CCIX Close Reference Price Index Methodology

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1 Version History

Version	Date	Details
1	01-Nov-2023	Initial version
2	10-Jan-2024	CCCAGG rebranded/renamed to CCIX update
3	04-Mar-2026	Annual methodology review Update of subsection 4.4, subsubsection 5.3.5

2 Introduction

2.1 Index Description

CCIX Close Reference Price indices refer to daily indices that track CCData's Aggregated Index ("CCIX") at a specific point in time.

CCIX for a given Currency Pair refers to the real-time index calculation methodology, the purpose of which is to show the best price estimation for digital asset traders and investors to value their portfolio at any time. CCIX is CCData's proprietary index calculation methodology for digital assets, based on 24-hour volume-weighted average calculation, time-penalty factor and outlier methodology. It aggregates transaction data of more than 250 Exchanges, using a 24-hour volume-weighted average. The CCIX is calculated for each digital asset in each market it is trading in (example: CCIX BTC-USD). A detailed list of available digital assets is available on request.

Digital assets such as Bitcoin, Ethereum, Monero, etc. are traded at various markets against multiple currencies including fiat currencies (USD, JPY, GBP, etc.) and other digital assets. Depending on the market type (exchange or OTC), liquidity level, trading volume, transaction fees, and many other factors, a digital asset can be traded at different prices across different markets, and therefore making it difficult to know the value of a digital asset at a certain time.

CCIX Close Reference Price indices represent a snapshot of the CCIX Currency Pair at a specific time of the day chosen by the client. Thus, the indices follow exactly the same methodology as CCIX.

2.2 Index Properties

Calculation agent	CC Data Limited
Day close	See each index specification (see section 6)
Publication time	10 minutes after the closing time
Methodology	24-hour volume-weighted average with time penalty and outlier adjustment
Calculation days	Every day of the week including business holidays
Markets	All digital asset markets

3 Definitions

24 Hour Volume means, with respect to a Currency Pair, an Exchange and a point in time, the sum of the volume of such Currency Pair on such Exchange over the last 23 calendar hours and the cumulative volume of the current calendar hour.

API stands for Application Programming Interface.

Average Daily Volume means, with respect to a Currency Pair, an Exchange and a calendar day, the average daily trading volume in USD over the past 30 calendar days calculated as follows:

$$ADV_d^{USD} = \frac{1}{30} \sum_{i=1}^{30} DailyVolume_{d-i}^{USD} \tag{1}$$

Where:

d denotes a calendar day in UTC timezone;

i denotes a positive integer; and

$d - i$ denotes i calendar days prior to d

Each day's trading volume is converted into USD using the day's CCIX of the Currency Pair's base or quote currency, as the case may be, against USD.

Calculation Date means any day for which a CCIX is published.

CCIX means, with respect to a Currency Pair, the CCData's Aggregate Index.

Constituent Exchange means, with respect to a Currency Pair, an Exchange that is selected to contribute to the respective CCIX as of the previous Constituent Exchange Selection and Review.

Currency Pair means a pair of:

- digital assets, or
- a digital asset and a fiat currency

Dynamic Index means the version of CCIX that is subject to retrospective backfilling in the event of a failure to retrieve exchange data in a timely manner.

Exchange means an exchange that trades digital assets and is part of our constituent exchange universe.

Exchange Benchmark means CCData's proprietary methodology for assessing exchange quality published on a semi-annual basis.

Liquidity Factor means, with respect to a Currency Pair, an Exchange and a calendar day, the ratio of the Average Daily Volume of such Currency Pair

on such Exchange compared to the aggregate Average Daily Volume of all Constituent Exchanges that contribute to the respective CCIX, calculated as follows:

$$LiquidityFactor = \frac{ExchangeADV}{\sum_{e \in E} ADV_c} \tag{2}$$

Where:

e denotes an Exchange in set E; and

E is, with respect to the Currency Pair and calendar day, the set of all Constituent Exchanges that contribute to the respective CCIX

Price Difference means, with respect to a Currency Pair, an Exchange and a calendar day, the price difference of such Currency Pair on such Exchange compared to the median price of such Currency Pair across all relevant Exchanges, calculated as follows:

$$PriceDifference = \frac{ExchangePrice - MedianPrice}{MedianPrice} \tag{3}$$

The assumption is that for a Currency Pair trading on multiple Exchanges, the price on the most liquid Exchanges will cluster around the median. This metric is preferred over a simple average as it can detect outliers without skewing the metric for the whole sample.

Price Impact means, with respect to a Currency Pair, an Exchange and a calendar day, a valuation metric used to assess how much of the Price Difference would materialise when added to the CCIX. For a given Currency Pair and Exchange, it is the volume-weighted Price Difference calculated as follows:

$$PriceImpact = PriceDifference \cdot LiquidityFactor \tag{4}$$

This is an important metric as a higher Price Difference on a low-volume Exchange would materialise less, in certain cases, than a lower Price Difference on a high-volume Exchange. This is due to the fact that CCIX uses a 24 Hour Volume-weighted average calculation.

Outlier Detection Factor means a factor used for penalising a price deemed to be an outlier in the CCIX calculation and is determined in accordance with Equation 7.

Static Index means the immutable version of CCIX, which does not account for missed trades.

Time Penalty Factor means a factor used for penalising outdated prices in the CCIX calculation and is determined in accordance with Equation 10.

UTC stands for Coordinated Universal Time.

4 Data Collection

4.1 Data Source

Transactional data (historical trades) is collected from each Exchange via public REST API polled every 2-5 seconds and WebSocket endpoints. All collected data will be standardized internally, stored and backed up in servers.

Exchanges and markets are added on an ongoing basis based on research or user request. Exchanges that do not meet the technical requirements (available API for transactional data) cannot be added to the data collection. Unlike many data providers, who use snapshot data, CCIX approach of using transactional data enables auditability and replicability.

4.2 Data Format

The collected data consists of:

- Trade ID: string or numerical
- Timestamp: Unix timestamp in seconds
- Price: numerical
- Amount: numerical
- Position: buy/sell

4.3 Data Validation

Each trade is validated for the following:

- Each field has the correct data format
- Price and amount is positive
- Timestamp is not in the future
- Trades are not duplicated

4.4 Failure of Data Retrieval

In the event of a failure to retrieve data from an Exchange (due to service outage of the Exchange API service), per design of the CCIX, the last price of the respective Exchange will expire over time (its weighting will decrease to close to zero). As long as the Currency Pair is trading on other Exchanges, the CCIX calculation is uninterrupted.

If the missed data is recoverable, CCData makes its best effort to retrospectively backfill the data to ensure historical accuracy. This may result in the recalculation of certain CCIX pairs.

Further details on the Recalculation Policy can be found in the CoinDesk Digital Asset Indices Policy & Methodology.

5 CCIX Index Calculation Methodology

5.1 Input Data

CCIX is calculated every time a new transaction is received. Transactional data (historical trades) is collected from each Exchange via public REST API polled every 2-5 seconds and WebSocket endpoints when available. The following input data is needed from each transaction:

- Trade price
- Trade amount
- Trade timestamp
- Exchange where the transaction was executed

5.2 Constituent Exchanges

Constituent Exchanges are selected based on the Constituent Exchange Selection and Review process. More details can be found in Sections 6 and 7 of the CCIX methodology document here.

5.3 Index Calculation

5.3.1 24 Hour Volume

CCIX uses a 24 Hour Volume-weighted average, as defined in this document, to calculate prices. 24 Hour Volumes are calculated solely based on transactional data. This ensures CCIX gives greater weight to liquid market prices, and the Price Impact of illiquid (and therefore more volatile) markets is reduced.

5.3.2 Time Penalty Factor

The Time Penalty Factor is added to ensure that Exchanges that suspend trading have an expiring Price Impact. An example of a case where this methodology was particularly advantageous was the Bitfinex hack in 2016.

Bitfinex had one of the highest trading volumes in Bitcoin, and therefore had a significant weight in most price indices. As a result, when trading was suddenly suspended on Bitfinex, causing a crash on all other markets, most indices still showed a Bitcoin price close to the last price on Bitfinex, although markets had already moved on.

CCIX takes last trade time into account, therefore the last Bitfinex price expired with time and the index could move with the market.

5.3.3 Aggregation over Trading Currency

CCIX only takes direct trading pairs into consideration for calculation. For example CCIX BTC-USD only accepts trades from Exchanges trading BTC-USD directly, therefore no currency conversion is needed for the aggregated index calculation.

The reason for this methodology is that a digital asset can trade on multiple currency markets with a significant Price Difference (premium or discount), therefore aggregating across all markets would result in an average price that is not useful for a trader or investor who holds a crypto position in a certain currency and most likely trades in that currency.

5.3.4 Mathematical Representation

We use the notation $|\cdot|$ to represent size of sets. What follows is the calculation of each relevant variable.

For a pre-specified Currency Pair, the CCIX is a volume-weighted average (last trade) price calculated as follows:

$$P_t = \sum_{e \in E_t} w_t^e \cdot p_t^e \tag{5}$$

Where:

t denotes a point in time, where the integer value represents seconds in unix timestamps [1]

P_t is the CCIX price at time t

e denotes an Exchange in set E_t

E_t is the set of all Exchanges used in the calculation of CCIX at time t

w_t^e is the weight assigned to Exchange e at time t and is calculated in accordance with Equation 6

p_t^e is, with respect to Exchange e and time t, the price of the last trade to contribute to CCIX [2]

The weight of Exchange e at time t is calculated as follows:

$$w_t^e = \frac{\mathbb{1}_t^e \cdot V_t^e \cdot \gamma_t^e}{\sum_{x \in E_t} \mathbb{1}_t^x \cdot V_t^x \cdot \gamma_t^x} \tag{6}$$

[1] Therefore 0 represents 00:00:00 on January 1st, 1970 UTC.

[2] For a trade from an Exchange to contribute to CCIX, it should have taken place after the Exchange was last added as a constituent of CCIX.

Where:

x denotes an Exchange (including Exchange e) in set E_t

$\mathbb{1}_t^e$ is, with respect to Exchange e and time t, the Outlier Detection Factor determined in accordance with Equation 7

V_t^e is, with respect to Exchange e and time t, the 24 Hour Volume calculated in accordance with Equation 8

γ_t^e is, with respect to Exchange e and time t, the Time Penalty Factor determined in accordance with Equation 10

The Outlier Detection Factor, with respect to Exchange e and time t, is determined as follows:

$$\mathbb{1}_t^e = \begin{cases} 0 & \text{if } |E_t| > 2 \text{ and } (p_t^e > A \cdot P_{l_t} \text{ or } A \cdot p_t^e < P_{l_t}) \\ 1 & \text{otherwise} \end{cases} \tag{7}$$

Where:

E_t and p_t^e are as defined above

A is a constant that denotes the price deviation threshold; it is currently set to 4

l_t is, with respect to t, the time of the last trade from any Exchange to contribute to CCIX [3]

P_{l_t} is the CCIX price at time l_t

The 24 Hour Volume, as defined in this document, with respect to Exchange e and time t, is calculated as follows:

$$V_t^e = \sum_{h_t \leq s < t} v_s^e \tag{8}$$

Where:

h_t is, with respect to time t, the timestamp of the last calendar hour in UTC in the previous 24-hour period determined as follows:

$$h_t = t - (23 \cdot 3600 + c) \tag{9}$$

Where:

c is the number of seconds past in the current hour

[3] This would be the last time that the CCIX was calculated.

s denotes a point in time between h_t (inclusive) and t (exclusive) for which there was a trade on Exchange e

v_s^e is the quantity traded on Exchange e at time s [4]

The Time Penalty Factor, with respect to Exchange e and time t, is determined as follows:

$$\gamma_t^e = \begin{cases} 1 & \text{if } \tau_t^e < 5 \\ 0.8 & \text{if } 5 \leq \tau_t^e < 10 \\ 0.6 & \text{if } 10 \leq \tau_t^e < 15 \\ 0.4 & \text{if } 15 \leq \tau_t^e < 20 \\ 0.2 & \text{if } 20 \leq \tau_t^e < 25 \\ 0.001 & \text{otherwise} \end{cases} \tag{10}$$

Where:

τ_t^e is, with respect to Exchange e and time t, the length of time in minutes since the last trade on Exchange e calculated as follows:

$$\tau_t^e = \frac{t - l_t^e}{60} \tag{11}$$

Where:

l_t^e is, with respect to Exchange e and time t, the time of the last trade on such Exchange e to contribute to CCIX

5.3.5 Outlier Detection

The outlier detection algorithm removes exchange prices that deviate significantly from the consolidated market price as defined in Equation 7.
If prices from multiple constituent exchanges subsequently converge toward the previously excluded price level, those prices will be treated as valid observations for subsequent calculation intervals.
Outlier filtering decisions are applied on an interval-by-interval basis and are not subject to retrospective adjustment. Accordingly, CCData does not recalculate previously published CCIX values due solely to automated outlier filtering.
Trade exclusions outside the automated process defined in Equation 7 are governed by the CoinDesk Digital Asset Indices Policy & Methodology under the section Errors and Recalculation.

5.4 Auditability and Replicability

CCIX is auditable and replicable since its calculation is based on transaction data retrieved from Exchanges via public API. Anyone who has access to this

[4] Note we include the volumes of trades deemed to be outliers.

data can recreate the CCIX.

6 CCIX Close Reference Price Index

CCIX Close Reference Price Index represents a daily snapshot of CCIX price at a specific moment in time [5].

$$PC_t = P_t \tag{12}$$

Where:

t denotes a point in time, where the integer value represents seconds in unix timestamps

PC_t is the CCIX Close Reference Price Index at time t

P_t is the CCIX price at time t

Currently, the following CCIX Close Reference Prices are available:

- CCData Bitcoin Reference Price 15:20 London Time (CCBTCUSD1520LDN)
- CCData Bitcoin Reference Price 15:40 London Time (CCBTCUSD1540LDN)
- CCData Bitcoin Reference Price 16:00 London Time (CCBTCUSD1600LDN)
- CCData Ethereum Reference Price 15:20 London Time (CCETHUSD1520LDN)
- CCData Ethereum Reference Price 15:40 London Time (CCETHUSD1540LDN)
- CCData Ethereum Reference Price 16:00 London Time (CCETHUSD1600LDN)

[5] The index follows CCIX Static version.

7 Dissemination

CCIX Close Reference Price indices are disseminated via REST API. The relevant API endpoint can be found here: `https://developers.coindesk.com/documentation/data-api/index_cc`.

8 Disclaimer

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