

CoinGecko Price Aggregation Methodology

Last Updated January 26, 2026

Table of Contents

Table of Contents	1
1 Version History	2
2 Introduction	3
3 Governance	4
4 Raw Ticker Data Collection	5
5 Price Indices	6
5.1 Stablecoin Price Indices (USDI) Calculation	6
5.2 BPI Calculation	6
6 Ticker Data Processing	8
6.1 Crypto-to-Fiat Currency Tickers	8
6.2 Crypto-to-crypto Tickers (Non-fiat Tickers)	8
6.3 Displaying Ticker Data	9
7 Aggregated Coin Market Price Calculation	10
7.1 Initial Ticker Set Construction	10
7.2 Outlier Detection and Exclusion	10
Outlier Detection 1 (For coins with less than three tickers)	10
Outlier Detection 2 (For coins with three tickers or more)	11
7.3 Final Price Aggregation	13
8 Manual Intervention / Exception Handling	14
9 Calculation Examples	16
9.1 USDI Calculation Example	16
9.2 BPI Calculation Example	16
9.3 MAD Outlier Detection Example 1 (Ticker Set A under Condition A)	17
9.4 MAD Outlier Detection Example 2 (Ticker Set B under Condition B)	18
10 Appendices	20
Appendix A: BPI Exchanges & Tickers (BTC/<all CG-supported fiat currencies where available>, BTC/USDT, BTC/USDC tickers)	20
Appendix B: USDIUSDT Exchanges & Tickers	20
Appendix C: USDIUSDC Exchanges & Tickers	21
11 Notice and Disclaimers	22

1 Version History

Version No	Version Date	Changes to Previous
v1.0	February 14, 2019	Initial documented version on our website
v2.0	October 6, 2023	Amendments to BPI and Improved Outlier Detection
v2.1	August 1, 2024	Improvements to Outlier Detection, and Utilization of USD_ONRAMP indices to resolve USDT and USDC in pathfinder algorithm
v3.0	Jan 26, 2026	Updated to reflect the usage of USDI now as the main reference price for price aggregation

2 Introduction

While CoinGecko provides a wide variety of data across many coins, one of the most important is the price of coins, which we aggregate across a broad range of centralized and decentralized exchanges. After taking in data from multiple sources, we apply a comprehensive algorithm to determine the aggregated market price of any particular coin listed on CoinGecko.

The overall price aggregation methodology is divided into two parts: -

1. a process to calculate internal reference conversion rates used for ticker processing and price aggregation, known internally as the Stablecoin Price Indices (USDI) and the Bitcoin Price Index (BPI), and
2. a process to calculate the aggregate market price for all coins listed on CoinGecko.

The USDI indices are crucial for CoinGecko to convert all ticker data e.g. price and volume, across all coins, into USD base before being processed further. Prior to this, CoinGecko used to convert all ticker data to BTC base, as crypto trading was more diverse and spread out across different base currencies. However one weakness of this methodology was that due to the volatility of BTC price during major market events, converting to BTC base could result in BTC volatility permeating through to the prices of some tokens which were in fact, not seeing much price movements. Notable examples were stablecoins which could be mistakenly processed as being depegged during such events.

Given shifts in the crypto trading landscape where most trading activity is now denominated in USD or USD stablecoins, we have architected the shift towards utilizing the USDI indices and USD base for tickers instead for more accurate and stable tracking of prices.

Once ticker data is available for coins, we then aggregate said data to calculate the market price, after removing outliers.

This document describes both processes in detail, with calculation examples provided at the end.

3 Governance

1. Due to the importance of the Price Aggregation methodology, CoinGecko has an internal BPI & USDI Governance Forum that governs the entire methodology from end-to-end. This also includes the list of exchanges and tickers used within the BPI and USDI calculations.
2. No changes can be made to any part of the Price Aggregation methodology, without an explicit majority decision made by the governance forum.
3. The members of the governance forum currently include the following CoinGecko personnel:
 - a. TM Lee, President
 - b. Bobby Ong, CEO
 - c. Cedric Chan, CTO
 - d. Ho Xing Yi, Head of Product
 - e. Chan Zhong Yang, Head of Research
 - f. Jack Wong, Principal Engineering Manager, Crypto Data Team
 - g. Chong Yee Xin, Senior Operations Associate
4. The forum meets regularly on a quarterly basis. Emergency meetings of the forum can be called for if circumstances require.
5. Discussions and decisions made during each meeting of the governance forum are recorded in writing to provide an audit trail.

4 Raw Ticker Data Collection

CoinGecko collects all available price and liquidity data across all tickers on all exchanges integrated to CoinGecko. For every coin, each exchange and corresponding tickers are manually mapped by our Operations team to the right coin, with particular attention paid to cases of multiple ticker symbols referring to the same coin (e.g. BTC and XBT for bitcoin), or duplicate coin ticker symbols for different coins (e.g. PEPE being used to refer to a myriad of coins). For duplicate coin ticker symbols, our Operations team checks against information on the exchange to ensure that the right tickers are mapped to the right coins.

For the purposes of price aggregation:

1. The current aggregated price only takes into account data from spot exchanges (both centralized and decentralized).
2. Tickers include all pairs and not just limited to fiat or stablecoin pairs.
3. We filter out DEX tickers with less than \$1,000 liquidity to avoid manipulated / anomalous prices
4. We currently snapshot data from exchanges every 1 minute before preparing and aggregating the price.
5. Once we begin to collect ticker data, they are individually displayed on our Coins page under the Markets tab.

5 Price Indices

Before aggregating the price of all other coins on CoinGecko, we first calculate the Stablecoin Price Indices (USDI), and the Bitcoin Price Index (BPI), which serves as internal reference conversion rates in our ticker processing and price aggregation calculations.

5.1 Stablecoin Price Indices (USDI) Calculation

1. The USDI is a set of indices that provides a reference exchange rate for major stablecoins to fiat currency. Currently there are two USDI indices, $USDI_{USD\text{T}}$ and $USDI_{USD\text{C}}$, which are our internal reference USDT/USD and USDC/USD exchange rates respectively.
2. These reference rates are calculated as the volume weighted average price (VWAP) of selected USD stablecoin / USD tickers across a selection of reputable exchanges (see *list of exchanges and tickers in [Appendix B](#) and [Appendix C](#)*).
3. For the purpose of USDI calculations:
 - a. Only data from USDI tickers which have been updated within the last 5 minutes are included,
 - b. USDI tickers with $Price_{USD}$ equals NaN or Null are excluded,
 - c. USDI tickers whose USD Price deviates from the median of the USDI ticker set by more than 4% are excluded.
4. For reference to how the USDI indices are calculated, we have provided an [abbreviated example](#) at the end of the document.

5.2 BPI Calculation

1. The BPI is calculated as the volume weighted average price (VWAP) of selected BTC/USD, BTC/USDT, BTC/USDC, or BTC/EUR tickers across a selection of reputable exchanges (see *list of exchanges and tickers in [Appendix A](#)*). While in the past the BPI has taken into account BTC tickers with alternate currencies (such as BTC/KRW for example) to take into account factors such as the kimchi premium, over time given that the market has largely consolidated around trading on USD and USD-denominated stablecoin pairs, we have refined the BPI to its current form to better reflect its role as the reference rate for a large majority of the industry. The BTC/EUR pairs are included as a backup in case of issues with the other tickers, given BTC/EUR's historically tight spread with BTC/USD.

2. For the purpose of BPI calculations:
 - a. Only data from BPI tickers which have been updated within the last 5 minutes are included,
 - b. BPI tickers with $\text{Price}_{\text{USD}}$ equals NaN or Null are excluded,
 - c. BPI tickers whose USD Price deviates from the median of the BPI ticker set by more than 4% are excluded.
3. BPI tickers include BTC/USD, BTC/<non-USD fiat>, BTC/USDT and BTC/USDC pairs. Before performing the VWAP calculation, we need to first convert the non-USD tickers into USD base.
4. For USDT and USDC tickers within the BPI, we apply the USDI indices to convert them to USD base.
5. For non-USD fiat tickers, e.g. BTC/EUR, we convert the price to USD base using the USD exchange rates from [Open Exchange Rates](#). In case of a failure in obtaining exchange rates from Open Exchange Rates, our platform will automatically fallback to obtaining exchange rates from [Exchange Rates API](#) such that there will be no interruption in the calculation of the BPI.
6. Once all BPI tickers have been converted to USD base, we perform a VWAP calculation to arrive at the $\text{BPI}_{\text{BTC/USD}}$.
7. From $\text{BPI}_{\text{BTC/USD}}$ we subsequently apply the corresponding fiat/USD exchange rate from Open Exchange Rates to obtain the BPI for all other fiat currencies supported on CoinGecko, e.g. $\text{BPI}_{\text{BTC/EUR}}$, $\text{BPI}_{\text{BTC/GBP}}$, $\text{BPI}_{\text{BTC/TRY}}$, etc.
8. A user can also choose a particular crypto, e.g. BTC, ETH or XRP, as the base currency on our website, and we use the BPI as a reference rate to calculate the crypto exchange rate. Hence we also calculated rates such as $\text{BPI}_{\text{BTC/ETH}}$, $\text{BPI}_{\text{BTC/XRP}}$ as well. This is done by using the aggregated market price of a particular token (in USD), and converting that using $\text{BPI}_{\text{BTC/USD}}$ to convert that to BTC base. Using $\text{BPI}_{\text{BTC/ETH}}$ as an example:
$$\text{BPI}_{\text{BTC/ETH}} = \text{Aggregated_Market_Price}_{\text{ETH}} / \text{BPI}_{\text{BTC/USD}}$$
For more on how we aggregate the market price for a particular coin, refer to [Section 7](#).
9. For reference to how the BPI is calculated, we have provided an [abbreviated example](#) at the end of the document.

6 Ticker Data Processing

Once the USDI and BPI indices are calculated, we can now process the tickers for all coins listed on CoinGecko. As we have mentioned before, the ticker data collected and stored within CoinGecko are denominated in USD. Tickers can either be a crypto-to-fiat currency pair, or a crypto-to-crypto pair. We have two different processes to transform them to USD base.

6.1 Crypto-to-Fiat Currency Tickers

For crypto-to-USD currency tickers, they are stored as-is in our database.

For all other crypto-to-fiat tickers, we convert their data to USD base by applying the appropriate foreign exchange conversion rate obtained through Open Exchange Rates.

6.2 Crypto-to-crypto Tickers (Non-fiat Tickers)

Crypto-to-crypto tickers can be grouped into USDI-relevant pairs, currently only USDT and USDC pairs, e.g. ETH/USDT and ETH/USDC, as well as non-USDI-relevant pairs, such as ETH/LTC, or even pairs with less wellknown stablecoins such as SOL/USDY.

1. For USDI-relevant pairs, e.g. ETH/USDT and ETH/USDC, we utilize the USDI indices, i.e. $USDI_{USDT}$ and $USDI_{USDC}$ respectively, to convert them to USD base. Using ETH/USDT as an example,

$$\begin{aligned} USD_PRICE_{ETH/USD} &= PRICE_{ETH/USDT} / USDI_{USDT} \\ USD_VOLUME_{ETH/USD} &= VOLUME_{ETH/USDT} / USDI_{USDT} \end{aligned}$$

2. For non-USDI-relevant pairs, we utilize an internal pathfinder algorithm to arrive at the USD price, similar to how DEXes uses pathfinders to perform a complex swap.
3. Using ETH/LTC as an example, the pathfinder will find the USD price for ETH by finding a path to a USDI-relevant, i.e. USDT or USDC ETH pair, e.g. a straightforward path of ETH/LTC => LTC/USDT => apply $USDI_{USDT}$ to get to USD base. The more obscure the coin is, the more complex the path may be, e.g. ABC/DEF => DEF/GHJ => GHJ/USDC => apply $USDI_{USDC}$. Once the USD price is found, it is stored within our database.
4. The “paths” are systematically determined, based on certain rules configured in the backend. In general, our system tries to find a viable path based on tickers from the same exchange first, before looking for alternate paths on other exchanges. For certain well-established pairs, or in some cases obscure pairs, there are also manually defined, fixed paths that the system follows.
5. The pathfinder algorithm applies to both the base or target coin, i.e. the algorithm will work as long as either one of the base or target coin has an identifiable path to a

USDI-relevant pair. For example with ticker pair ABC/DEF, it will be able to calculate a USD price for the ticker as long as either one of ABC or DEF coin has a path to a USDT or USDC pair.

7 Aggregated Coin Market Price Calculation

While we display individual data for each coin ticker, CoinGecko also displays one aggregated market price for coins. For avoidance of doubt this also includes the aggregated market price for BTC, USDT and USDC. The methodology to calculate the aggregated market price for a particular coin from its individual tickers is described below.

7.1 Initial Ticker Set Construction

1. An initial ticker set for a particular coin is constructed based on the top 600 tickers of the coin by volume. Tickers outside of the top 600 in volume will not be factored into the later calculation of the aggregated market price.
2. Within this initial ticker set, we also filter out tickers based on the criteria below. The tickers are then marked as anomalies:
 - a. Stale tickers, i.e. tickers where its data has not been updated since 8 hours ago
 - b. $\text{Price}_{\text{USD}}$ equals 0, NaN, or Null
 - c. Volume equals Null
 - d. $\text{Volume}_{\text{USD}}$ equals 0 or Null
 - e. Price or Volume could not be converted to USD
 - f. Ticker with inflated volume, i.e. the volume of the ticker is more than 5x the volume of the coin from its most recent update (*only applicable to tickers of coins with at least 50BTC in 24H volume*).

7.2 Outlier Detection and Exclusion

From the initial ticker set, we apply the appropriate outlier detection algorithms to filter out outliers. We currently implement two different outlier detection algorithms depending on the number of available tickers in the ticker set.

Outlier Detection 1 (For coins with less than three tickers)

For coins with less than three tickers, due to the lack of market data we use a simplified outlier detection algorithm. For these coins, any ticker price change that is greater than 100x from the previous price will cause the ticker to be classified as an outlier.

Outlier Detection 2 (For coins with three tickers or more)

1. For coins with three tickers or more in the ticker set, CoinGecko applies an outlier detection algorithm based on the modified median absolute deviation (MMAD) of the ticker set. To utilize this algorithm, we assume that the ticker set conforms to the [central limit theorem](#), namely that the ticker prices are independently and identically distributed, and tends toward a normal distribution. You can read more about MAD and MMAD [here](#).
2. Before applying the MMAD outlier detection algorithm, we consider an additional condition of whether the coin is:
 - A. listed in less than 5 exchanges, or
 - B. listed in 5 or more exchanges
3. Under Condition A, we utilize the algorithm based on the volume-weighted median and volume-weighted median absolute deviation of the ticker set, whereas under Condition B, we utilize the unweighted median and unweighted median absolute deviation of the ticker set.
4. Consider two ticker sets, Ticker Set A and Ticker Set B which both have three tickers or more. Ticker Set A fulfills Condition A, and Ticker Set B fulfills Condition B. Assume that a , b are tickers within Ticker Sets A and B respectively.
5. For Ticker Set A:
 - i. Calculate the volume-weighted median of the ticker set,
 $\text{MEDIAN} = \text{weighted_median}_{\text{refl}}(\text{PRICE}_{\text{Ticker_a}}, \text{VOLUME}_{\text{Ticker_a}})$ of all a .
 - ii. For each of the tickers, calculate the absolute deviation (ABS) from the volume-weighted median, $\text{ABS}_{\text{Ticker_a}} = \text{PRICE}_{\text{Ticker_a}} - \text{MEDIAN}$ for all a .
 - iii. Calculate the volume-weighted median absolute deviation (MAD) for the entire ticker set, where $\text{MAD} = \text{weighted_median}(\text{ABS}_{\text{Ticker_a}}, \text{VOLUME}_{\text{Ticker_a}})$ for all a .
6. For Ticker Set B instead:
 - i. Calculate the (unweighted) median of the ticker set,
 $\text{MEDIAN} = \text{median}(\text{PRICE}_{\text{Ticker_b}})$ of all b .
 - ii. For each of the tickers, calculate the absolute deviation (ABS) from the median,
 $\text{ABS}_{\text{Ticker_a}} = |\text{PRICE}_{\text{Ticker_a}} - \text{MEDIAN}|$ for all b .
 - iii. Calculate the unweighted median absolute deviation (MAD) for the entire ticker set, where $\text{MAD} = \text{median}(\text{ABS}_{\text{Ticker_a}})$ for all b .
7. After calculating the appropriate MEDIAN, ABS and MAD, regardless of Ticker Set A or B, we proceed with the same steps as below:

- i. Calculate the modified MAD (MMAD) by multiplying MAD with the consistency constant for normal distribution: $MMAD = MAD * 1.4826$. This allows the MMAD to estimate the standard deviation of the sample set.
- ii. The upper and lower bounds for outlier detection are calculated based on 4 standard deviations from the median. Using the MMAD calculated above,
 $LOWER_BOUND = MEDIAN - (MMAD * 4)$
 $UPPER_BOUND = MEDIAN + (MMAD * 4)$
- iii. There are certain edge cases where:
 - i. the MMAD is overly large, it is possible for the calculated $LOWER_BOUND$ to be negative.
 - ii. Where the MMAD is too small below our minimum defined threshold of 0.0018, and certain legitimate tickers may be excluded by mistake.

To address these edge cases, there is a standard deviation anomaly control that can be toggled on a case-by-case basis. When this control is enabled for a coin, the bounds are re-calculated as follows:

$$LOWER_BOUND = MEDIAN - (MEDIAN * 0.3)$$

$$UPPER_BOUND = MEDIAN + (MEDIAN * 0.3)$$

8. We then test every ticker price against the lower and upper bounds. If the price falls outside the bounds, i.e. $PRICE_{\text{Ticker}_a} < LOWER_BOUND$ or $PRICE_{\text{Ticker}_a} > UPPER_BOUND$, we consider those tickers as outliers and exclude them from the final price aggregation calculation.
9. When a ticker has been identified as an outlier, the system will automatically add an asterisk * behind the ticker price displayed on the coins' Markets tab.
10. For reference, we have provided examples of the MMAD outlier detection for a [Ticker Set A under Condition A](#) and a [Ticker Set B under Condition B](#) at the end of the document.

7.3 Final Price Aggregation

Once outliers have been removed, we calculate the volume weighted average price (VWAP) of all remaining tickers in the ticker set to arrive at the final aggregated price. This is the aggregated market price that is then displayed on our coins page.

As the Price Aggregation is performed on tickers with USD base data, the final aggregated price will also be in USD base. However we have options to return price data in multiple different fiat currencies, or even crypto (such as BTC, ETH, XRP, etc). To do so we either utilize Open

Exchange Rates for fiat currency conversion, or the BPI for crypto conversion. Using ETH as an example:

$$\text{EUR_Price}_{\text{ETH}} = \text{USD_Price}_{\text{ETH}} * \text{USD/EUR exchange rate from Open Exchange Rates}$$

$$\text{BTC_Price}_{\text{ETH}} = \text{USD_Price}_{\text{ETH}} / \text{BPI}_{\text{BTC/USD}}$$

$$\text{XRP_Price}_{\text{ETH}} = \text{USD_Price}_{\text{ETH}} / \text{BPI}_{\text{BTC/USD}} / \text{BPI}_{\text{BTC/XRP}}$$

8 Manual Intervention / Exception Handling

While we endeavor to use a systematic approach to arrive at the aggregated price, in certain cases manual interventions are required, particularly when it comes to excluding outliers.

1. Once such cases are detected, our operations team will conduct a review to investigate the veracity of certain anomalous tickers.
2. If the team believes a certain ticker price to be anomalous but was not excluded by our outlier detection algorithm, there are several options that the team can undertake:
 - a. The team can unapprove a specific ticker from the coin. This will result in the ticker data to no longer be displayed on the Coin's Markets List, and the ticker will not be taken into account for price aggregation. However the ticker will still be visible on the individual Exchange's page under the "Unverified Tickers" section, but its volume will not count towards the total volume of the exchange.
 - b. The team can blacklist a ticker. This will result in the ticker data to no longer be displayed on the Coin's Market List, as well as the Exchange's page. The ticker will not be taken into account for price aggregation, and its volume will not count towards the total volume of the exchange.
 - c. The team can delist a coin. This will result in all ticker data for the specific coin to be blacklisted (*see 2b above*), and the complete removal of all coin and related ticker data from CoinGecko. No data will be taken into account for any form of calculation.
3. In cases where an entire exchange may be behaving anomalously, our operations team can also manually intervene against exchange data as well:
 - a. If an exchange is behaving anomalously towards a single coin, our operations team can unmap an exchange from a coin. This will give the same result as unmapping a single ticker (*see 2a above*), except across all tickers from the exchange for that specific coin.
 - b. If the exchange is returning anomalous volume or price across most pairs, the team can exclude the volume from that particular exchange. The ticker data will still be visible on Coins pages, but it will not be taken into account for price aggregation. The exchange will still be available if users perform a search, but its volume will not be taken into account towards the total crypto market volume.
 - c. If the issue is more serious, the team can delist an exchange. This will result in the complete removal of all ticker and exchange data from CoinGecko, and no ticker or exchange data will be taken into account for any form of calculation.

4. When a ticker is manually flagged it will be temporarily removed from the ticker list on the coins' Markets tab.
5. Over time should the ticker or exchange eventually recover to normal behavior, our operations team can reverse the steps above so that the ticker data is reincluded in the aggregate price calculation.

9 Calculation Examples

Do note that these are abbreviated examples, and are only meant to be illustrative.

9.1 USDI Calculation Example

Consider a set of USDI tickers for USDT below, and we wish to calculate the $USDI_{USDT}$ index :

Ticker 1 - USDT/USD, \$1.001, Coinbase, Volume: \$10000

Ticker 2 - USDT/USD, \$1.002, Kraken, Volume: \$8000

$$\begin{aligned} USDI_{USDT} &= VWAP_{(Ticker\ 1,\ Ticker\ 2)} \\ &= \frac{SUM(Price * Volume)_{(Ticker\ 1,\ Ticker\ 2)}}{SUM(Volume)_{(Ticker\ 1,\ Ticker\ 2)}} \\ &= \frac{(\$1.001 * \$10000 + \$1.002 * \$8000)}{(\$10000 + \$8000)} \\ &= \$1.00144 / USDT \end{aligned}$$

9.2 BPI Calculation Example

Consider a set of BPI tickers below:

Ticker 3 - BTC/USDT, 28000 USDT, Binance, Volume: 25000USDT

Ticker 4 - BTC/USD, \$28100, OKX, Volume: \$20000

Ticker 5 - BTC/USD, \$27900, Bitfinex, Volume: \$18000

Ticker 6 - BTC/EUR, €25700, Bitstamp, Volume: €10000

As Ticker 3 is a BTC/USDT ticker, we need to convert it to a USD base. We do this by utilizing the $USDI_{USDT}$ index from Example 8.1 above:

$$\begin{aligned} USD_PRICE_{Ticker\ 3} &= PRICE_{Ticker\ 3} * USDI_{USDT} \\ &= 28000USDT * \$1.00144 / USDT \\ &= \$28040.32 \end{aligned}$$

$$\begin{aligned} USD_VOLUME_{Ticker\ 3} &= VOLUME_{Ticker\ 3} * USDI_{USDT} \\ &= 25000USDT * \$1.00144 / USDT \\ &= \$25036 \end{aligned}$$

For Tickers 4 and 5 we can take the data as-is as they are already in USD base.

As for Ticker 6 as it is a non-USD fiat pair, in this case a BTC/EUR ticker, we have to also convert it to a USD base using Open Exchange Rates:

$$\begin{aligned} USD_PRICE_{Ticker\ 6} &= PRICE_{Ticker\ 6} * EUR/USD\ Exchange\ Rate \\ &= €25700 * \$1.10 / EUR \\ &= \$28270 \end{aligned}$$

$$\begin{aligned}\text{USD_VOLUME}_{\text{Ticker 6}} &= \text{VOLUME}_{\text{Ticker 6}} * \text{EUR/USD Exchange Rate} \\ &= €10000 * \$1.10 / \text{EUR} \\ &= \$11000\end{aligned}$$

Finally, the $\text{BPI}_{\text{BTC/USD}}$ is calculated based on all the BTC tickers in the set:

$$\begin{aligned}\text{BPI}_{\text{BTC/USD}} &= \text{VWAP}_{(\text{Ticker 3 (converted to USD price and volume), Ticker 4, Ticker 5, Ticker 6 (converted to USD price and volume)})} \\ &= \text{SUM}(\text{PRICE} * \text{VOLUME})_{(\text{Ticker 3, Ticker 4, Ticker 5, Ticker 6})} / \text{SUM}(\text{VOLUME})_{(\text{Ticker 3, Ticker 4, Ticker 5, Ticker 6})} \\ &= ((\$28040.32 * \$25036) + (\$28100 * \$20000) + (\$27900 * \$18000) + (\$28270 * \$11000)) / \\ &\quad (\$25036 + \$20000 + \$18000 + \$11000) \\ &= \$28056.45 \text{ (rounded figure)}\end{aligned}$$

Once $\text{BPI}_{\text{BTC/USD}}$ is obtained, we can use it to derive the BPI for all other fiat currencies. For example,

$$\begin{aligned}\text{BPI}_{\text{BTC/GBP}} &= \text{BPI}_{\text{BTC/USD}} * \text{USD/GBP Exchange Rate} \\ &= \$28056.45 * £0.78 / \text{USD} \\ &= £21884.03 \text{ (rounded figure)}\end{aligned}$$

9.3 MAD Outlier Detection Example 1 (Ticker Set A under Condition A)

Consider Coin A with Ticker Set A as follows, where the coin fulfills Condition A, i.e. is listed on less than five exchanges::

Ticker 1 : 2.50, volume: 10000, exchange_A
Ticker 2 : 1.20, volume: 30000, exchange_B
Ticker 3 : 1.80, volume: 4000, exchange_C
Ticker 4 : 1.10, volume: 5000, exchange_B
Ticker 5 : 1.25, volume: 8000, exchange_D
Ticker 6 : 1.28, volume: 9000, exchange_D

$$\begin{aligned}\text{MEDIAN} &= \text{volume-weighted_median} \text{ [\[ref\]](#) }_{\text{Ticker Set A}} = 1.20 \\ \text{MAD Constant} &= 1.4826\end{aligned}$$

Absolute Deviation of each Ticker from (volume-weighted) MEDIAN,

$$\begin{aligned}\text{ABS}_{\text{Ticker_a}} &= | \text{PRICE}_{\text{Ticker_a}} - \text{MEDIAN} | \\ \text{ABS}_{\text{Ticker 1}} &= | 2.50 - 1.20 | = 1.30 \\ \text{ABS}_{\text{Ticker 2}} &= | 1.20 - 1.20 | = 0.00 \\ \text{ABS}_{\text{Ticker 3}} &= | 1.80 - 1.20 | = 0.60 \\ \text{ABS}_{\text{Ticker 4}} &= | 1.10 - 1.20 | = 0.10 \\ \text{ABS}_{\text{Ticker 5}} &= | 1.25 - 1.20 | = 0.05\end{aligned}$$

$$ABS_{\text{Ticker } 6} = |1.28 - 1.20| = 0.08$$

$$\text{Hence } ABS_{\text{Ticker Set A}} = \{1.30, 0.00, 0.60, 0.10, 0.05, 0.08\}$$

$$MAD = \text{volume-weighted_median}_{\text{ref}} (ABS_{\text{Ticker Set A}}, VOLUME_{\text{Ticker Set A}}) = 0.05$$

$$MMAD = MAD * MAD \text{ Constant} = 0.05 * 1.4826 = 0.07413 \text{ (this is more than the minimum MAD constant of 0.0018, so we can use the MMAD to calculate the bounds)}$$

$$\text{Standard_deviation} = 4$$

$$\text{LOWER_BOUND} = \text{MEDIAN} - MMAD * \text{Standard_deviation} = 0.90348$$

$$\text{UPPER_BOUND} = \text{MEDIAN} + MMAD * \text{Standard_deviation} = 1.49652$$

Hence based on these limits, Ticker_1 (2.50), Ticker_3 (1.80) > UPPER_BOUND (1.49652) and will be removed from the ticker set before the final price aggregation.

9.4 MAD Outlier Detection Example 2 (Ticker Set B under Condition B)

Consider Coin B with Ticker Set B as follows, where the coin fulfills Condition B, i.e. is listed on five or more exchanges:

Ticker 1 : 2.50

Ticker 2 : 0.83

Ticker 3 : 0.78

Ticker 4 : 0.77

Ticker 5 : 0.7643

Ticker 6 : 0.76

Ticker 7 : 0.7592

$$\text{MEDIAN} = \text{unweighted_median}_{\text{Ticker Set B}} = 0.77$$

$$\text{MAD Constant} = 1.4826$$

Absolute Deviation of each Ticker from MEDIAN, $ABS_{\text{Ticker}_b} = |PRICE_{\text{Ticker}_b} - \text{MEDIAN}|$

$$ABS_{\text{Ticker } 1} = |2.50 - 0.77| = 1.73$$

$$ABS_{\text{Ticker } 2} = |0.83 - 0.77| = 0.06$$

$$ABS_{\text{Ticker } 3} = |0.78 - 0.77| = 0.01$$

$$ABS_{\text{Ticker } 4} = |0.77 - 0.77| = 0.00$$

$$ABS_{\text{Ticker } 5} = |0.7643 - 0.77| = 0.01$$

$$ABS_{\text{Ticker } 6} = |0.76 - 0.77| = 0.01$$

$$ABS_{\text{Ticker } 7} = |0.7592 - 0.77| = 0.01$$

$$\text{Hence } ABS_{\text{Ticker Set B}} = \{1.73, 0.06, 0.01, 0.00, 0.01, 0.01, 0.01\}$$

$$\text{Median ABS Deviation (MAD)} = \text{median}(ABS_{\text{Ticker Set B}}) = 0.01$$

Modified MAD (MMAD) = MAD * MAD Constant = $0.01 * 1.4826 = 0.014826$ (this is more than the minimum MAD constant of 0.0018, so we can use the MMAD to calculate the bounds)

STANDARD_DEVIATION = 4

LOWER_BOUND = MEDIAN - MMAD * STANDARD_DEVIATION = 0.710696

UPPER_BOUND = MEDIAN + MMAD * STANDARD_DEVIATION = 0.829304

Hence based on these limits, Ticker_1 (2.50), Ticker_2 (0.83) > UPPER_BOUND (0.829304) and will be removed from the ticker set before the final price aggregation.

9.5 MAD Outlier Detection Example 3 (Ticker Set C under Condition B)

Consider Coin C with Ticker Set C as follows, where ticker prices are tightly clustered:

Ticker 1 : 7.001

Ticker 2 : 7.000

Ticker 3 : 7.002

Ticker 4 : 7.001

Ticker 5 : 7.000

Ticker 6 : 6.999

Ticker 7 : 50.00 (anomaly)

MEDIAN = $\text{unweighted_median}_{\text{Ticker Set C}} = 7.001$

Absolute Deviation of each Ticker from MEDIAN, $\text{ABS}_{\text{Ticker}_c} = |\text{PRICE}_{\text{Ticker}_c} - \text{MEDIAN}|$

$\text{ABS}_{\text{Ticker}_1} = |7.001 - 7.001| = 0.000$

$\text{ABS}_{\text{Ticker}_2} = |7.000 - 7.001| = 0.001$

$\text{ABS}_{\text{Ticker}_3} = |7.002 - 7.001| = 0.001$

$\text{ABS}_{\text{Ticker}_4} = |7.001 - 7.001| = 0.000$

$\text{ABS}_{\text{Ticker}_5} = |7.000 - 7.001| = 0.001$

$\text{ABS}_{\text{Ticker}_6} = |6.999 - 7.001| = 0.002$

$\text{ABS}_{\text{Ticker}_7} = |50.00 - 7.001| = 42.999$

Hence $\text{ABS}_{\text{Ticker Set C}} = \{0.000, 0.001, 0.001, 0.000, 0.001, 0.002, 42.999\}$

MAD = $\text{median}(\text{ABS}_{\text{Ticker Set C}}) = 0.001$

MMAD = MAD * 1.4826 (consistency constant) = $0.001 * 1.4826 = 0.0014826$

(This is below the minimum MMAD constant of 0.0018)

If we used the standard formula:

LOWER_BOUND = MEDIAN - MMAD * 4 = $7.001 - 0.0014826 * 4 = 6.9950696$

UPPER_BOUND = MEDIAN + MMAD * 4 = $7.001 + 0.0014826 * 4 = 7.0069304$

These bounds are too narrow (only $\pm 0.08\%$ from median), which may incorrectly flag legitimate price variations as outliers.

Since the standard deviation anomaly control is enabled for this coin, we re-calculate using the 30% threshold:

$$\text{LOWER_BOUND} = \text{MEDIAN} - (\text{MEDIAN} * 0.3) = 7.001 - 2.1003 = 4.9007$$

$$\text{UPPER_BOUND} = \text{MEDIAN} + (\text{MEDIAN} * 0.3) = 7.001 + 2.1003 = 9.1013$$

Hence based on these adjusted limits, only Ticker_7 (50.00) > UPPER_BOUND (9.1013) and will be removed from the ticker set before the final price aggregation. The other tickers with minor price variations are correctly retained.

10 Appendices

List of BPI and USDI exchanges and pairs.

Appendix A: BPI Exchanges & Tickers (BTC/<all CG-supported fiat currencies where available>, BTC/USDT, BTC/USDC tickers)

Exchanges	BPI Tickers
Binance	BTC/USDT, BTC/USDC, BTC/EUR
OKX	BTC/USDT, BTC/USDC
Coinbase	BTC/USD, BTC/USDT, BTC/EUR
Kraken	BTC/USD, BTC/USDT, BTC/USDC, BTC/EUR
Crypto.com	BTC/USD, BTC/USDT, BTC/EUR
Bitfinex	BTC/USD, BTC/USDT, BTC/EUR
Bitstamp	BTC/USD, BTC/USDT, BTC/EUR
Gemini	BTC/USD, BTC/USDT, BTC/EUR
Huobi	BTC/USDT, BTC/USDC

Appendix B: USDI_{USDT} Exchanges & Tickers

Exchanges	USDI _{USDT} Tickers
Coinbase	USDT/USD
Kraken	USDT/USD
Crypto.com	USDT/USD
Bitstamp	USDT/USD
Gemini	USDT/USD

Appendix C: $\text{USD} \backslash \text{USDC}$ Exchanges & Tickers

Exchanges	$\text{USD} \backslash \text{USDC}$ Tickers
Kraken	USDC/USD
Bitstamp	USDC/USD
Gemini	USDC/USD

11 Notice and Disclaimers

The content is strictly for your general information only. CoinGecko makes no warranties of any kind in relation to our content, including but not limited to accuracy and updatedness. No part of the information that is provided constitutes financial advice, legal advice or any other form of advice meant for your specific reliance for any purpose. Any use or reliance on the information is solely at your own risk and discretion.

CoinGecko does not make any express or implied warranties or representations with respect to the information (or the results to be obtained by the use thereof), and to the maximum extent permitted by applicable law, it expressly disclaims all implied warranties (including, without limitation, any implied warranties of originality, accuracy, timeliness, non-infringement, completeness, merchantability and fitness for a particular purpose) with respect to any of the information provided.

No part of this publication may be reproduced, distributed, or transmitted in any form or by any means without the prior written permission of Gecko Labs Pte Ltd, except in the case of non-commercial uses permitted by copyright law.

CoinGecko is the trademark of Gecko Labs Pte Ltd, a company registered in Singapore with company number 201510008G and registered address of 101 Upper Cross Street, #05-16 People's Park Centre, Singapore.