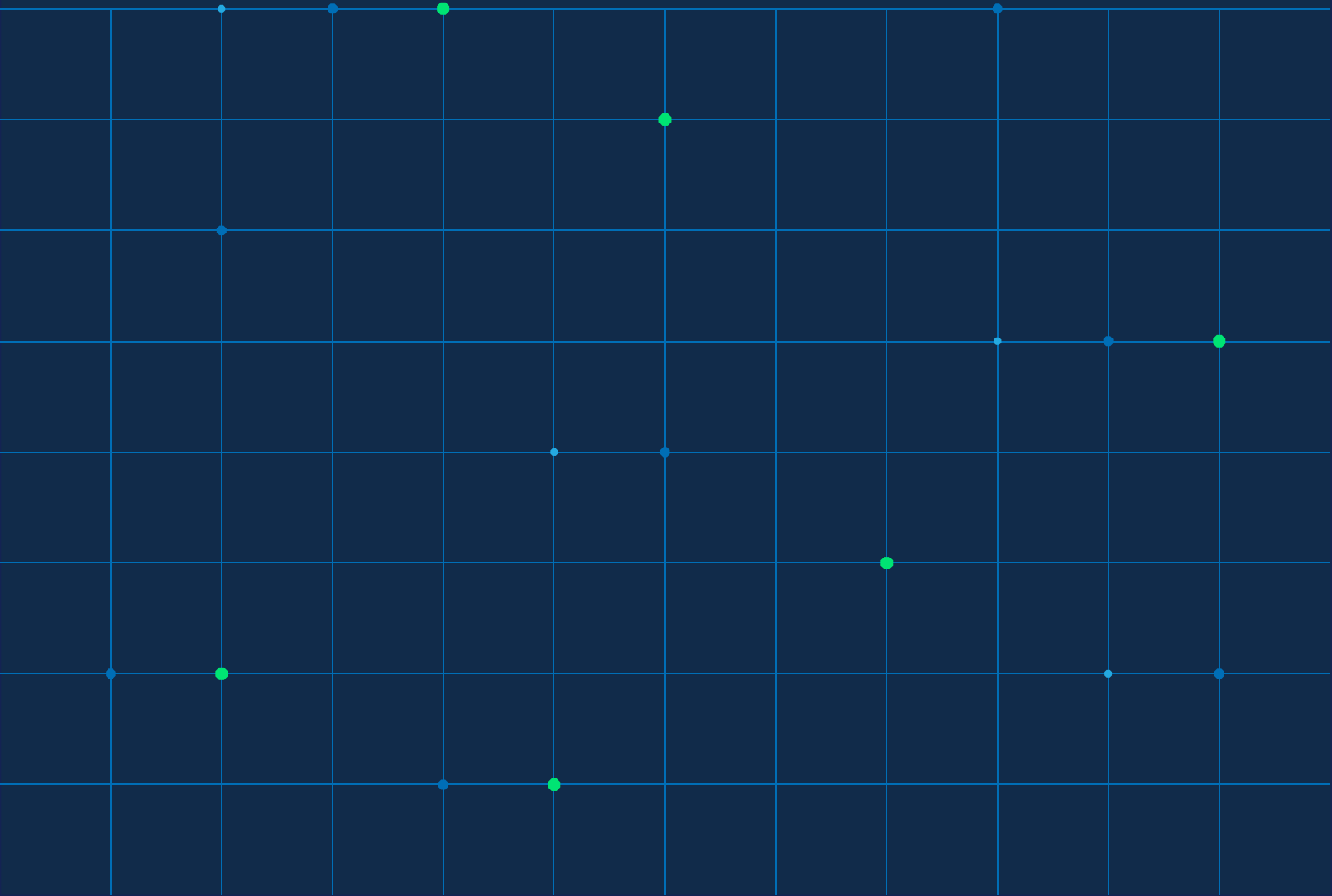


BrokerTec US Treasury Benchmarks Methodology

CME Group Benchmark Administration Limited

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Version Control

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1.0	Initial version	May 18 th , 2021
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1. Introduction

The BrokerTec US Treasury Benchmarks are a suite of benchmarks administered by CME Group Benchmark Administration Limited (CBA or the Administrator) which provide the volume weighted average prices (VWAP) and volume weighted average yields (VWAY) for on-the-run US Treasuries. The rates are calculated four times a day (1100 EST, 1500 EST, 1600 EST and 1700 EST) focussing on the 2, 3, 5, 7, 10, 20 and 30 Year on-the-run US Treasury bonds. The published rates reflect actual transactions and executable orders during the 15-minute observation window on the BrokerTec US¹ Central Limit Order Book (the BrokerTec CLOB).

1.1. CME Group and CME Group Benchmark Administration Limited

As a leading and diverse derivatives market operator, CME Group is the parent of four U.S.-based designated contract markets (“DCMs”): Chicago Mercantile Exchange Inc. (“CME”), Board of Trade of the City of Chicago, Inc. (“CBOT”), New York Mercantile Exchange, Inc. (“NYMEX”), and the Commodity Exchange, Inc. (“COMEX”) (collectively, the “CME Group Exchanges”). These exchanges offer a wide range of products available across all major asset classes, including futures and options based on interest rates, equity indexes, foreign exchange, energy, metals, and agricultural commodities. CME Group offers futures trading through the CME Globex® electronic trading platform (“Globex”), fixed income trading via BrokerTec, foreign exchange trading on the EBS platform, and central counterparty clearing services through CME Clearing, a division of CME.

CBA capitalizes on CME Group’s wealth of electronic transaction-based data in the calculation of its indices and benchmarks. CME Group Benchmark Administration Limited (CBA) is authorized and supervised by the UK Financial Conduct Authority (FCA). CBA is the Benchmark Administrator of the BrokerTec US Treasury Benchmarks Family of Benchmarks, with Chicago Mercantile Exchange Inc. providing calculation agent and distribution services.

1.2. Regulatory and IOSCO Compliance

The BrokerTec US Treasury Benchmarks is a family of benchmarks, designed on the basis of industry best practices and the IOSCO Principles for Financial Benchmarks. This will include but not be limited to the creation of an oversight committee and a published methodology. The Index will also be subject to an audit process. Material changes to the methodology will be announced via public consultation and any changes such as a re-balancing of the constituent components would be announced with a notice period of at least one month.

BrokerTec US Treasury Benchmarks are available for use under the UK Benchmark Regulation (BMR)².

¹ <https://www.cmegroup.com/trading/market-tech-and-data-services/brokertec.html>

² <https://www.fca.org.uk/markets/benchmarks/regulation>

2. Input Data

The BrokerTec US Treasury Benchmarks Methodology utilises the following hierarchy of input data sources:

1. All trades of on-the-run US Treasuries executed on the BrokerTec CLOB during the 15-minute observation window leading to the respective rate publication time.
2. The bid/ask prices and volumes from the top five levels of the order book on the BrokerTec CLOB.

The input data is captured during the 15-minute observation window prior to each rate publication time (10:45:00-11:00:00, 14:45:00-15:00:00, 15:45:00-16:00:00, and 16:45:00-17:00:00 US Standard Time (EST)).

BrokerTec Americas LLC offers the BrokerTec CLOB in accordance with the BrokerTec CLOB Rulebook and its Form ATS filed with the SEC.

2.1. Use of Expert Judgement

The BrokerTec US Treasury Benchmarks are determined on the basis of the methodology documented below. No expert judgement is applied to the determination of the BrokerTec US Treasury Benchmarks.

3. Calculation Methodology

The US Treasury rates are calculated as a volume weighted price based on the transaction and executable orders on the BrokerTec CLOB.

3.1. Target volume

A target volume ($Volume_{Target}$) is set for each treasury bond tenor and observation window. The target volume is calculated as the 25th percentile of the rolling three months traded volume rounded to the nearest \$10million.

The target volume is reset every month end and is applied to the calculation during the following month.

3.2. Treasury Benchmarks Price Calculation

The BrokerTec US Treasury Benchmarks are calculated following the procedure listed below.

On each business day a rate is determined for seven tenors (2 Year, 3 Year, 5 Year, 7 Year, 10 Year, 20 Year and 30 Year) of on-the-run US Treasury Bonds. The rate is calculated four times a day in the following 15-minute observation windows:

Rate calculation	Observation window
11:00EST	10:45:00 – 11:00:00
15:00 EST	14:45:00 – 15:00:00
16:00 EST	15:45:00 – 16:00:00
17:00 EST	16:45:00 – 17:00:00

All the trades executed during the observation window defined above are pooled to calculate the trade based VWAP as shown below:

$$VWAP_{Trade} = \frac{\sum P_i \times Q_i}{\sum Q_i}$$

The total traded volume is calculated as:

$$Volume_{Trade} = \sum Q_i$$

Where:

- P_i is the price of a given trade.
- Q_i is the volume of a given trade.

3.2.1. Calculation Methodology when trading volume is sufficient

If the traded volume for a given tenor is greater than or equal to the target volume ($Volume_{Trade} \geq Volume_{Target}$) during the observation window, the rate is calculated as the VWAP of all trades.

$$Rate = VWAP_{Trade}$$

If the traded volume is below the target volume ($Volume_{Trade} < Volume_{Target}$), the VWAP is supplemented with executable orders from top five levels of the order book to calculate the published rate as set out below.

3.2.2. Determining the Order Volume when trading volume is insufficient

Where $Volume_{Trade} < Volume_{Target}$, order book data is utilised to fill the *Gap* between the $Volume_{Trade}$ and $Volume_{Target}$.

$$Gap = Volume_{Target} - Volume_{Trade}$$

Sufficient volume in order book

Where the volume in the top five levels of the bid side of the order book and the volume in the top five levels of the ask side of the order book are greater than or equal to the *Gap* the order book volume ($Volume_{Order}$) is calculated as follows:

For:

$$\sum_{n=1}^5 BidV_n \geq Gap \quad \text{and} \quad \sum_{n=1}^5 AskV_n \geq Gap$$

The order book volume is calculated as follows:

$$Volume_{Order} = AskV = BidV = Gap$$

Where:

- n is the order book level.
- $BidV_n$ is the bid volume at order book level n .
- $AskV_n$ is the ask volume at order book level n .
- $BidV$ is the bid volume used in the final calculation.
- $AskV$ is the ask volume used in the final calculation.

Insufficient volume in order book

Where the volume in either the top five levels of the bid side of the order book and the volume in the top five levels of the ask side of the order book are less than the *Gap* the order book volume ($Volume_{Order}$) is calculated as follows:

For:

$$\sum_{n=1}^5 BidV_n < Gap \quad \text{or} \quad \sum_{n=1}^5 AskV_n < Gap$$

The order book volume is calculated as follows:

$$Volume_{Order} = AskV = BidV = \min \left\{ \sum_{n=1}^5 BidV_n, \sum_{n=1}^5 AskV_n \right\}$$

The volume of the bid and ask sides of the order book are limited to the $Volume_{Order}$ level defined in the formula above.

3.2.3. Calculation Methodology when trading volume is insufficient

The Volume Weighted Bid is calculated as follows:

$$OBVWAP_B = \sum_{n=1}^5 \frac{BidV_n}{Volume_{Order}} BidP_n$$

The Volume Weighted Ask is calculated as follows:

$$OBVWAP_A = \sum_{n=1}^5 \frac{AskV_n}{Volume_{Order}} AskP_n$$

Where:

- n is the order book level.
- $BidV_n$ is the bid volume at order book level n .
- $AskV_n$ is the ask volume at order book level n .
- $BidP_n$ is the bid price at order book level n .
- $AskP_n$ is the ask price at order book level n .

The VWAP of the order book is calculated as the mid-price of the Volume Weighted Bid and Volume Weighted Ask:

$$OBVWAP_M = \frac{OBVWAP_B + OBVWAP_A}{2}$$

The rate is then calculated as follows:

$$Rate = \frac{VWAP_{Trade} \times Volume_{Trade} + OBVWAP_M \times Volume_{Order}}{Volume_{Trade} + Volume_{Order}}$$

3.3. Treasury Benchmarks Yield Calculation

Yields to maturity are calculated for each trade and orderbook quote used in the VWAY calculation. The Newton-Raphson method is used to calculate the yields through the following iterative process:

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$
$$f(x_n) = -P + \frac{100}{(1+x_n)^k} + \sum_{i=1}^{2k} \frac{C}{(1+x_n)^{\frac{i}{2}}}$$
$$f'(x_n) = \frac{-100k}{(1+x_n)^{k+1}} - \sum_{i=1}^{2k} \frac{\left(\frac{i}{2}\right)C}{(1+x_n)^{\left(\frac{i}{2}+1\right)}}$$

Where:

x = Yield to Maturity

P = Price of the US Treasury

C = Semi – annual coupon of the US Treasury

k = Years to Maturity

The calculated yields are used to determine the VWAY for each Treasury. The VWAY calculation uses the same [calculation methodology](#) as the VWAP with the price input data replaced by yields.

4. Publication and Error Policy

4.1. Publication

The BrokerTec US Treasury Benchmarks are published 15 minutes after the rate calculation at 11:15EST, 15:15EST, 16:15EST and 17:15EST each business day (in accordance with the SIFMA US Holiday Schedule). BrokerTec US Treasury Benchmarks are published on the CME Group website and on licensed data vendor platforms.

On days where there is an early market close (in accordance with the SIFMA US Holiday Schedule), a rate may not be published for all Observation Windows, see [Appendix III](#) for further details. Appendix III will be updated by the Administrator and approved by the Oversight Committee annually.

4.2. Validation and integrity checks

The BrokerTec US Treasury Benchmarks are validated, by the Calculation Agent, for all publications. The Calculation Agent validates the integrity of the data, and monitors day on day yeild changes and traded volumes against pre-defined tolerances. If the the validation checks fail, the Calculation Agent will check the integrity of the input data and re-run the calculation. If the input data is unable to be validated, the index value, for the Treasury that cannot be validated, will be set to the previous published value.

If the previous value is used for more than three consecutive business days, the Administrator must promptly convene the Oversight Committee to assess available remedial actions.

4.3. Error policy

The Administrator takes the utmost care to ensure that input data and calculations are accurate; during the calculation process and prior to publication, the Administrator performs additional validation checks to identify possible errors, and swiftly recalculate and revalidate BrokerTec US Treasury Benchmarks prior to publication.

Once published, BrokerTec US Treasury Benchmarks will not be republished for that given publication time to prevent possible market disruptions.

5. Governance

The Administrator operates under a comprehensive Risk and Control Framework, providing clear policies on Governance, Oversight, Benchmark Design and Calculation, Outsourcing, Operations, Reporting of Infringements and Business Continuity.

CBA has in place a "Three Lines of Defence" model, enabling close cross-monitoring of the governance process - this being business, compliance and audit who all have a key role in ensuring that CBA meets its regulatory requirements.

5.1. Oversight Committee

An Oversight Committee is appointed by the Administrator to review the integrity of the benchmark, in accordance with the CBA Terms of Reference for the Oversight Committees.

The Oversight Committee will provide independent oversight of, and challenge, to the Administrator on all aspects of the Benchmark determination process. The minutes of the Oversight Committee are made available on the Administrator's website.

The Oversight Committee will escalate to the CBA Board if required.

5.2. Review of the Methodology

The Administrator constantly monitors the Benchmark Methodology and its consistency with the stated objectives. The Benchmark Methodology is reviewed annually by the Administrator and the Oversight Committee.

The Oversight Committee approves proposed changes to the Benchmark Methodology including, but not limited to, the structure of the Benchmark, input data used and all aspects of the Calculation Methodology.

The Oversight Committee may direct the Administrator to consult on any changes to the methodology with Stakeholders and the wider market.

5.3. Consultation Process

The Administrator will engage relevant stakeholders and end-users on material changes to the Benchmark Methodology, if required by regulation or where the Oversight Committee requests such consultation.

Changes to the Methodology are deemed material on the basis of an assessment conducted by the Administrator and submitted to the Oversight Committee for advice and feedback.

The Administrator will publish notice of the consultation on its website, inviting feedback from stakeholders and the wider market. Notice of a consultation will be posted at least 1 (one) month prior to the deadline for responses. The notice will include the details of the proposed material change, the timeline and the rationale for the change.

Findings of the consultation process and proposed changes to the Benchmark Methodology, recommended as a result of the consultation, will be presented by the Administrator to the Oversight Committee for its consideration.

Feedback to a consultation is considered confidential, however the Administrator will publish an anonymized summary with its conclusions, as soon as it is practical, but before implementation of any changes.

5.4. Cessation

The Administrator constantly monitors the representativeness of the Benchmark. If the Benchmark is deemed to be unrepresentative of the underlying economic reality due to paucity of input data or systemic changes in the related markets, the Administrator will engage the Oversight Committee at the earliest opportunity. These cessation arrangements are designed to mitigate cessation and transition risks.

The Oversight Committee may direct the Administrator to consult with Stakeholders as described in the [Consultation Process section](#).

As a last resort, if no alternative arrangements are feasible, the Oversight Committee may advise the Administrator to discontinue the Benchmark, providing Stakeholders at least 6 (six) months' notice and assistance to explore alternative reference instruments.

The Administrator will endeavour to identify alternative benchmarks; however, this might not always be possible due to Regulations, market conditions or suitable alternatives.

Users of the benchmark are recommended to ensure that they have adequate fallback policies and procedures in the event of the Benchmark becoming unrepresentative of its economic interest.

5.5. Records Retention

The Administrator has in place policies for the retention of any relevant evidence and documentation related to the determination and dissemination of the Benchmark, either in paper or in electronic format, for at least the mandatory term of 5 (five) years.

5.6. Auditing

An internal audit process is undertaken regularly, to ensure adherence to the stated Methodology, the IOSCO principles and regulatory requirements.

External audits can be requested at any time by the Administrator's Board, the Oversight Committee or the internal audit function.

5.7. Data Licensing and Distribution

The Benchmark is made available subject to execution of an Information License Agreement (ILA) together with the appropriate Schedules. Market participants that intend to subscribe to the benchmark should contact the Administrator at the following email address: datasales@cmegroup.com

5.8. Complaints Procedures

The [CME Group EMEA / APAC Complaints Procedures](#) sets out details on the management of customer complaints to ensure that they are handed fairly and effectively, in a prompt and transparent manner and in accordance with applicable regulatory requirements.

Complaints will be dealt with by a senior member of staff not directly involved with the benchmark calculation and dissemination.

Information related to complaints will be stored in a restricted access area and kept for a period of at least 5 (five) years following the date when the complaint was first lodged. Complaints can be submitted at internationalcompliance@cmegroup.com

Appendix I – Key Terms & Definitions

TERM	DESCRIPTION
Administrator	CME Group Benchmark Administration Limited
BMR	UK Benchmark Regulation (Regulation (EU) 2016/2011, as retained in UK law under the EUWA)
CBA	CME Group Benchmark Administration Limited
CLOB	Central Limit Order Book
EST	Eastern Standard Time
EUWA	European Union (Withdrawal) Act 2018, as amended from time to time
SIFMA	Securities Industry and Financial Markets Association
UST	US Treasury
VWAP	Volume Weighted Average Price
VWAY	Volume Weighted Average Yield

Appendix II – ESG Disclosures

Explanation of how ESG Factors are Reflected in the Key Elements of the Benchmark Methodology		
Item 1	Name of the benchmark administrator.	CME Group Benchmark Administration Limited
Item 2	Type of benchmark or family of benchmarks.	Sovereign Debt
Item 3	Name of the benchmark or family of benchmarks.	BrokerTec US Treasury Benchmarks
Item 4	Does the benchmark methodology for the benchmark or family of benchmarks take into account ESG factors?	No

Appendix III – BrokerTec US Treasury Benchmarks Early Close Calendar

2023 Early Close Calendar

DATE	SIFMA CALENDAR/ MARKET CLOSE TIME	BrokerTec US Treasury Benchmarks Published
07-Apr-2023	12:00pm ET	11:00 am
26-May-2023	2:00pm ET	11:00 am
03-Jul-2023	2:00pm ET	11:00 am
24-Nov-2023	2:00pm ET	11:00 am
22-Dec-2023	2:00pm ET	11:00 am
29-Dec-2023	2:00pm ET	11:00 am

2024 Early Close Calendar

DATE	SIFMA CALENDAR/ MARKET CLOSE TIME	BrokerTec US Treasury Benchmarks Published
28-Mar-2024	2:00pm ET	11:00 am
24-May-2024	2:00pm ET	11:00 am
03-Jul-2024	2:00pm ET	11:00 am
29-Nov-2024	2:00pm ET	11:00 am
24-Dec-2024	2:00pm ET	11:00 am
31-Dec-2024	2:00pm ET	11:00 am

