Coin Metrics Prices Methodology

Version 1.0

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Contents

1 Introduction

Coin Metrics publishes a collection of prices for a set of cryptocurrencies and fiat currencies consisting of the Coin Metrics Hourly Reference Rates ("Hourly Reference Rates"), the Coin Metrics Real-Time Reference Rates ("Real-Time Reference Rates"), and the Coin Metrics Principal Market Prices ("Principal Market Prices"), which are collectively referred to as the Coin Metrics Prices ("CM Prices"). This document describes the data inputs, calculation methodologies, and data exclusion rules for the CM Prices.

The Hourly Reference Rates are published once an hour and utlize volume-weighted median and time-weighted average techniques over a 61-minute calculation window. Common use cases for the Hourly Reference Rates include research, backtesting, calculating net asset value for investment funds, calculating closing prices for indexes or financial benchmarks, and settling financial derivatives.

The Real-Time Reference Rates are published once a second and once every 200 milliseconds and utilize volume-weighted median and inverse price variance-weighted median techniques. Common use cases for the Real-Time Reference rates include serving as a data source for on-chain price oracles, risk management, indicative intraday values for investment funds and financial benchmarks, and any use cases where real-time pricing is needed.

The Principal Market Prices are published once a second and adhere to the guidelines regarding fair value measurement issued by the International Financial Reporting Standards and the Association of International Certified Professional Accountants, specifically standards IFRS 13 and FASB ASC 820. The Principal Market Prices identify a principal market for each asset and utilize the most recent price from this market. Common use cases are for fair value measurement, preparing financial statements, and calculating closing prices for indexes or financial benchmarks.

The CM Prices are designed to serve as a set of transparent and independent pricing sources that promote the functioning of efficient markets, reduce information asymmetries among market participants, facilitate trading in standardized contracts, and accelerate the adoption of cryptocurrencies as an asset class with the highest standards. The CM Prices are calculated using robust and resilient methodologies that are resistant to manipulation and adhere to international best practices for financial benchmarks, including the International Organization of Securities Commissions' (IOSCO) Principles for Financial Benchmarks. The Coin Metrics Oversight Committee (the "Oversight Committee") and an independent governance structure protect the integrity of the CM Prices and ensure the CM Prices serve as a source of transparent and independent pricing.

2 Other Documents

The CM Prices are collectively governed by policies described in Coin Metrics Prices Policies which describes the administration, oversight, conflicts of interest, material changes and terminations, recalculations, internal controls, complaints, record retention, and compliance policies.

The CM Prices are supervised by the Coin Metrics Oversight Committee Charter which defines the responsibilities of the Oversight Committee.

3 Data Inputs

The Oversight Committee evaluates markets traded on digital asset exchanges as potential input data sources for the CM Prices using a Market Selection Framework. The framework consists of a fully-systematized process for evaluating markets along a wide set of criteria to determine if the data source reflects trading activity in a transparent and representative manner. In this framework, a market refers to a specific traded asset pair on a specific exchange. Only spot markets are considered. It produces a unique set of candidate selected markets for each asset in the coverage universe.

The Oversight Committee evaluates new markets for inclusion as a selected market and assesses already selected markets using the Market Selection Framework on a quarterly basis and during interim periods if market conditions warrant. Such market conditions include, but are not limited to, material changes in an exchange's solvency risk, material changes in the degree of free capital flows in and out of an exchange, the presence of long-lasting price differences from other exchanges, and during times of market stress.

Markets that are approved by the Oversight Committee are added to a list of constituent markets (the "Constituent Markets"). A separate list of Constituent Markets is maintained for each of the assets in the coverage universe.

A candidate market can be nominated for inclusion and an existing constituent market can be nominated for exclusion by any member of the public or member of the Oversight Committee. Public nominations for inclusion or exclusion of a market can be submitted in writing to `support@coinmetrics.io`. The Oversight Committee may convene to apply the Market Selection Framework to evaluate the inclusion or exclusion of a market between regularly-scheduled quarterly meetings if market conditions or circumstances warrant. Coin Metrics publishes a current list of Constituent Markets for each asset in the coverage universe, as well as updates on inclusions or exclusions of constituent markets, and the rationale for making any change.

The data inputs for the calculation of the CM Prices are observable transactions in a constituent where the given asset is traded.

3.1 Feature Descriptions

The Market Selection Framework consists of 45 features, 36 of which are in active use. Features represent individual measurable properties that provide an indication of the suitability for a market to serve as an input data source, which are combined to form a market rating.

Some of the features described in this section are indicator variables that encode qualitative information about a market or exchange. These indicator variables can require a degree of subjectivity in determining whether a market or exchange meets a certain criteria. In such cases, the indicator variable is set to true only if an unambiguous source is found that provides sufficient information to make an evaluation. In the absence of such a source, the indicator variable is set to false.

3.1.1 Technology

An assessment of whether the technology infrastructure of the market's exchange provides sufficient availability and reliability for input data collection. Evaluates whether the exchange offers a REST API or websocket feed for data collection. Evaluates the performance of the API in terms of reliability.

1. `has_rest_api`: An indicator variable for the existence of a REST API.
2. `has_websocket_feed`: An indicator variable for the existence of a websocket feed.
3. `has_fix_gateway`: An indicator variable for the existence of a FIX gateway.
4. `has_historical_trade_data`: An indicator variable for whether the exchange offers historical trade data via its API.
5. `has_real_time_trade_data`: An indicator variable for whether the exchange offers real-time trade data via its API.
6. `has_real_time_order_book_data`: An indicator variable for whether the exchange offers real-time order book data via its API.
7. `api_downtime_incidents`: A feature that represents the stability of an API.

3.1.2 Legal and Compliance

An assessment of selected indicator variables relating to compliance and risk for each exchange. These indicator variables include whether the exchange has publicly-disclosed trading policies, uses market surveillance technology, obtains

regulatory licenses, has fiat and crypto insurance, requires customers to verify their identity before opening an account as part of its KYC and AML process, and whether the exchange has functioning fiat and cryptocurrency withdrawals processed within a normal timeframe.

1. **has_trading_policy**: An indicator variable for whether the exchange has a trading policy to promote fair and transparent markets. The trading policy should explicitly address manipulative trading policies like front-running, wash trading, spoofing, layering, churning, and quote stuffing.
2. **has_market_surveillance**: An indicator variable for whether the exchange uses market surveillance technology to detect market manipulation practices, including front-running, wash trading, spoofing, layering, churning, and quote stuffing.
3. **has_regulatory_oversight**: An indicator variable for whether the exchange obtains licenses from national or regional regulatory organizations.
4. **has_fiat_insurance**: An indicator variable for whether the exchange maintains commercial insurance or is covered under government-provided insurance to insure against losses of customer funds denominated in fiat currencies.
5. **has_crypto_insurance**: An indicator variable for whether the exchange maintains commercial insurance to insure against losses of customer funds denominated in digital assets.
6. **has_kycaml**: An indicator variable for whether the exchange requires identity verification before being able to open an account as part of its KYC and AML process. For the purposes of this indicator variable, an exchange which requires identity verification only if a customer wishes to deposit or withdraw fiat or if a customer wishes to withdraw digital assets is determined to not have sufficient controls. An exchange must require customers to verify their identity when opening an account as part of its KYC and AML process.
7. **has_free_capital_flows**: An indicator variable for whether the exchange has had a history of free capital flows over the last quarter, including functioning fiat and digital asset deposits and withdrawals that are processed within a normal timeframe.

3.1.3 Business Model

An assessment of the market's exchange with respect to its business model, including its fee structure and asset listing standards.

1. **has_fiat_markets**: An indicator variable that indicates whether the exchange has markets where the quote currency is a fiat currency.

2. **has_fees**: An indicator variable that indicates whether the exchange charges trading fees as a percentage of the trade size. Exchanges that charge zero fees or charge fees indirectly through a transaction mining model are determined to not charge fees.

3. **has_listing_standards**: An indicator variable that indicates whether the exchange has publicly disclosed a framework for deciding which assets to list.

4. **has_usa_hq**: An indicator variable for whether the company's headquarters are domiciled in the United States.

3.1.4 Data Availability

An assessment of the available data the market's exchange offers for the given digital asset, including the amount of historical data available for a market and the quoted currency of the market.

1. **market_days_history**: The number of days of historical data for the market.

2. **market_quote_modifier**: An optional modifier to give greater weight to a certain quote currency. Currently all quote currencies have equal weight.

3.1.5 Price

An assessment of the quality of the market's price data, including testing for the occurrence of price outliers and impactful price deviations from other markets, and implementing tests that determine whether the exchange's markets function as active markets in the underlying digital asset and are anchored by observable transactions entered into at arm's length between buyers and sellers.

In this section, prices are compared to the global median price. The global median price is defined as the median price of all markets in which the digital asset is the base currency from the following list of exchanges: `["Coinbase", "Poloniex", "Bittrex", "Gemini", "Kraken", "Binance", "Bitstamp", "itBit"]`. This list of exchanges was selected by first calculating the market ratings for each market but without the price-related features below. The median market rating was then calculated for each exchange and the top 8 exchanges were selected.

1. **market_open_mape_all**: The mean absolute percentage error of the market's daily open price compared to the global median's daily open price over the last 90 days.

2. `market_close_mape_all`: The mean absolute percentage error of the market's daily close price compared to the global median's daily close price over the last 90 days.

3. `market_low_mape_all`: The mean absolute percentage error of the market's daily low price compared to the global median's daily low price over the last 90 days.

4. `market_high_mape_all`: The mean absolute percentage error of the market's daily high price compared to the global median's daily high price over the last 90 days.

5. `market_open_mape_trimmed`: The mean absolute percentage error of the market's daily open price trimmed to exclude the bottom and top 5th percentiles compared to the global median's daily open price over the last 90 days.

6. `market_close_mape_trimmed`: The mean absolute percentage error of the market's daily close price trimmed to exclude the bottom and top 5th percentiles compared to the global median's daily close price over the last 90 days.

7. `market_low_mape_trimmed`: The mean absolute percentage error of the market's daily low price trimmed to exclude the bottom and top 5th percentiles compared to the global median's daily low price over the last 90 days.

8. `market_high_mape_trimmed`: The mean absolute percentage error of the market's daily high price trimmed to exclude the bottom and top 5th percentiles compared to the global median's daily high price over the last 90 days.

3.1.6 Volume

An assessment of the quality of the market's volume data, including testing for manipulated volume figures, and implementing tests that determine whether the exchange's markets function as active markets in the underlying digital asset and are anchored by observable transactions entered into at arm's length between buyers and sellers. The size of the exchange's markets is also considered.

1. `market_volume_usd`: The total volume of the market over the past 90 days in U.S. dollars.

2. `market_volume_dispersion`: The coefficient of variation of the market's daily volume in U.S. dollars over the past 90 days.

3. `market_volume_price_corr_raw`: The correlation of the market's daily return to detrended daily volume where volume is quoted in raw units over the past 90 days.

4. `market_volume_price_corr_usd`: The correlation of the market's daily return to detrended daily volume where volume is quoted in U.S. dollars over the past 90 days.

5. `alexa_rank`: The global rank of the exchange's website as reported by Alexa.

6. `alexa_page_views_per_million`: The average page views per million visitors of the exchange's website over the past month as reported by Alexa.

7. `alexa_reach_per_million`: The average reach per million visitors of the exchange's website over the past month as reported by Alexa.

8. `alexa_pvpmvu`: The total U.S. dollar volume of the exchange over the past month divided by the page views per million visitors as reported by Alexa.

9. `alexa_rpmvu`: The total U.S. dollar volume of the exchange over the past month divided by the reach per million visitors as reported by Alexa.

10. `similarweb_global_rank`: The global rank of the exchange's website as reported by SimilarWeb.

11. `similarweb_visit_monthly`: The number of monthly visits as reported by SimilarWeb.

12. `similarweb_vmvu`: The total U.S. dollar volume of the exchange over the past month divided by the monthly visits as reported by SimilarWeb.

3.1.7 Order Book

An assessment of the quality of the market's order book data, including tests for manipulated orders, and implementing tests that determine whether the market functions as an active market in the underlying digital asset and are anchored by observable transactions entered into at arm's length between buyers and sellers. The liquidity of the market is also considered.

1. `order_book_depth`: The total volume of bids and offers on the order book within 1 percent of the mid price of the exchange's largest traded market where the given asset is the base currency reported in U.S. dollars.

2. `slippage`: The amount of slippage in percent terms if an immediate market sell order of $50,000 U.S. dollars is executed of the exchange's largest traded market where the given asset is the base currency.

3. `spread`: The median of the spread calculated as the difference between the best bid minus the best ask divided by the mid-price over the past 30 days.

4. `order_book_depth_residual`: A regression model is fit by regressing volume on order book depth for the largest traded market for a collection of exchanges. Given an order book depth, an estimated volume is calculated and a residual is calculated as `actual_volume - estimated_volume`.

5. `slippage_residual`: A regression model is fit by regressing volume on slippage for the largest traded market for a collection of exchanges. Given a slippage, an estimated volume is calculated and a residual is calculated as `actual_volume - estimated_volume`.

3.2 Feature Normalization

All features are normalized to between 0 and 1, with a number closer to 1 meaning that the feature contributes positively to the likelihood that the market will be selected. The qualitative features are all indicator variables that take values 0 or 1. For quantitative features, a separate empirical cumulative distribution function is calculated for all the markets for each asset. The quantitative feature is normalized by converting the value to its equivalent value on the empirical cumulative distribution function.

3.3 Rating Algorithm

In order for a market to be eligible to receive a rating, the following three indicator variables for the market must be true: `has_rest_api`, `has_real_time_trade_data`, `has_real_time_order_book_data`. These indicator variables are required to be true because the ability to collect real-time trade data and real-time order book data via an API is necessary in order for the market to serve as an input data source.

The rating algorithm uses a weighted sum using a custom weighting function of the normalized features:

Feature	Weight
has_websocket_feed	1
has_fix_gateway	1
has_historical_trade_data	1
has_trading_policy	1
has_market_surveillance	1
has_regulatory_oversight	1
has_kycaml	1
has_fiat_insurance	1

Feature	Weight
has_crypto_insurance	1
has_free_capital_flows	3
has_fiat_market	1
has_fees	1
has_listing_standards	1
has_usa_hq	3
market_days_history	1
market_quote_modifier	1
market_open_mape_all	1
market_close_mape_all	1
market_low_mape_all	1
market_high_mape_all	1
market_open_mape_trimmed	1
market_close_mape_trimmed	1
market_low_mape_trimmed	1
market_high_mape_trimmed	1
market_volume_usd	3
market_volume_dispersion	1
market_volume_price_corr_raw	1
market_volume_price_corr_usd	1
alexa_rank	2
alexa_page_views_per_million	1
alexa_reach_per_million	1
alexa_pvpmvu	1
alexa_rpmvu	1
similarweb_global_rank	2
similarweb_visit_monthly	1
similarweb_vmvu	1

3.4 Selection Algorithm

Markets with a rating higher than 22.5 are selected. For each asset in the coverage universe, markets that are in the top 4 by rank are also selected, regardless of the market's rating. Any market with volume, measured in U.S. dollars over the past 90 days, of less than 5 percent of the volume of the selected market with the largest volume is excluded.

3.5 Candidate Markets

The pool of candidate markets that are evaluated by the Market Selection Framework are determined by a hierarchy of data inputs that varies depending on the given asset.

3.5.1 Bitcoin (BTC) and Ethereum (ETH)

The pool of candidate markets that are evaluated for the calculation of the CM Prices for Bitcoin (BTC) and Ethereum (ETH) are determined using the following data hierarchy:

1. The primary data input is observable transactions in an active market where the given cryptocurrency is the base currency and the quote currency is U.S. dollars.
2. Markets where the given cryptocurrency is the base currency and the quote currency is not U.S. dollars are not considered, including markets quoted in other fiat currencies or markets quoted in stablecoins.

3.5.2 Other Cryptocurrencies Excluding Stablecoins

The pool of candidate markets that are evaluated for the calculation of the CM Prices for cryptocurrencies, excluding Bitcoin (BTC), Ethereum (ETH), and stablecoins are determined using the following data hierarchy:

1. The primary data input is observable transactions in an active market where the given cryptocurrency is the base currency and the quote currency is U.S. dollars.
2. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where the given cryptocurrency is the base currency and quote currency is Bitcoin (BTC).
3. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where the given cryptocurrency is the base currency and quote currency is Ethereum (ETH).
4. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where the given cryptocurrency is the base currency and quote currency is USD Coin (USDC).
5. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where the given cryptocurrency is the base currency and quote currency is Tether (USDT).

3.5.3 Stablecoins

The pool of candidate markets that are evaluated for the calculation of the CM Prices for stablecoins are determined using the following data hierarchy:

1. The primary data input is observable transactions in an active market where the given stablecoin is the base currency and the quote currency is U.S. dollars.
2. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where Bitcoin (BTC) is the base currency and quote currency is the given stablecoin.
3. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where Ethereum (ETH) is the base currency and quote currency is the given stablecoin.
4. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where the given stablecoin is the base currency and quote currency is USD Coin (USDC).
5. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where the given stablecoin is the base currency and quote currency is Tether (USDT).

The data hierarchy for stablecoins differs from other cryptocurrencies because market convention sets stablecoins as the quote currency for the majority of active markets. The following assets in the coverage universe are considered to be stablecoins:

Name	Ticker
Tether	usdt
TrueUSD	tusd
USD Coin	usdc
Paxos Standard	pax
Gemini Dollar	gusd
Binance USD	busd
Dai	dai
USDK	usdk
BIDR	bidr
sUSD	susd
Neutrino USD	usdn

Name	Ticker
TerraUSD	ust
Pax Dollar	usdp
USDD	usdd
Euro Coin	euroc
Staked Ether Lido	steth
poundtoken	gbpt

3.5.4 Fiat Currencies

The pool of candidate markets that are evaluated for the calculation of the CM Prices for fiat currencies are determined using the following data hierarchy:

1. The primary data input is observable transactions in an active market where the given fiat currency is the base currency and the quote currency is U.S. dollars.
2. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where Bitcoin (BTC) is the base currency and quote currency is the given fiat currency.
3. If the above data inputs do not exist or are insufficient to calculate the price, the universe of data inputs will expand to include observable transactions in an active market where Ethereum (ETH) is the base currency and quote currency is the given fiat currency.

The data hierarchy for fiat currencies differs from other cryptocurrencies because market convention sets fiat currencies as the quote currency for the majority of active markets. The following assets in the coverage universe are considered to be fiat currencies:

Name	Ticker
Euro	eur
British Pound	gbp
Japanese Yen	jpy
Canadian Dollar	cad
Korean won	krw
Russian Ruble	rub
Ukrainian Hryvnia	uah
Turkish Lira	try
Australian Dollar	aud
Brazilian Real	brl

Name	Ticker
Swiss Franc	chf
Hong Kong Dollar	hkd
Singapore Dollar	sgd

4 Hourly Reference Rates Calculation Methodology

The Hourly Reference Rates are published hourly, every day of the year, and represent the reference rate of one unit of the asset quoted in U.S. dollars or other currency. The Hourly Reference Rates are calculated at the end of every hour (the "Calculation Time") and are published within 5 minutes (the "Publication Time").

4.1 Coverage Universe

The set of assets included in the Hourly Reference Rates coverage universe are included in Appendix A.

4.2 Calculation Algorithm

The calculation algorithm of the Hourly Reference Rates is described below.

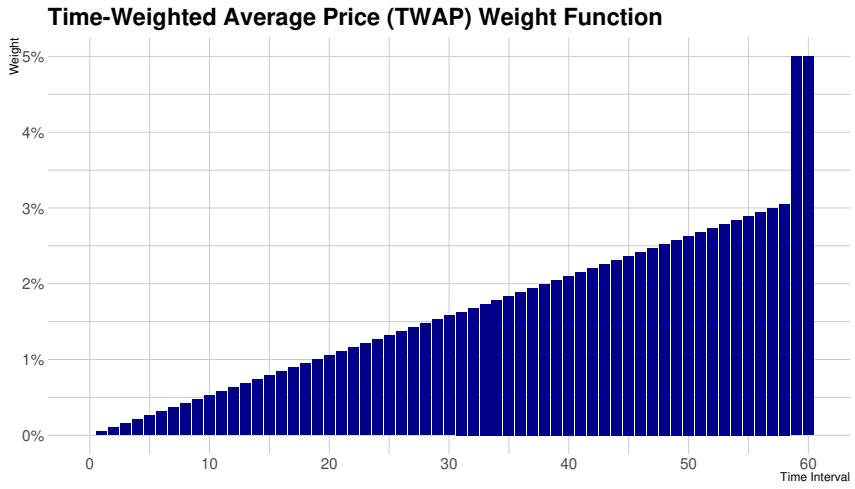
1. All observable transactions from Constituent Markets are combined and partitioned into time intervals, with each time interval spanning a period of one minute. The first one-minute time interval begins 60 minutes before the Calculation Time and the last one-minute time interval begins at the Calculation and ends one minute after the Calculation Time. In total, the calculation period spans a period of 61 minutes (the "Observation Window"). A total of 61 one-minute time intervals are created.

2. The price of each observable transaction for one unit of the given asset is converted to U.S. dollars if necessary using the Reference Rates calculated for Bitcoin (BTC), Ethereum (ETH), USD Coin (USDC), or Tether (USDT).

3. The volume-weighted median price (VWMP) of each time interval is calculated. The volume-weighted median rate is calculated by ordering the transactions from lowest to highest price, taking the cumulative sum of volumes of these transactions, and identifying the price associated with the trades at the 50th percentile of volume measured in native units.

4. The time-weighted average price (TWAP) of the 61 time intervals is calculated using a custom weight function. The weight function assigns a weight of 0 percent to the first time interval, subsequent time intervals are assigned a weight that increases linearly, and the last two time intervals are assigned a weight of 5 percent such that the sum of all weights equals 100 percent. The weight function assigns more weight to time slices that are closer to the Calculation Time. The resulting figure is the published reference rate.

A chart of the weights is included below and the exact weights for each time interval are listed in Appendix B:



4.3 Data Contingency Rules

The following contingency rules are followed to address situations where data is delayed, missing, or unavailable due to periods of illiquidity, extraordinary market circumstances, or outside factors beyond the control of Coin Metrics.

1. If observable transactions from a constituent market are unable to be collected due to technical problems specific to the constituent market's exchange during the calculation of a reference rate, the observable transactions from the constituent market are not included in the calculation of the specific instance of the given reference rate.

2. If no observable transactions from constituent markets occur during the first one-minute time interval, the next one-minute time interval's volume-weighted median price is used as the volume-weighted median price. This contingency rule is applied recursively if necessary.

3. If no observable transactions from constituent markets occur during any one-minute time intervals, excluding the first and last one-minute time intervals in the Calculation Window, the next one-minute time interval's volume-weighted median price is used as the volume-weighted median price. This contingency rule is applied recursively if necessary.

4. If no observable transactions from constituent markets occur during the last one-minute time interval, the previous time interval's volume-weighted median price is used as the volume-weighted median price. This contingency rule is applied recursively if necessary.

5. If no observable transactions from constituent markets exist during the Calculation Period for a reference rate, the reference rate will be determined to equal the previous hourly reference rate in which there were trades during that hour's Observation Window.

5 Real-Time Reference Rates Calculation Methodology

The Real-Time Reference Rates ("Real-Time Reference Rates") are published once per second and once per 200 milliseconds, every day of the year, and represent the reference rate of one unit of the asset quoted in U.S. dollars or other currency.

5.1 Coverage Universe

The set of assets included in the Real-Time Reference Rates coverage universe are included in Appendix A.

5.2 Calculation Algorithm

The calculation algorithm of the Real-Time Reference Rates is described below.

1. Calculate the volume denominated in units of the given asset from observable transactions that occurred over the trailing 60 minutes for each of the Constituent Markets. Calculate the volume weight for each of the Constituent Markets by dividing the volume figure for each of the Constituent Markets by the total volume across all Constituent Markets. The resulting figure is referred to as the volume weight.

2. Convert the trade price of all observable transactions over the trailing 60 minutes for each of the Constituent Markets to U.S. dollars if necessary using the Real-Time Reference Rate calculated for Bitcoin (BTC),

Ethereum (ETH), USD Coin (USDC), or Tether (USDT). Calculate the inverse variance of the trade price converted to U.S. dollars for each of the Constituent Markets using the population mean in the calculation of variance, where the population mean is defined as the mean price of all trades from Constituent Markets over the trailing 60 minutes. If a Constituent Market has an infinite or undefined inverse price variance, the inverse price variance for that Constituent Market is set to zero. Calculate the inverse price variance weight for each of the Constituent Markets by dividing the inverse price variance by the total inverse price variance across all Constituent Markets. The resulting figure is referred to as the inverse price variance weight.

3. Calculate the final weight for each of the Constituent Markets by taking a mean of the volume weight and the inverse price variance weight.

4. Extract the most recent observable transaction from each of the Constituent Markets. Convert the trade price of the most recent observable transactions to U.S. dollars if necessary using the Real-Time Reference Rate calculated for Bitcoin (BTC), Ethereum (ETH), USD Coin (USDC), or Tether (USDT).

5. Calculate the weighted median price of the most recent observable transactions using the prices calculated in step 4 and the final weights calculated in step 3. The weighted median price is calculated by ordering the transactions from lowest to highest price, and identifying the price associated with the trades at the 50th percentile of final weight. The resulting figure is the Real-Time Reference Rate for the given asset.

5.3 Data Contingency Rules

The following contingency rules are followed to address situations where data is delayed, missing, or unavailable due to periods of illiquidity, extraordinary market circumstances, or outside factors beyond the control of Coin Metrics.

1. If observable transactions from a constituent market are unable to be collected due to technical problems specific to the constituent market's exchange during the calculation of a real-time reference rate, the observable transactions from the constituent market are not included in the calculation of the specific instance of the given real-time reference rate.

2. If no observable transactions from constituent markets exist during the trailing 60 minutes, the value of the real-time reference rate will be determined to equal the value calculated during the previous second.

6 Principal Market Prices Calculation Methodology

The Principal Market Prices are published once per second, every day of the year, and represent the price of one unit of the asset quoted in U.S. dollars.

6.1 Fair Market Valuation Background

The Principal Market Prices were developed taking into account the requirements of IFRS 13 and FASB ASC 820 accounting guidelines defining what a Principal Market is and how it should be selected. These guidelines also allow for additional controls to verify the market is active and trades are orderly.

As Coin Metrics already provides Hourly Reference Rates and Real-Time Reference Rates methodologies to price cryptocurrencies which we believe to be robust and stable, it is worth briefly describing the philosophy behind producing the Principal Market Prices to supplement the reference rates. The first and most significant criteria is that certain regulatory agencies require a methodology consistent with the aforementioned accounting principles. These principles clearly describe the preferred "fair market value" calculation as one which identifies a Principal Market by trade volume and tracks executed trades in that market.

Beyond external requirements, the benefits for a Principal Market Prices methodology are that it is clearly defined and auditable. The price is always taken from a single market, which tends to remain constant, and can easily be traced and verified for a given time stamp. We minimize computations being done on the price, which reduces the likelihood of unforeseen behavior. Additionally, the trades are always taken from the exchange where the most of the activity occurs, which is a characteristic users are interested in.

Like all things in life, this comes with some trade offs. Our Hourly Reference Rates and Real-Time Reference Rates look for a central tendency among several markets. In some cases this can avoid volatility and the presence of outliers if the Principal Market Prices deviate from the global average, but it also means that the final price may be taken from comparatively insignificant market where the price is between the prices of markets of larger volume. With these tradeoffs in mind, our methodology seeks to err on the side of trusting the largest market by volume of trades and only excludes a market in extreme situations.

We also attempt to avoid numerical comparisons of the price between markets in the methodology, in order to minimize the possibility that a price anomaly in another market could affect the calculation. Our Hourly Reference Rates and Real-Time Reference Rates by contrast choose to combine multiple markets to identify a more stable price representative of the global environment.

6.2 Coverage Universe

The set of assets included in the Principal Market Prices coverage universe are included in Appendix A.

6.3 Calculation Algorithm

The calculation algorithm of the Principal Market Prices is described below.

1. Consider the list of Constituent Markets selected by the Market Selection Framework.

2. Identify any inactive markets, and exclude all trades associated with the inactive market. A market is considered inactive if it meets the following conditions:

   The last trade was more than 1-minute ago and the last trade was either: longer than 10 minutes from the calculation time or longer than 100 * [mean trade interval].

   The mean trade interval is defined as the the average of all intervals between sequential trades in the window 0 to 60 minutes before the calculation time. For example, if trades occur at timestamps `[00:02, 00:12, 00:37, 01:15]`, the mean trade interval will be `mean([10 seconds, 25 seconds, 38 seconds]) = 23.3 seconds`.

   If there are no active markets, then the Principal Market Price will forward-fill the last non-null value available.

3. Check if any trades in the markets are not considered orderly (IFRS 13.B37-B38). Exclude any non-orderly trades from the calculation.

   This is accomplished by examining the window 60 to 120 minutes before the calculation time to calculate a reference standard deviation of prices in each market separately. If there are insufficient trades to calculate a standard deviation, then all trades are considered orderly (i.e. no trades are dropped if there is sparse data).

   We then partition the calculation window 0 to 60 minutes before the calculation time into 60 one-minute time intervals and calculate how far each trade is from the mean price of trades from that market in the one-minute time interval the trade resides in.

   Finally, we exclude trades that occur more than three reference standard deviations from the mean price of trades within a particular one-minute time interval.

   We require at least five trades occur in a particular one-minute time interval in order to exclude trades. The two parameters (3 reference deviations and 5 trades) may be adjusted in the future.

4. Identify the active market with the largest volume of orderly trades in the calculation window 0 to 60 minutes before the calculation time. This will serve as the Principal Market (IFRS 13.16, FASB ASC 820-35-5).

5. Use the most recent orderly trade from the Principal Market and publish its price as the Principal Market Price.

7 Data Exclusion Rules

All observable transactions from constituent markets are evaluated using a systematic data quality control process. If potential errors or anomalies in the data are detected, the exercise of expert judgment will be applied to determine if the potentially erroneous data is included in the calculation of the price. The exercise of expert judgment in this circumstance is used to determine if the potentially erroneous data reflects observable transactions that are entered into at arm's length between buyers and sellers and constitute an active market in the underlying asset, whether the observable transactions in question are formed by the competitive forces of supply and demand, and whether the observable transactions in question are a credible indicator of executable prices in the underlying asset.

An investigation into the causes of the potential error, including whether any price deviations are specific to the exchange itself, is conducted. Any exercise of expert judgment is subject to dual approval by staff members, and is logged and reported to the Oversight Committee which periodically reviews the application of expert judgment to ensure consistency.

8 Appendix A

The following table lists the current coverage universe:

#	Name	Ticker
1	Bitcoin	btc
2	Bitcoin Cash	bch
3	Litecoin	ltc
4	Euro	eur
5	XRP	xrp
6	Ethereum	eth
7	Ethereum Classic	etc
8	British Pound	gbp
9	Zcash	zec
10	Monero	xmr
11	Dash	dash

#	Name	Ticker
12	Japanese Yen	jpy
13	IOTA	miota
14	EOS	eos
15	OMG Network	omg
16	Neo	neo
17	Metaverse ETP	etp
18	Qtum	qtum
19	Aventus	avt
20	Bitcoin Gold	btg
21	Streamr	data
22	QASH	qash
23	Status	snt
24	Basic Attention Token	bat
25	Decentraland	mana
26	FUNToken	fun
27	0x	zrx
28	Time New Bank	tnb
29	TRON	trx
30	iExec RLC	rlc
31	Augur	rep
32	aelf	elf
33	IOST	iost
34	Aion	aion
35	Request	req
36	Loopring	lrc
37	WAX	waxp
38	Aragon	ant
39	Mithril	mith
40	Storj	storj
41	Stellar	xlm
42	Verge	xvg
43	Lympo	lym
44	Maker	mkr
45	VeChain	vet
46	Kyber Network Crystal	knc
47	Utrust	utk
48	Ripio Credit Network	rcn_ripiocreditnetwork
49	Polymath	poly
50	Fusion	fsn
51	Nitro Network	ncash
52	Cortex	ctxc
53	DATA	dta
54	Zilliqa	zil
55	Bancor	bnt

#	Name	Ticker
56	MonaCoin	mona
57	NEM	xem
58	BNB	bnb
59	Gas	gas
60	Tether	usdt
61	OAX	oax
62	district0x	dnt
63	Waltonchain	wtc
64	Chainlink	link
65	Moeda Loyalty Points	mda
66	Metal DAO	mtl_metal
67	AirSwap	ast
68	Viberate	vib
69	Powerledger	powr
70	Ark	ark
71	Enjin Coin	enj
72	Komodo	kmd
73	NULS	nuls
74	AirDAO	amb
75	Quantstamp	qsp
76	BitShares	bts
77	Lisk	lsk
78	Bitcoin Diamond	bcd
79	Ambire AdEx	adx
80	Cardano	ada
81	CyberMiles	cmt
82	Waves	waves
83	ICON	icx
84	PIVX	pivx
85	OST	ost
86	ChatCoin	chat
87	Civic	cvc
88	Steem	steem
89	Nano (New)	nano
90	Bluzelle	blz
91	Aeternity	ae
92	Ontology	ont
93	Wanchain	wan
94	Kepple	qlc
95	Syscoin	sys
96	Ardor	ardr
97	Holo	hot_holo
98	Loom Network	loom
99	Bytecoin	bcn

#	Name	Ticker
100	TrueUSD	tusd
101	Horizen	zen
102	Theta Network	theta
103	IoTeX	iotx
104	QuarkChain	qkc
105	SelfKey	key
106	Siacoin	sc
107	Nebulas	nas
108	Dent	dent
109	Dock	dock
110	Gnosis	gno
111	Canadian Dollar	cad
112	Enzyme	mln
113	Dogecoin	doge
114	Bytom	btm
115	BitKan	kan
116	Arcblock	abt
117	Auto	auto
118	CyberVein	cvt
119	Decred	dcr
120	DigiByte	dgb
121	Cred	lba
122	Measurable Data Token	mdt
123	Molecular Future	mof
124	TenX	pay
125	Revain	rev
126	Ren	ren
127	SwftCoin	swftc
128	Nxt	nxt
129	VITE	vite
130	Odyssey	ocn
131	Huobi Token	ht
132	Elastos	ela
133	WaykiChain	wicc
134	SIRIN LABS Token	srn
135	DeepBrain Chain	dbc
136	Propy	pro
137	Bibox Token	bix
138	HyperCash	hc_hypercash
139	MaidSafeCoin	maid
140	Amp	amp
141	Chrono.tech	time
142	Pluton	plu
143	Tezos	xtz

#	Name	Ticker
144	Stacks	stx
145	Ignis	ignis
146	Atletico De Madrid Fan Token	atm
147	PolySwarm	nct
148	Kin	kin
149	IndiGG	indi
150	SwissBorg	chsb
151	OriginTrail	trac
152	Nexo	nexo
153	Telcoin	tel
154	Berry	berry
155	Crypterium	crpt
156	IHT Real Estate Protocol	iht
157	VeThor Token	vtho
158	DxChain Token	dx
159	CEEK VR	ceek
160	Oxygen	oxy
161	UNUS SED LEO	leo
162	Vertcoin	vtc
163	Game.com	gtc_gamecom
164	MediBloc	med
165	Creditcoin	ctc
166	NKN	nkn
167	Uquid Coin	uqc
168	Korean won	krw
169	IQ	iq
170	Ravencoin	rvn
171	LBRY Credits	lbc
172	ReddCoin	rdd
173	Numeraire	nmr
174	Russian Ruble	rub
175	Ukrainian Hryvnia	uah
176	Turkish Lira	try
177	Aurora Chain	aoa
178	Australian Dollar	aud
179	Brazilian Real	brl
180	Swiss Franc	chf
181	Ethernity	ern
182	Hong Kong Dollar	hkd
183	Singapore Dollar	sgd
184	OpenDAO	sos
185	Dragonchain	drgn
186	Kleros	pnk
187	USD Coin	usdc

#	Name	Ticker
188	KuCoin Token	kcs
189	Paxos Standard	pax
190	Gemini Dollar	gusd
191	Constellation	dag
192	Nimiq	nim
193	GoChain	go
194	Electroneum	etn
195	Bitcoin SV	bsv
196	MXC	mxc
197	TomoChain	tomo
198	Livepeer	lpt
199	RSK Infrastructure Framework	rif
200	v.systems	vsys
201	Grin	grin
202	Seele	seele
203	Lambda	lamb
204	Dora Factory	dora
205	Beam	beam
206	Unibright	ubt
207	FTX Token	ftt
208	Kryll	krl
209	Fetch.ai	fet
210	Ontology Gas	ong_ontologygas
211	Ankr	ankr
212	Haven Protocol	xhv
213	Quant	qnt
214	SOLVE	solve
215	Aergo	aergo
216	Circuits of Value	coval
217	Cronos	cro
218	Cosmos	atom
219	Orbs	orbs
220	Theta Fuel	tfuel
221	BORA	bora
222	Function X	fx
223	IRISnet	iris
224	Celer Network	celr
225	ABBC Coin	abbc
226	Verasity	vra
227	Wrapped Bitcoin	wbtc
228	Polygon	matic
229	Litentry	lit
230	Fantom	ftm
231	Algorand	algo

#	Name	Ticker
232	Dusk Network	dusk
233	XYO	xyo
234	Ocean Protocol	ocean
235	Celsius	cel
236	Synthetix	snx
237	ThunderCore	tt
238	MovieBloc	mbl
239	Reserve Rights	rsr
240	STP	stpt
241	Harmony	one_harmony
242	ARPA	arpa
243	Phoenix	phb
244	WINkLink	win_wink
245	Binance USD	busd
246	Dai	dai
247	Tether Gold	xaut
248	PAX Gold	paxg
249	OKB	okb
250	Hedera	hbar
251	Nervos Network	ckb
252	Solar	sxp
253	Terra Classic	luna
254	Chiliz	chz
255	Orchid	oxt
256	LCX	lcx
257	Nahmii	nii
258	USDK	usdk
259	WazirX	wrx
260	Band Protocol	band
261	Kusama	ksm
262	Hive	hive
263	Energi	nrg
264	GateToken	gt
265	Kava	kava
266	MX TOKEN	mx
267	Arweave	ar
268	Compound	comp
269	NuCypher	nu
270	Keep Network	keep
271	Origin Protocol	ogn
272	Render Token	rndr
273	Cocos-BCX	cocos
274	DREP	drep
275	LTO Network	lto

#	Name	Ticker
276	COTI	coti
277	Solana	sol
278	Cartesi	ctsi
279	Chromia	chr
280	StormX	stmx
281	BIDR	bidr
282	Polkadot	dot
283	Celo	celo
284	Filecoin	fil
285	sUSD	susd
286	Travala.com	ava
287	Wirex Token	wxt
288	Syntropy	noia
289	Akropolis	akro
290	Ampleforth	ampl
291	SENSO	senso
292	DigitalBits	xdb
293	Sylo	sylo
294	Neutrino USD	usdn
295	KardiaChain	kai
296	Energy Web Token	ewt
297	yearn.finance	yfi
298	UMA	uma
299	renBTC	renbtc
300	Avalanche	avax
301	BOSagora	boa
302	JUST	jst
303	Bifrost	bfc
304	DIA	dia
305	ForTube	for
306	Green Satoshi Token	gst
307	Helium	hnt
308	IDEX	idex
309	Kadena	kda
310	Klaytn	klay
311	mStable Governance Token: Meta (MTA)	mta
312	NEST Protocol	nest
313	MANTRA	om
314	Orion Protocol	orn
315	Prom	prom
316	PARSIQ	prq
317	Rocket Pool	rpl
318	Reserve	rsv
319	THORChain	rune

#	Name	Ticker
320	ShareToken	shr
321	Serum	srm
322	SUKU	suku
323	tBTC	tbtc
324	Tellor	trb
325	BiLira	tryb
326	Curve DAO Token	crv
327	Velas	vlx
328	Wrapped NXM	wnxm
329	DFI.Money	yfii
330	Balancer	bal
331	SushiSwap	sushi
332	Swerve	swrv
333	Cream Finance	cream
334	Sun Token	sun
335	MultiversX	egld
336	Uniswap	uni
337	Alchemy Pay	ach
338	Aleph.im	aleph
339	Bella Protocol	bel
340	Frontier	front
341	Insight Protocol	inx
342	Klever	klv
343	TrustSwap	swap
344	Toncoin	ton
345	TerraUSD	ust
346	Handshake	hns
347	Ultra	uos
348	BakeryToken	bake
349	Aavegotchi	ghst
350	Rarible	rari
351	Velo	velo
352	Aave	aave
353	PancakeSwap	cake
354	DODO	dodo
355	Harvest Finance	farm
356	Polkastarter	pols
357	Secret	scrt
358	Venus	xvs
359	Core	core
360	Dego Finance	dego
361	Ergo	erg
362	MATH	math
363	NEAR Protocol	near

#	Name	Ticker
364	DeFiChain	dfi
365	Audius	audio
366	Axie Infinity	axs
367	Conflux	cfx
368	Shentu	ctk
369	Celo Dollar	cusd
370	Injective	inj
371	Keep3rV1	kp3r
372	Oasys	oas
373	Smooth Love Potion	slp
374	StaFi	fis
375	Flamingo	flm
376	Oasis Network	rose
377	TrueFi	tru
378	Unifi Protocol DAO	unfi
379	Golem	glm
380	Hegic	hegic
381	API3	api3
382	Badger DAO	badger
383	Firo	firo
384	MobileCoin	mob
385	Synapse	syn
386	Virtua	tvk
387	The Graph	grt
388	1inch	1inch
389	Alpha Venture DAO	alpha
390	OctoFi	octo
391	saffron.finance	sfi
392	Perpetual Protocol	perp
393	AS Roma Fan Token	asr
394	BarnBridge	bond
395	CUDOS	cudos
396	DeXe	dexe
397	Bonfida	fida
398	Frax	frax
399	Frax Share	fxs
400	Juventus Fan Token	juv
401	Linear	lina
402	Mdex	mdx
403	Mirror Protocol	mir
404	OG Fan Token	og
405	Marlin	pond
406	Paris Saint-Germain Fan Token	psg
407	REVV	revv

#	Name	Ticker
408	Rook	rook
409	Trust Wallet Token	twt
410	ZKSpace	zks
411	Flow	flow
412	Stratis	strax
413	Reef	reef
414	Bitcoin Standard Hashrate Token	btcst
415	The Sandbox	sand
416	SafePal	sfp
417	SKALE	skl
418	Phala Network	pha
419	WOO Network	woo
420	Raydium	ray
421	AC Milan Fan Token	acm
422	Akash Network	akt
423	Alchemix	alcx
424	DAO Maker	dao
425	DerivaDAO	ddx
426	Dypius	dyp
427	Inverse Finance	inv
428	MAPS	maps
429	Mask Network	mask
430	NFTX	nftx
431	Prosper	pros
432	BENQI	qi
433	Radicle	rad
434	Rally	rly
435	SuperVerse	super
436	Tornado Cash	torn
437	AIOZ Network	aioz
438	Alpaca Finance	alpaca
439	Anchor Protocol	anc
440	Boson Protocol	boson
441	Convergence	conv
442	Fei USD	fei
443	Fire Protocol	fire
444	Flux	flux
445	Franklin	fly
446	Galxe	gal
447	Illuvium	ilv
448	JasmyCoin	jasmy
449	Polkacity	polc
450	Rai Reflex Index	rai
451	Strike	strk

#	Name	Ticker
452	Alien Worlds	tlm
453	Tribe	tribe
454	Symbol	xym
455	Internet Computer	icp
456	Shiba Inu	shib
457	FC Barcelona Fan Token	bar
458	SpookySwap	boo
459	Somnium Space Cubes	cube
460	Dogelon Mars	elon
461	Ampleforth Governance Token	forth
462	Gitcoin	gtc
463	Kishu Inu	kishu
464	Liquity	lqty
465	Media Network	media
466	APENFT	nft
467	QuickSwap	quick
468	Songbird	sgb
469	Step Finance	step
470	Persistence	xprt
471	Liquity USD	lusd
472	Lido DAO	ldo
473	Baby Doge Coin	babydoge
474	BitDAO	bit
475	Coin98	c98
476	Celo Euro	ceur
477	Tranchess	chess
478	CLV	clv
479	Covalent	cqt
480	Convex Finance	cvx
481	Dvision Network	dvi
482	Gala	gala
483	Goldfinch	gfi
484	Metahero	hero
485	Karura	kar
486	MOBOX	mbox
487	Moonriver	movr
488	PlayDapp	pla
489	Qredo	qrdo
490	RadioCaca	raca
491	SuperRare	rare
492	Saitama	saitama
493	Shiden Network	sdn
494	SOMESING	ssx
495	StarLink	starl

#	Name	Ticker
496	Wrapped NCG	wncg
497	XCAD Network	xcad
498	eCash	xec
499	Yield Guild Games	ygg
500	Pax Dollar	usdp
501	My Neighbor Alice	alice
502	ASD	asd
503	XDC Network	xdc
504	Mina	mina
505	Adventure Gold	agld
506	Star Atlas DAO	polis
507	dYdX	dydx
508	Spell Token	spell
509	Angle	angle
510	Ariva	arv
511	Assemble Protocol	asm
512	AstroSwap	astro
513	Star Atlas	atlas
514	Beta Finance	beta
515	BinaryX	bnx
516	Braintrust	btrst
517	Manchester City Fan Token	city
518	Clearpool	cpool
519	FLOKI	floki
520	Gods Unchained	gods
521	Highstreet	high
522	JOE	joe
523	S.S. Lazio Fan Token	lazio
524	Moss Carbon Credit	mco2
525	Marinade Staked SOL	msol
526	Olympus	ohm
527	Orca	orca
528	PackagePortal	port
529	Ribbon Finance	rbn
530	Samoyedcoin	samo
531	Saber	sbr
532	ssv.network	ssv
533	Strips Finance	strp
534	Tokemak	toke
535	VEMP	vemp
536	Wrapped Centrifuge	wcfg
537	Mines of Dalarnia	dar
538	Ethereum Name Service	ens
539	GM Wagmi	gm

#	Name	Ticker
540	GYEN	gyen
541	ImmutableX	imx
542	KOK	kok
543	Magic Internet Money	mim
544	FC Porto Fan Token	porto
545	ParaSwap	psp
546	Aurora	aurora
547	Binance Beacon ETH	beth
548	Boba Network	boba
549	Everscale	ever
550	Merit Circle	mc
551	Maple	mpl
552	ONSTON	onston
553	ConstitutionDAO	people
554	Santos FC Fan Token	santos
555	BitTorrent (new)	bttc
556	Vulcan Forged PYR	pyr
557	Tether EURt	eurt
558	Casper	cspr
559	Automata Network	ata
560	ApeCoin	ape
561	LooksRare	looks
562	Moonbeam	glmr
563	Tulip Protocol	tulip
564	Osmosis	osmo
565	STEPN	gmt
566	Biconomy	bico
567	Alpine F1 Team Fan Token	alpine
568	Astar	astr
569	Biswap	bsw
570	PowerPool	cvp
571	Gari Network	gari
572	Index Cooperative	index
573	Multichain	multi
574	Optimism	op
575	REI Network	rei
576	SHPING	shping
577	Stargate Finance	stg
578	Voxies	voxel
579	Zebec Protocol	zbc
580	Acala Token	aca
581	Bounce Governance Token	auction
582	Eden	eden
583	Ellipsis	epx

#	Name	Ticker
584	Shapeshift FOX Token	fox
585	League of Kingdoms Arena	loka
586	MetisDAO	metis
587	Ooki Protocol	ooki
588	Pundi X	pundix
589	Threshold	t
590	Voyager Token	vgx
591	USDD	usdd
592	Chia	xch
593	Euro Coin	euroc
594	Beefy Finance	bifi_beef
595	Staked Ether Lido	steth
596	poundtoken	gbpt
597	Terra 2.0	luna2
598	Nano	xno
599	Onyxcoin	xcn
600	NYM	nym
601	Efinity Token	efi
602	WEMIX	wemix
603	Step App	fitfi
604	Sweat Economy	sweat
605	FirmaChain	fct2
606	Tokenlon Network Token	lon
607	pSTAKE Finance	pstake
608	Vesper	vsp
609	GuildFi	gf
610	LeverFi	lever
611	Euler	eul
612	EthereumPoW	ethw
613	Crabada	cra
614	Reflexer Ungovernance Token	flx
615	JUNO	juno
616	Altered State Token	asto
617	BreederDAO	breed
618	Saddle	sdl
619	Arsenal Fan Token	afc
620	Aptos	apt
621	Axelar	axl
622	Bitcicoin	bitci
623	Cult DAO	cult
624	Forta	fort
625	GMX	gmx
626	Hashflow	hft
627	Polymesh	polyx

#	Name	Ticker
628	Agoric	bld
629	Avocado DAO Token	avg
630	ECOx	ecox
631	Evmos	evmos
632	PathDAO	path
633	Stader	sd
634	Tribal Token	tribl
635	Bonk	bonk
636	Hooked Protocol	hook
637	Dogechain	dc
638	Flare	flr
639	Hifi Finance	hifi
640	DeFi Kingdoms	jewel
641	Dopex	dpx
642	MAGIC	magic

9 Appendix B

The following table lists the weights applied to each one-minute time interval described in the Hourly Reference Rates Methodology section.

Time Interval	Weight
0	0.000000
1	0.000526
2	0.001052
3	0.001578
4	0.002104
5	0.002630
6	0.003156
7	0.003682
8	0.004208
9	0.004734
10	0.005260
11	0.005786
12	0.006312
13	0.006838
14	0.007364
15	0.007890
16	0.008416
17	0.008942
18	0.009468

Time Interval	Weight
19	0.009994
20	0.010520
21	0.011046
22	0.011572
23	0.012098
24	0.012624
25	0.013150
26	0.013676
27	0.014202
28	0.014728
29	0.015254
30	0.015780
31	0.016306
32	0.016832
33	0.017358
34	0.017884
35	0.018410
36	0.018936
37	0.019462
38	0.019988
39	0.020514
40	0.021040
41	0.021566
42	0.022092
43	0.022618
44	0.023144
45	0.023670
46	0.024196
47	0.024722
48	0.025248
49	0.025774
50	0.026300
51	0.026826
52	0.027352
53	0.027878
54	0.028404
55	0.028930
56	0.029456
57	0.029982
58	0.030508
59	0.050000
60	0.050000

10 Change Log

1. **Version 1.0 on March 16, 2023**: Initial publication of Coin Metrics Pricing Methodology. Previous versions of this document were contained in our Market Selection Framework, Hourly Reference Rates Methodology, Real-Time Reference Rates Methodology, and Principal Mark Price Methodology. Those four documents are now consolidated into the Coin Metrics Pricing Methodology. The coverage universe is expanded to include the following assets: bonk, cusd, cra, jewel, apt, asto, aurora, avg, axl, bld, breed, ceur, cpool, ecox, evmos, flx, fly, fort, gf, index, indi, inx, multi, path, rpl, rsv, sd, sdl, tbtc, tribl, gmx, bifi_beef, dpx, boo, beth, magic, juno, port, phb, kishu, lever, flr, hft, porto, polyx, lazio, atm, acm, xcad, ssv, pros, rei, qlc, dego, vite, firo, iq, bar, og, hifi, asr, dyp, time, sylo, polc, bitci, fct2, onston, vsp, afc, bsw, epx, xno, dexe, core, vemp, cult, saitama, ever, babydoge, dc, kar, fsn, hero, oas, hook, cocos. The following assets are terminated from the coverage universe: mft, hpt, hxro, usdn, aion.

2. **Coin Metrics Real-Time Reference Rates Methodology Version 0.15 on February 9, 2023**: Added a 200 milliseconds publication frequency.

3. **Coin Metrics Hourly Reference Rates Methodology Version 2.13 and Coin Metrics Real-Time Reference Rates Methodology Version 0.14 on September 21, 2022**: The coverage universe is expanded to include the following assets: loka, mc, polis, sgb, steth, frax, rai, lusd , dfi, gbpt, ooki, fis, nest, drep, math, aleph, media, luna2, t, ethw, bttc, vra, swftc, raca, pyr, mbox, sweat, fitfi, qrdo, wemix, zbc, psg, voxel, chess, prq, gari, nym, arv, cudos, efi, for, juv, cvp, mbl, auto, eden, xcn, kai, velo, akt, berry, klv, kok, senso, floki, sdn, alpine, step, eurt, bfc, toke, shping, oxy, ssx, lit, conv. The publication of reference rates is terminated for the following assets: ramp, grs, ppt, nav, itc, qc, meta, cope, zb. Minor changes to internal audit section.

4. **Coin Metrics Hourly Reference Rates Methodology Version 2.12 and Coin Metrics Real-Time Reference Rates Methodology Version 0.13 on July 1, 2022**: The coverage universe is expanded to include the following assets: fei, op, usdd, xch, gmt, bico, ctk, flm, sfp, starl, glmr, tulip, astro, sfi, gst, mob, bit, vgx, auction, pundix, stg, ata, bel, dar, gal, astr, cqt, cspr, metis, boba, twt, aca, dao, xprt, cube. The publication of reference rates is terminated for the following assets: gxs, dgtx, wluna, dgd, foam, csp, cnn, bft.

5. **Market Selection Framework Version 1.0.2 on February 15, 2022**: The selection algorithm was modified so that any market with volume,

measured in U.S. dollars over the past 90 days, of less than 5 percent of the volume of the selected market with the largest volume is excluded.

6. **Coin Metrics Hourly Reference Rates Methodology Version 2.11 and Coin Metrics Real-Time Reference Rates Methodology Version 0.12 on February 15, 2022**: The coverage universe is expanded to include the following assets: `xec`, `kda`, `mina`, `xdc`, `elon`, `flux`, `movr`, `ceek`, `win_wink`, `dvi`, `dusk`, `asd`, `gala`, `spell`, `ens`, `tru`, `alcx`, `clv`, `imx`, `agld`, `jasmy`, `farm`, `alice`, `chr`, `dydx`, `tlm`, `mdt`, `gtc`, `sun`, `c98`, `people`, `lina`, `rndr`, `ach`, `super`, `mask`, `quick`, `arpa`, `qi`, `idex`, `rad`, `bond`, `mir`, `joe`, `gods`, `front`, `pla`, `orn`, `ramp`, `rgt`, `fida`, `forth`, `tribe`, `wluna`, `coval`, `rbn`, `lcx`, `asm`, `ddx`, `suku`, `krl`, `rari`, `mco2`, `gyen`, `btrst`, `api3`, `rly`, `wcfg`, `musd`, `ilv`, `atlas`, `usdp`, `joe`, `ldo`, `cvx`, `fxs`, `kp3r`, `alpaca`, `bnx`, `boson`, `dora`, `ghst`, `nft`, `ohm`, `om`, `pond`, `rare`, `revv`, `stpt`, `torn`, `tvk`, `wncg`, `xym`, `ygg`. The publication of reference rates is terminated for the following assets: `hedg`, `eurs`, `bzrx`, `poa`, `wpr`, `dmg`, `cdt`, `phx`, `appc`, `btt`, `idrt`, `rdn`, `via`, `evx`. The section "Data Inputs", subsections "Other Cryptocurrencies Excluding Stablecoins" and "Stablecoins", was modified to consider markets quoted in USD Coin or Tether to serve as constituent markets. The constituent markets for all assets in the coverage universe are updated. The constituent markets for all assets in the coverage universe are updated.

7. **Coin Metrics Hourly Reference Rates Methodology Version 2.10 and Coin Metrics Real-Time Reference Rates Methodology Version 0.11 on September 28, 2021**: The coverage universe is expanded to include the following assets: `amp`, `axs`, `shib`, `audio`, `bake`, `med`, `dag`, `slp`, `xdb`. The publication of reference rates is terminated for the following assets: `agi` ,`btmx`, `dgx`, `ethos`, `mco`, `sngls`, `cpay`, `eng`, `lun`, `pnt`. The constituent markets for all assets in the coverage universe are updated.

8. **Coin Metrics Hourly Reference Rates Methodology Version 2.9 and Coin Metrics Real-Time Reference Rates Methodology Version 0.10 on May 27, 2021**: The coverage universe is expanded to include the following assets: `icp`, `cope`, `maps`, `btcst`, `ctsi`, `erg`, `woo`, `prom`, `strax`, `usdn`, `cfx`, `mdx`, `nkn`, `sand`, `fx`, `pha`. The publication of reference rates is terminated for the following assets: `tnt`, `npxs`, `zar`. The constituent markets for all assets in the coverage universe are updated.

9. **Coin Metrics Hourly Reference Rates Methodology Version 2.8 and Coin Metrics Real-Time Reference Rates Methodology Version 0.9 on April 25, 2021**: The methodology was modified to add fiat currencies to the coverage universe. The coverage universe is expanded to include the following assets: `eur`, `krw`, `gbp`, `jpy`, `aud`, `try`, `brl`, `rub`, `sgd`, `bidr`, `ngn`, `cad`, `chf`, `zar`, `idrt`, `hkd`, `uah`, `qc`, `klay`, `cake`, `btmx`, `flow`, `zks`, `stmx`, `skl`, `reef`, `dodo`, `coti`, `bora`, `cream`, `ray`, `tryb`, `rook`. The publication of reference rates is terminated for the following assets: `xzc`, `bcpt`, `yamv2`, `xns`, `tmtg`, `kp3r`.

10. **Coin Metrics Hourly Reference Rates Methodology Version 2.7 and Coin Metrics Real-Time Reference Rates Methodology Version 0.8 on February 23, 2021**: The coverage universe is expanded to include the following assets: `1inch`, `alpha`, `octo`, `perp`, `scrt`, `grt`, `keep`, `xvs`, `nu`, `tel`, `badger`.

11. **Coin Metrics Hourly Reference Rates Methodology Version 2.6 and Coin Metrics Real-Time Reference Rates Methodology Version 0.7 on January 26, 2021**: The coverage universe is expanded to include the following assets: `susd`, `pols`, `ust`, `lto`, `swap`, `nim`, `lbc`, `mta`, `kp3r`, `glm`, `near`, `noia`, `rose`, `inj`. The publication of reference rates is terminated for the following assets: `gnt`, `fxc`, `bht`, `cmct`, `strat`, `loki`. The constituent markets for all assets in the coverage universe are updated.

12. **Coin Metrics Hourly Reference Rates Methodology Version 2.5 and Coin Metrics Real-Time Reference Rates Methodology Version 0.6 on November 5, 2020**: The coverage universe is expanded to include the following assets: `akro`, `ampl`, `ar`, `bal`, `bzrx`, `celo`, `comp`, `crv`, `csp`, `dmg`, `dot`, `foam`, `kin`, `oxt`, `rune`, `sol`, `srm`, `vtho`, `wbtc`, `wnxm`, `xhv`, `xyo`, `yamv2`, `yfi`, `yfii`, `uma`, `ewt`, `rev`, `rsr`, `avax`, `tmtg`, `jst`, `hnt`, `trac`, `vlx`, `mxc`, `fet`, `aoa`, `iris`, `pnk`, `mln`, `shr`, `uqc`, `one_harmony`, `trb`, `ogn`, `ava`, `loki`, `hxro`, `wxt`, `cpay`, `fil`, `uni`, `swrv`, `sushi`, `aave`, `egld`, `hns`, `dia`, `boa`, `uos`, `ctc`, `renbtc`. The publication of reference rates is terminated for the following assets: `arn`, `pma`, `erd`, `man`, `iq`, `lend`. The Market Selection Framework was amended such that extremely low volume markets are less likely to be selected as a constituent market if higher volume markets of similar quality are available. The constituent markets for all assets in the coverage universe are updated.

13. **Market Selection Framework Version 1.0.1 on November 5, 2020**: The selection algorithm was modified so that any market with volume, measured in U.S. dollars over the past 90 days, of less than 1 percent of the volume of the selected market with the largest volume is excluded.

14. **Coin Metrics Hourly Reference Rates Methodology Version 2.4 on July 29, 2020 and Coin Metrics Real-Time Reference Rates Methodology Version 0.5 on July 29, 2020**: The coverage universe is expanded to include the following assets: `wrx`, `band`, `ksm`, `usdk`, `snx`, `stx`, `fxc`, `kcs`, `hive`, `nrg`, `cel`, `ubt`, `chsb`, `crpt`, `bht`, `cvt`, `data`, `eurs`, `xns`, `gt`, `dgtx`, `kava`, `tt`, `sxp`, `mx`, `ocean`, `erd`, `lpt`. The publication of reference rates is terminated for the following assets: `storm`, `gto`. A revision policy was amended. The constituent markets for all assets in the coverage universe are updated.

15. **Coin Metrics Hourly Reference Rates Methodology Version 2.3 on February 27, 2020 and Coin Metrics Real-Time Reference Rates Methodology Version 0.4 on February 27, 2020**: The coverage universe is expanded to include the following assets: `xaut`, `paxg`,

husd, dgx, busd, ftt, hedg, okb, zb, hbar, ckb, mof, vsys, cennz, luna, chz, seele, dx, matic, abbc, rif, tomo, hpt, and ant.

16. **Coin Metrics Hourly Reference Rates Methodology Version 2.2 on February 6, 2020 and Coin Metrics Real-Time Reference Rates Methodology Version 0.3 on February 6, 2020**: The constituent markets for all assets in the coverage universe are updated. The coverage universe is adjusted to remove the following assets: box, cosm, fsn, medx, pst, and ttc_protocol. The coverage universe was expanded to include Dai and the previous asset with this name was renamed to Sai to appropriately reflect MakerDAO's transition from Single-Collateral Dai (Sai) to Multi-Collateral Dai (Dai).

17. **Coin Metrics Hourly Reference Rates Methodology Version 2.1 on December 9, 2019 and Coin Metrics Real-Time Reference Rates Methodology Version 0.2 on December 9, 2019**: The coverage universe is expanded to include the following assets: algo and beam. Updated calculation methodology to include price inverse variance weighting to reduce the impact of outliers.

18. **Coin Metrics Real-Time Reference Rates Methodology Version 0.1 on August 30, 2019**: Initial publication of Real-Time Reference Rates Methodology.

19. **Coin Metrics Hourly Reference Rates Methodology Version 2.0 on July 8, 2019**: Increased publication times from once daily at midnight UTC to once hourly. Changed human oversight from once daily at midnight UTC to once daily at 16:00 New York time.

20. **Coin Metrics Hourly Reference Rates Methodology Version 1.2 on June 13, 2019**: The coverage universe is expanded to include the following assets: gno, hot_holo, maid, nuls, qkc, rdd, rvn, zen, and mona.

21. **Coin Metrics Hourly Reference Rates Methodology Version 1.1 on May 30, 2019**: Updated data contingency rules. If no observable transactions from constituent markets occur during a one-minute time interval, the next one-minute time interval's volume-weighted median price is used instead of the previous. This contingency rule is applied recursively.

22. **Coin Metrics Hourly Reference Rates Methodology Version 1.0 on May 13, 2019**: Initial publication of Reference Rates Methodology.

23. **Market Selection Framework Version 1.0.0 on May 13, 2019**: Initial publication of Market Selection Framework.