier Collection Window is published as the Tradeweb ICE U.S. Treasury Closing Price for the relevant U.S. Treasury Security.

### Example Calculation of the Closing Price

The following example illustrates the calculation of the Dealer Mid-Price for a single Market Snapshot for a single U.S. Treasury Security.

See below an example table of Mid-Prices for a given U.S. Treasury Security for the relevant quoting dealers arranged by Tier.



Dealer	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Dealer Mid-Price
DLR1	100.11914	100.11914	100.12109			100.11979
DLR2	100.12305	100.12109	100.12305	100.12109	100.12109	100.12188
DLR3	100.11914	100.11914	100.11914			100.11914
DLR4	100.11914	100.11914	100.11914			100.11914
DLR5	100.11914	100.11914	100.11914	100.11914	100.11914	100.11914
DLR6	100.12109	100.12109	100.12109			100.12109
DLR7	100.12109	100.12109	100.12109	100.12109	100.12109	100.12109
DLR8	100.12109	100.12109	100.12109	100.12109		100.12109
DLR9	100.11719					100.11719
DLR10	100.12695	100.12695	100.12695	100.12695		100.12695
DLR11	100.12109	100.11914	100.11914			100.11979
DLR12	100.12109	100.12109	100.12109	100.12109	100.12109	100.12109
DLR13	100.12109					100.12109
DLR14	100.11914					100.11914
DLR15	100.11914	100.11914	100.11914	100.11914	100.11914	100.11914

In this case there are 15 dealers quoting for the relevant U.S. Treasury Security, each quoting for up to 5 separate Tiers.

The price shown for each dealer for each Tier is the volume-weighted Mid-Price of each dealer's Ladder within that Tier. For each dealer, the arithmetic mean of the Mid-Prices for all of their available Tiers is calculated. This is the column labelled "Dealer Mid-Price".

The mean and standard deviation of this set of 15 Dealer Mid-Prices is calculated, giving the following.

$$\text{Mean} = 100.120451$$

$$\text{Standard Deviation (SD)} = 0.002105$$

For the Outlier Filtering, Dealer Mid-Prices are removed from the calculation if they are more than +/- 1 standard deviation from the mean. In this case the minimum and maximum allowed values for a Dealer Mid-Price to be retained are:

$$\text{Max Dealer Mid-Price} = 100.120451 + 0.002105 = 100.122557$$

$$\text{Min Dealer Mid-Price} = 100.120451 - 0.002105 = 100.118346$$

DLR9 has a Dealer Mid-Price below the minimum and is excluded from the calculation.  
 DLR10 has a Dealer Mid-Price above the maximum and is also excluded from the calculation.  
 All other dealers have Dealer Mid-Prices between the minimum and the maximum; they are retained.

There are 13 Dealer Mid-Prices remaining. With this number of remaining Dealer Mid-Prices, 3 additional Dealer Mid-Prices are randomly removed from the calculation. Assume that Dealer Mid-Prices for dealers DLR3, DLR6 and DLR13 are randomly selected for removal. There are now 10 Dealer Mid-Prices remaining - these are the records below shown in **black font**. The dealers removed due to the Outlier Filtering are shown in **red** and the dealers removed by the Random Dealer Filtering are shown in **orange**.

Dealer	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Dealer Mid-Price
DLR1	100.11914	100.11914	100.12109			100.11979
DLR2	100.12305	100.12109	100.12305	100.12109	100.12109	100.12188
DLR3	100.11914	100.11914	100.11914			100.11914
DLR4	100.11914	100.11914	100.11914			100.11914
DLR5	100.11914	100.11914	100.11914	100.11914	100.11914	100.11914
DLR6	100.12109	100.12109	100.12109			100.12109
DLR7	100.12109	100.12109	100.12109	100.12109	100.12109	100.12109
DLR8	100.12109	100.12109	100.12109	100.12109		100.12109
DLR9	100.11719					100.11719
DLR10	100.12695	100.12695	100.12695	100.12695		100.12695
DLR11	100.12109	100.11914	100.11914			100.11979
DLR12	100.12109	100.12109	100.12109	100.12109	100.12109	100.12109
DLR13	100.12109					100.12109
DLR14	100.11914					100.11914
DLR15	100.11914	100.11914	100.11914	100.11914	100.11914	100.11914

The Market Snapshot Price for this Market Snapshot is then calculated as the arithmetic mean of the 10 Dealer Mid-Prices that remain after all the filtering has been applied.

**Market Snapshot Price = 100.12013**

The above process is repeated for the other 23 Market Snapshots taken for the relevant U.S. Treasury Security.

The Tradeweb ICE U.S. Treasury Closing Price for the U.S. Treasury Security is the arithmetic mean of all 24 Market Snapshot Prices.

### Step 5 - Verification process

The Tradeweb ICE U.S. Treasury Closing Price for each U.S. Treasury Security, calculated as above, is subject to a verification process to determine whether an alternative Tradeweb ICE U.S. Treasury Closing Price using Market Snapshots from an alternative, earlier Collection Window should be published in respect of that U.S. Treasury Security.

The verification process includes one or more of the following checks, conducted in the following order. Where a verification check is passed, then the calculated Tradeweb ICE U.S. Treasury Closing Price can be published. Where a verification check is failed, then the next following check is conducted and so on, until either a verification check is passed and the calculated Tradeweb ICE U.S. Treasury Closing Price can be published, or until all verification checks are failed.

- Levels of market liquidity within the Market Snapshots are checked, to ensure an active market, by comparing against a minimum threshold number of dealers per U.S. Treasury Security per Market Snapshot.
- The price, rate or yield for a U.S. Treasury Security is checked against transaction data for that U.S. Treasury Security, to identify market activity, errors and exceptional market circumstances, by comparing against a threshold maximum difference.

- The day-on-day change in the price, rate or yield for a U.S. Treasury is checked, to identify errors and exceptional market circumstances, by comparing against a threshold maximum daily change per U.S. Treasury Security, which may vary based on the time remaining until maturity of the U.S. Treasury Security.
- The price, rate or yield for a U.S. Treasury is checked against the Tradeweb Composite Price for that U.S. Treasury Security for that day, to identify errors and exceptional market circumstances, by comparing against a threshold maximum deviation (see [https://cdn.tradeweb.com/497f01/globalassets/our-businesses/data--reporting/market-data/tradeweb-composite-price\\_final.pdf](https://cdn.tradeweb.com/497f01/globalassets/our-businesses/data--reporting/market-data/tradeweb-composite-price_final.pdf) for further details on the Tradeweb Composite Price).

If all the verification checks are failed (or there are no dealers providing quotes for the relevant U.S. Treasury Security in that Collection Window and so no Tradeweb ICE U.S. Treasury Closing Price could be derived) then the Tradeweb ICE U.S. Treasury Closing Price is re-calculated as above using Market Snapshots from a Collection Window commencing 5 minutes prior to the standard Collection Window. The verification process above is then conducted in respect of this re-calculated Tradeweb ICE U.S. Treasury Closing Price. Where a verification check is passed, then the re-calculated Tradeweb ICE U.S. Treasury Closing Price can be published. Where a verification check is failed, then the next following check is conducted and so on, until either a verification check is passed and the re-calculated Tradeweb ICE U.S. Treasury Closing Price can be published, or until all verification checks are again failed.

If all the verification checks are again failed (or again there are no dealers providing quotes for the relevant U.S. Treasury Security in that Collection Window and so no Tradeweb ICE U.S. Treasury Closing Price could be derived), then the Tradeweb ICE U.S. Treasury Closing Price is re-calculated again as above using Market Snapshots from a Collection Window commencing 10 minutes prior to the standard Collection Window. The verification process above is then conducted in respect of this re-calculated Tradeweb ICE U.S. Treasury Closing Price. Where a verification check is passed, then the re-calculated Tradeweb ICE U.S. Treasury Closing Price can be published. Where a verification check is failed, then the next following check is conducted and so on, until either a verification check is passed and the re-calculated Tradeweb ICE U.S. Treasury Closing Price can be published, or until all verification checks are again failed.

In this case (or again there are no dealers providing quotes for the relevant Security in that Collection Window and so no Tradeweb ICE U.S. Treasury Closing Price could be derived), the [Tradeweb ICE U.S. Treasury Closing Prices Insufficient Data Policy](#) will apply to the determination of the Tradeweb ICE U.S. Treasury Closing Price for the relevant U.S. Treasury Security.

## **SPECIAL CASES**

### **Special Case - U.S Treasury Securities Nearing Maturity**

As U.S. Treasury Securities approach maturity, the yield calculations can be skewed due to the short period between the standard settlement date and the maturity date.

As a result, U.S. Treasury Securities that are close to maturity will be priced at par, rather than having a price derived from market snapshots of dealer quotes. The point at which a U.S. Treasury Security will default to being priced at par is determined by the number of days remaining to maturity. Any U.S. Treasury Security with fewer than 3 days to maturity will be priced at par. This value could change in the future and may be varied by U.S. Treasury Security Type.

In this special case, the par price will be the published Tradeweb ICE U.S. Treasury Closing Price in respect of such U.S. Treasury Security.

### **Special Case - Illiquid Strips**

For STRIPS that have fewer than 12 Market Snapshots with at least 4 dealers quoting the U.S. Treasury Security (Illiquid STRIPS), the price (yield) is derived from a zero-coupon curve rather than from the dealer quotes.

Please refer to Appendix 1 for the calculation methodology used for Illiquid STRIPS.

In this special case, this calculated price will be the published Tradeweb ICE U.S. Treasury Closing Price in respect of such U.S. Treasury Security.

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## APPENDIX 1 CALCULATION METHODOLOGY FOR ILLIQUID STRIPS

Tradeweb derives Illiquid STRIPS yields from a zero-coupon yield curve calculated from the yields of liquid STRIPS (i.e. STRIPS that are not Illiquid STRIPS). STRIPS are deemed illiquid when there are fewer than 12 Market Snapshots with at least 4 dealers quoting the U.S. Treasury Security. To handle inherent differences between Principal STRIPS and Interest STRIPS, a separate zero-coupon yield curve is derived for each.

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

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

where  $\tau$  is the maturity of the bond.

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

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

By minimising the following objective function, the values of the cubic spline parameters  $\beta$  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 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:

- The first is the sum of the squared STRIPS price differences, weighted by modified durations.
- The second is the Variable Roughness Penalty, being 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  $L, S, \mu$  are roughness penalty parameters maximized over the sampling set of liquid STRIPS.

**APPENDIX 2  
DERIVED PRICES AND ASSOCIATED INFORMATION**

Field	Description	Applicability
CUSIP	CUSIP Identifier for the U.S. Treasury Security. Can be repeated where security has WIA- or WIB- prefix.	All U.S Treasury Securities.
coupon	Annual coupon rate for the U.S. Treasury Security. 0 = not applicable.	REGNOTE, REGTIPS, WIANOTE AND WIATIPS
description	A description of the U.S. Treasury Security.	All U.S Treasury Securities.
securitytype	U.S. Treasury Security Type. See page 2 for the list of U.S Treasury Security Types.	All U.S Treasury Securities.
ontherun	On-the-run indicator. 1 = On-the-run (current). >1 = On-the-run (historic) up to 10 (beyond that = 0). -1 = WIBBILL, WIBTIPS or WIBNOTE. STRIPPRIN or STRIPINT = 0.	All U.S Treasury Securities.
whenissued	When Issued Indicator. -1 = WIA- or WIB- prefix. 0 = has been issued.	All U.S Treasury Securities.
maturitydate	Maturity date of the U.S. Treasury Security.	All U.S Treasury Securities.
datedated	First accrual date of the U.S. Treasury Security. 0 = not applicable.	All U.S Treasury Securities except STRIPS.
dateissued	Date the U.S. Treasury Security is issued. 0 = not applicable.	All U.S Treasury Securities except STRIPS.
auctiondate	Auction date of the U.S. Treasury Security. 0 = not applicable.	All U.S Treasury Securities except STRIPS.
firstcoupondate	First coupon payment date of the U.S. Treasury Security. 0 = not applicable.	All U.S Treasury Securities except STRIPS.
issuedas	Number of issue months of the U.S. Treasury Security. Blank = not applicable.	All U.S Treasury Securities except STRIPS and REGBILL, WIABILL, WIBBILL if has issuedays value.
Issuedays	Number of issue days of the U.S. Treasury Security. 0 = not applicable.	REGBILL, WIABILL, WIBBILL unless has issuedas value.
currency	Currency ISO Code (always USD).	All U.S Treasury Securities.
indexratio	Index Ratio, calculated in accordance with formulae below. Blank = not applicable.	REGTIPS and WIATIPS.
midprice	Mid Clean Price (for REGNOTE, REGTIPS, WIANOTE and WIATIPS as per methodology, for REGBILL, WIABILL, WIBBILL, STRIPINT and STRIPPRIN, as per formulae below). Blank = not applicable.	All U.S Treasury Securities except WIBTIPS and WIBNOTE.
middirtyprice	Mid Dirty Price, calculated in accordance with formulae below. Blank = not applicable.	REGTIPS and WIATIPS.
nominalprice	Mid Nominal Price, calculated in accordance with formulae below. Blank = not applicable.	REGTIPS and WIATIPS.
midyield	Mid Clean Yield (for STRIPINT, STRIPPRIN, WIBNOTE and WIBTIPS as per methodology, for REGBILL, WIABILL, WIBBILL and REGNOTE, REGTIPS, WIANOTE and WIATIPS in accordance with formulae below).	All U.S Treasury Securities.
nominalyield	Mid Nominal Yield, calculated in accordance with formulae below. Blank = not applicable.	REGTIPS and WIATIPS.
bondyield	Mid Bond Yield (for REGBILL, WIABILL, WIBBILL,	All U.S Treasury

Field	Description	Applicability
	REGNOTE, WIANOTE,, STRIPPRIN and STRIPINT in accordance with formulae below). 0 = REGTIPS and WIATIPS. Blank = WIBNOTE or WIBTIPS.	Securities.
midrate	Mid Discount Rate, calculated in accordance with the methodology. Blank = not applicable.	REGBILL, WIABILL and WIBBILL.
accrued	Accrued interest since preceding payment date or interest at maturity, calculated in accordance with formulae below. 0 = WIANOTE. Blank = not applicable.	REGNOTE, REGTIPS, WIANOTE, and WIATIPS.
mdur	Modified duration, calculated in accordance with formulae below). Blank = not applicable.	All U.S Treasury Securities except WIBTIPS, WIBNOTE.
effdur	Effective duration, calculated in accordance with formulae below. Blank = not applicable.	REGTIPS and WIATIPS.
amended	Amended flag. Defaults to 0. A value of 1 indicates U.S Treasury Security has been corrected in a republished file.	All U.S Treasury Securities.

See general formulae for the derived prices for the Tradeweb ICE U.S. Treasury Closing Prices below:

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