cfbenchmarks
a Kraken company

CME CF Bitcoin Volatility Index - Real Time (BVX)

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Contents

1 Version History

Version	Date Issued	Summary of Change	Owner
V1.0	9 Apr 2024	N/A	CF Benchmarks Management
V1.1	16 May 2024	Added Section 7 methodology review and changes	CF Benchmarks Compliance
V1.2	16 May 2024	Addition of Contingency Calculation Rules concerning: • Delayed Data • Erroneous Data • Potentially Erroneous Data • Expert Judgement • Calculation Failure Clarified reference to "CF SPOT RATES" methodology Updated Notice and Disclaimer	CF Benchmarks Management
V1.3	02 Jul 2025	Added Micro Bitcoin Futures and Micro Bitcoin Options Contract to Relevant Order Book	CF Benchmarks Management
V1.4	24 Oct 2025	Rebranded to CME CF Bitcoin Volatility Index - Real Time	CF Benchmarks Management

2 Overview

The CME CF Bitcoin Volatility Index - Real Time (BVX) represents a single, real-time measure of implied volatility in the CME Bitcoin Options market. It is a forward-looking measure, indicating how dispersed price movements in the underlying asset may be over a given time horizon. Volatility indices in this class are often referred to as fear gauges given how they capture the stress embedded in options markets based on what market participants price into options contracts.

The CME CF Bitcoin Volatility Index - Real Time is constructed using tradable prices of options contracts available on CME, where price discovery is facilitated by the GLOBEX central limit order book system and transactions are centrally cleared.

The index calculation methodology is based on the pricing of variance swaps to isolate exposure to volatility of an asset, independent of the price evolution of Bitcoin prices. The weighting method of option prices based on their strikes matches the standard market approach of creating a replicating portfolio of traded options to match the payoff of a volatility swap. This allows for the creation of volatility index derivatives with constant vega over a wide span of market movements of the underlying asset.

Underlying Economic Reality

The CME CF Bitcoin Volatility Index is intended to measure the underlying economic reality of creating a weighted portfolio of CME Bitcoin options contracts with a view to replicating the payoff of a Bitcoin volatility swap. A volatility swap is an OTC traded financial instrument that allows an investor to gain direct linear exposure to Bitcoin volatility over a given time horizon, priced relative to a fair volatility strike defined at inception of the trade. The fair volatility strike is calculated by combining option contracts of different strike prices to produce a constant vega (volatility) exposure in the overall portfolio. This calculation is accomplished by the use of order input data from the CME that facilitate the trading of said options contracts

3 Definitions

API: Application programming interface.

Front Contract: CME Bitcoin Futures contract which is closest to its expiry date.

Next Contract: CME Bitcoin Futures contract with expiry date after the Front Contract expiry date.

Next+1 Contract: CME Bitcoin Futures contract with expiry date immediately following the Next Contract expiry date.

Expiry Day: The last Friday of the Front Contract's month. If this is not either a UK or a U.S. business day, the contract expiry day will take place on the immediately preceding business day which is either a UK or a U.S. business day.

Expiry Datetime: 4:00 pm London on the Expiry Day.

Calculation Time: Any time as of which the CME CF Bitcoin Volatility Index - Real Time is published.

Relevant Order Book: The universe of the currently unmatched limit orders to buy or sell a unit of a given CME Bitcoin Futures, Micro Bitcoin Futures, CME Bitcoin Options contract, or CME Micro Bitcoin Options contract, aggregated by price, that is reported through its API to the Calculation Agent.

Retrieval Time: The time, as given by the server clock of the Calculation Agent, which the Relevant Order Book corresponds to. When obtained from a request/response API such as a REST API, this would be the time of the request made by the Calculation Agent through the API. When obtained from a real-time feed such as a Websocket API, this would be the most recent time as of which the Calculation Agent has a valid Order Book from an unbroken connection.

4 Methodology

4.1 Qualitative Description

The CME CF Bitcoin Volatility Index - Real Time is constructed using orderbook data from CME Bitcoin Futures and CME Options on Bitcoin Futures and Micro Bitcoin Futures. The index is calculated using a widely accepted standard variance swap replication technique, whereby option price data from different strikes and expiration dates is converted into a fair, constant maturity measure of Bitcoin volatility.

The steps in the calculation of the index are as follows:

1. Collate the list of relevant CME Futures and Options contracts on Bitcoin Futures and Micro Bitcoin Futures for the relevant calculation time and collect the corresponding orderbook data.
2. Consolidate the relevant CME Futures and Options contracts on Bitcoin Futures and Micro Bitcoin Futures by aggregating liquidity at identical strike prices and expiration dates, with all contract quantities normalized to BTC-equivalent notional amounts.
3. Calculate Spot Rates for every CME Futures and Options contract.
4. Select final list of option prices after filtering for erroneous data and liquidity thresholds.
5. Strip a US Dollar yield curve and calculate interest rates for a maturity equivalent to the time to expiry of the relevant options contracts.
6. Calculate the front and next term fair variance strikes, then interpolate linearly for the 30-day constant maturity Bitcoin Volatility Index.

4.2 Volatility Index Calculation

The CME CF Bitcoin Volatility Index - Real Time at Effective Time is calculated as a 30-day constant maturity fair variance strike by way of linear interpolation of variance strikes calculated based on options pricing data of the two closest expirations[1] traded on CME Globex. The variance σ_n^2 for the relevant expiration dates $n = \{1, 2\}$ — where expiration date 1 immediately precedes the 30-day maturity and expiration date 2 immediately follows it — are calculated as follows:

$$\sigma_n^2 = \frac{2}{T_n} e^{r_n T_n} \sum_i \frac{\Delta K_{i,n}}{K_{i,n}^2} Q(K_{i,n}) - \frac{1}{T_n} \left(\frac{F_n}{K_{ATM,n}} - 1 \right)^2 \quad (1)$$

[1] See Demeterfi et al. (1999)

Using the fair variance strikes calculated in Eq. 1, the CME CF Bitcoin Volatility Index - Real Time is then determined by:

$$\sigma_{BVX,t} = 100 \times \sqrt{\left(\sigma_1^2 T_1 \frac{S_2 - S_{CM}}{S_2 - S_1} + \sigma_2^2 T_2 \frac{S_{CM} - S_1}{S_2 - S_1}\right) \times \frac{S_A}{S_{CM}}} \quad (2)$$

where:

Symbol	Name	Description	Type
t	Effective Time	The time as of which a CME CF Bitcoin Volatility Index - Real Time value is calculated.	Parameter
S_n	Seconds to maturity	Number of seconds between the Effective Time and the nth expiry date.	Output
S_{CM}	Seconds to constant maturity	Number of seconds in 30 days, calculated as: $30 \times 24 \times 60 \times 60$.	Input
S_A	Seconds per annum	Number of seconds in a 365-day year, calculated as: $365 \times 24 \times 60 \times 60$.	Input
T_n	Years to maturity	The time to maturity of the relevant futures or options contract with the nth expiry date, calculated as: $\frac{S_n}{S_A}$.	Output
r_n	Interest rate	The interest rate on the nth expiration date as defined by the US Dollar yield curve (see Section 4.5).	Output

$\Delta K_{i,n}$	Strike interval	The difference between strikes relevant to strike K_i for the nth expiry date, calculated as: • Highest out-of-the-money strike: $K_i - K_{i-1}$ • Lowest out-of-the-money strike: $K_{i+1} - K_i$ • For all other K_i: $\frac{K_{i+1}-K_{i-1}}{2}$ For the avoidance of doubt: all relevant option contracts for the nth expiry date are ordered by strike K in ascending order; subscript i denotes the position of the individual option within that ordered list.	Output
$K_{ATM,n}$	ATM strike	The at-the-money strike of the options contract with the nth expiry date.	Output
$\sigma_{K,n}$	Implied volatility	The implied volatility of the call/put option with strike K and expiry n.	Output
$Q(K_n)$	Option spot price	The spot price of the options contract with strike K and the nth expiry date, calculated at time t. The spot price $Q(K_{ATM,n})$ is calculated as the average of the ATM Put and ATM Call option prices.	Output
F_n	Futures spot price	The spot price of the futures contract with the nth expiry date, calculated at time t.	Output

With regards to the selection of contract expiration dates to create the constant-maturity index, the Front Contract can only be used in the calculation up to the Front Contract Inclusion Threshold (as defined in Section 6) ahead of the expiration date of the contract, due to erratic price movements and illiquidity near expiry. After that date, the front contracts are ignored, and the next and next+1 contract expiration dates are used to interpolate the 30-day index. For the avoidance of doubt, since the index maturity is set at 30 days and the year convention is 365 days, the constant time to maturity in years is calculated as: $\frac{30}{365} \approx 0.082192$ years.

4.3 Spot Price Determination

Spot Prices for CME Bitcoin Futures Contracts and CME Bitcoin Option Contracts are calculated as per the "CF SPOT RATES" methodology Section 4 available here. The relevant set of parameters used for calculating Spot Prices of both options and futures contracts for the calculation of the CME CF Bitcoin Volatility Index - Real Time are listed in section 6 of this methodology.

4.4 Option Strike Selection

As an initial step, all available option contracts with an expiry equal to either the expiry date of the front contract or the next contract are selected. The strikes available for trading on any given trading day can be viewed on the CME website here.

For each of the two relevant expiry dates individually, a set of options is selected based on the following steps:

1. Determine the at-the-money (ATM) strike: The ATM strike is calculated as the strike which is nearest to the Spot Price of the futures contract with matching expiry date, calculated at the same Effective Time as the relevant option contracts.
2. Remove all Put options with strikes greater than the ATM, and remove all Call options with strikes smaller than the ATM.
3. From this filtered list, remove any option contract with a Delta (BD) that is smaller than the Delta Threshold (as defined in Section 6). Option contracts with very low Deltas are considered to be too volatile and pricing information too unreliable for inclusion in the index calculation. The Delta is calculated as follows for Call (C) and Put (P) options respectively:

$$\begin{aligned} BD_{C,k,n} &= N(d1) \\ BD_{P,k,n} &= abs(N(d1) - 1) \\ d1_{k,n} &= \frac{\ln\left(\frac{F_n}{K_n}\right) + \sigma_{k,n}^2 \frac{T_n}{2}}{\sigma_{k,n}\sqrt{T_n}} \end{aligned} \tag{3}$$

where $N()$ is the cumulative standard normal distribution function and the implied volatility $\sigma_{k,n}$ is computed algorithmically using Brent's method[2] to find the root of the following function:

[2] see Brent (1973)

$$
\begin{aligned}
f(\sigma_{k,n}) &= BlackPrice_{\sigma,k,n} - Q(K_n) \\
BlackPrice_{\sigma,k,n} &= \begin{cases} e^{-r_n T_n}[F_n N(d1_{k,n}) - K_n N(d2_{k,n})], & \text{if option type is Call} \\ e^{-r_n T_n}[K_n N(-d2_{k,n}) - F_n N(-d1_{k,n})], & \text{if option type is Put} \end{cases} \\
d2_{k,n} &= d1_{k,n} - \sigma_{k,n}\sqrt{T_n}
\end{aligned}
\tag{4}
$$

4. From this filtered list, remove any option contract that has two (2) consecutive option strikes on both sides of said option with zero Spot Prices. For example, if the Put option with strike price 10,000 has a viable Spot Price, but the Spot Prices of Put options with strikes 9,000, 9,500, 10,500, and 11,000 all have zero Spot Prices, then the Spot Price of the 10,000 Put option is set to zero. Therefore, this option price does not influence the calculation of the BVIX for the respective calculation time.

The set of options selected using above steps comprise the constituent options for the volatility index calculation.

4.5 Interest Rate Calculation

The risk-free interest rate is calculated based on a US Dollar yield curve interpolated from the Secured Overnight Financing Rate (SOFR) and U.S. Treasury yield curve rates. The yield curve is calculated once a day at 4 pm London time based on the latest publications of both input rates (from the Federal Reserve and the U.S. Treasury) website.

Given that the BVX index calculation methodology described in Section 4.2 is based on a continuous time framework, the yield curve must consist of continuously compounded rates. Both SOFR rates and Constant Maturity Treasury (CMT) yields (i.e., bond equivalent yields — BEY) are therefore converted to annualised percentage yields (APY), and subsequently to continuously compounded rates. Finally, the rates are linearly interpolated to form the final risk-free yield curve.

The continuously compounded (CC) interest rates at calculation time t are calculated as follows (for tenor T in the case of Treasury rates):

$$SOFR_{CC,t} = \ln\left(\left(1 + \frac{SOFR_t}{360}\right)^{360}\right) \times \frac{365}{360}$$
$$TY_{CC,t,T} = \ln\left(\left(1 + \frac{BEY_{t,T}}{2}\right)^{2}\right) \times \frac{365}{360} \quad (5)$$

The SOFR and Treasury (TY) rates calculated using Eq. 5 are used to construct the US Dollar yield curve at Effective Time t by way of linear interpolation. The day count convention applied in the calculation of the US Dollar yield curve is UK Money Market ACT/365. Overnight is treated as one actual day.

4.6 Publication

The CME CF Bitcoin Volatility Index - Real Time (BVX) is calculated and published every second on any given Index Calculation Day, subject to Contingency Calculation Rules. The final index is rounded to two decimal places.

Index Calculation Days are defined as days on which the CME is open for CME Bitcoin Futures and CME Bitcoin Options trading and Settlement Rates for the same instruments are published.

5 Contingency Calculation Rules

5.1 Delayed Data

If the Retrieval Time of a Relevant Order Book is at least 30 seconds older than the Calculation Time, it is disregarded in the index calculation. If this applies to all Relevant Order Books observed at the Calculation Time, Calculation Failure occurs for that Calculation Time (see Section 5.5).

5.2 Erroneous Data

All Relevant Order Books are subject to an automated screening for erroneous data according to the following rules:

1. If the format of a Relevant Order Book deviates from the expected format such that it cannot be parsed, it is flagged as erroneous.
2. If the Relevant Order Book contains no bid orders or no ask orders, it is flagged as erroneous.
3. If the Relevant Order Book crosses, it is flagged as erroneous.
4. If a Relevant Order Book contains any entries with a non-numeric or non-positive limit price or size then any such entries are flagged as erroneous.

All entries in a Relevant Order Book which are flagged as erroneous for a given Calculation Time are disregarded in the calculation of the respective Spot Price for that Calculation Time. If all entries in a Relevant Order Book are flagged as erroneous, then the Spot Price of the corresponding contract is marked as zero and deemed not viable for the given Calculation Time.

If all Relevant Order Books are flagged as erroneous for a given Calculation Time, Calculation Failure occurs for that Calculation Time (see Section 5.5)

5.3 Potentially Erroneous Data

All input data used for index calculation purposes are subject to an automated screening for potentially erroneous data according to the following rules:

1. If no viable Spot Price can be calculated at the Effective Time for a given Futures or Options contract, the most recent viable Spot Price of the respective contract observed within no more than 10 seconds prior to the Effective Time will be used

as the Spot Price. If there is no viable Spot Price within 10 seconds before the Effective Time, then the Spot Price of the corresponding contract is marked as zero and deemed not viable for the given Calculation Time.

2. At least two (2) out-of-the-money strikes with viable Spot Prices on both sides of the at-the-money strike are required for the index to be calculated. If this is not the case for any given Calculation Time, the current Spot Price data linked to Options Order Books will be deemed to be potentially erroneous and ignored in the index calculation. Instead, the most recently published CME CF Bitcoin Volatility Index - Real Time Value will be republished as long as the most recently published index value has a timestamp no older than 10 seconds before the Effective time. Otherwise, an Index Calculation Failure occurs for that Calculation Time.
3. If the required tenors on the US Dollar yield curve cannot be determined, either because the data is unavailable through the respective APIs or there is holiday calendar mismatch between Fed/Treasury and CME, then the most recently available yield curve will be used. If there is no available yield curve for two (2) consecutive index calculation days, an Index Calculation Failure occurs for that Calculation Time.

5.4 Expert Judgement

The Administrator does not utilise expert judgment in the day to day calculation of the Spot Rates. In extraordinary circumstances Expert Judgement may be exercised by the Administrator in accordance with its codified policies and processes which are available upon request.

5.5 Calculation Failure

If the CME CF Bitcoin Volatility Index - Real Time cannot be calculated for a given Calculation Time, for instance because:

- the Retrieval Times of all Relevant Order Books are at least 30 seconds older than the Calculation Time, or
- there is no viable Spot Price for futures and options, or no available yield curve, or
- any other reason or circumstance that prevents the orderly calculation of the CME CF Bitcoin Volatility Real Time index,

then the CME CF Bitcoin Volatility Index - Real Time for that Calculation Time is not published. The occurrence of any calculation failure is reported to CF management

and persistent failure will lead to a review of the methodology.

6 Parameters

Parameter	Specification
Constituent Exchange	CME Globex
Effective Time (t)	Approximately every second of every Index Calculation Day
Lambda (λ)	$\frac{1}{0.3\,\bar{v}_t}$

	Futures Contracts	Options Contracts
Spacing (s)	1	1
Deviation from Mid (D)	1%	10%
Order Size Cap	None	None
Delta Threshold	Not applicable	0.05 (also known as 5 Delta)
Front Contract Inclusion Threshold	3 calendar days ($3 \times 24 \times 60 \times 60$ seconds)	

7 Methodology Review and Changes

This methodology is subject to internal review by the Administrator and the CF Cryptocurrency Index Family Oversight Function ("Oversight Function") at least annually.

Any changes to this methodology are overseen by the Oversight Function, and in accordance with UK BMR Article 13.

All material changes to the methodology shall only be implemented after a consultation process with users and relevant stakeholders that shall be conducted according to the Administrator's policies and overseen by the Oversight Function.

Should the Administrator deem it necessary to cease providing the Index it shall only do so after a consultation process with users and relevant stakeholders that shall be conducted according to the Administrator's policies and overseen by the Oversight Function.

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