Hourly Reference Rates Methodology

Version 2.12

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Contents

1 Introduction **2**

2 Description **2**

3 Coverage Universe **2**

4 Data and Calculation Methodology **2**

4.1 Data Sources 2

4.2 Market Selection Framework 3

4.3 Data Inputs 4

4.4 Calculation Algorithm 7

4.5 Data Contingency Rules 9

4.6 Data Exclusion Rules 9

5 Recalculations **10**

6 Administration **10**

7 Internal Oversight **11**

8 Conflicts of Interest **11**

9 Material Changes or Termination **11**

10 Internal Controls **12**

11 Complaints **12**

12 Record Retention **13**

13 Compliance **13**

14 Change Log **13**

15 Appendix A **16**

16 Appendix B **27**

1 Introduction

Coin Metrics produces the Coin Metrics Hourly Reference Rates (the "Reference Rates"), a collection of reference rates quoted in U.S. dollars and other currencies, published once per hour, for a set of cryptocurrencies and fiat currencies. The Reference Rates are designed to serve as a transparent and independent pricing source that promotes the functioning of efficient markets, reduces information asymmetries among market participants, facilitates trading in standardized contracts, and accelerates the adoption of cryptocurrencies as an asset class with the highest standards. The Reference Rates are calculated using a robust and resilient methodology that is resistant to manipulation and adheres 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 Reference Rates and ensure the Reference Rates serve as a source of transparent and independent pricing.

2 Description

The 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 Reference Rates are calculated at the end of every hour (the "Calculation Time") and are published within 5 minutes (the "Publication Time").

3 Coverage Universe

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

4 Data and Calculation Methodology

4.1 Data Sources

The input data source for the Reference Rates are markets traded on cryptocurrency exchanges that are approved to serve as pricing sources by the Oversight Committee. The Oversight Committee evaluates markets using a Market Selection Framework that assesses markets along a wide set of criteria to determine if the data source reflects trading activity in a transparent and representative manner. The Oversight Committee evaluates new markets for inclusion as constituent markets and evaluates existing constituent markets using the Market

Selection Framework on a quarterly basis or as market conditions warrant. 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 Reference Rates 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 Reference Rates coverage universe, updates on inclusions or exclusions of constituent markets, and the rationale for making any change.

4.2 Market Selection Framework

The Market Selection Framework consists of a fully-systematized process for evaluating markets to serve as input pricing sources for the calculation of the Reference Rates. It produces a unique set of candidate markets for each asset in the coverage universe that are then subsequently reviewed by the Oversight Committee. The market selection framework evaluates markets based on the following criteria:

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, Websocket feed, or FIX API suitable for data collection. Evaluates the performance of the API in terms of reliability and latency.

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.

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

4. *Data Availability*: An assessment of the available data the market's exchange offers for the given asset, including the number of markets where the given asset is the base currency, whether the markets are quoted in fiat currencies or other cryptocurrencies, and the type of markets offered.

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 market functions as an active market in the underlying asset and are anchored by observable transactions entered into at arm's length between buyers and sellers.

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 market functions as an active markets in the underlying asset and are anchored by observable transactions entered into at arm's length between buyers and sellers. The size of the exchange's markets are also considered.

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 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.

The full Market Selection Framework can be found here.

4.3 Data Inputs

The data inputs for the calculation of the Reference Rates are observable transactions in an active market where the given asset is traded. 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.

4.3.1 Bitcoin (BTC) and Ethereum (ETH)

The pool of candidate markets that are evaluated for the calculation of the Reference Rates 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.

4.3.2 Other Cryptocurrencies Excluding Stablecoins

The pool of candidate markets that are evaluated for the calculation of the Reference Rates for other 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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).

4.3.3 Stablecoins

The pool of candidate markets that are evaluated for the calculation of the Reference Rates 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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
HUSD	husd
Binance USD	busd
Dai	dai
USDK	usdk
BIDR	bidr
sUSD	susd
Neutrino USD	usdn
TerraUSD	ust
mStable USD	musd
Pax Dollar	usdp
USDD	usdd
Staked Ether Lido	steth
poundtoken	gbpt

4.3.4 Fiat Currencies

The pool of candidate markets that are evaluated for the calculation of the Reference Rates 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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 the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, 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
Swiss Franc	chf
Hong Kong Dollar	hkd
Singapore Dollar	sgd

4.4 Calculation Algorithm

The calculation algorithm of the Reference Rates is described below.

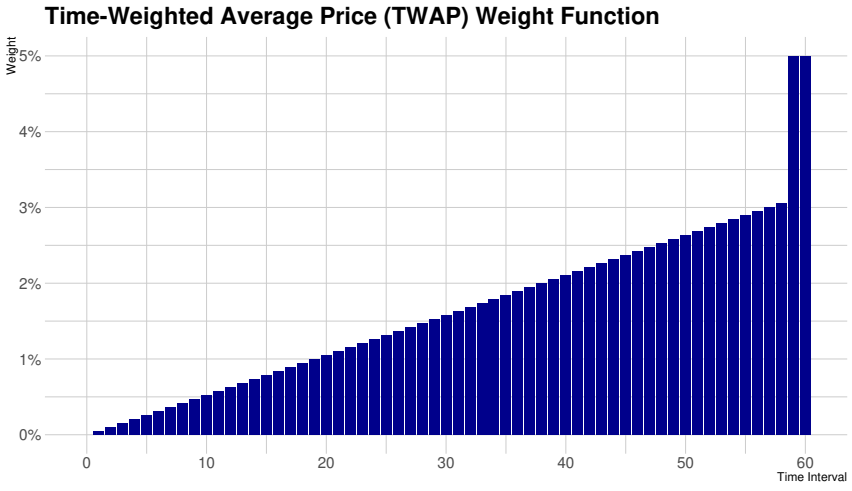
1. All observable transactions from Constituent Markets are combined and partitioned into time intervals, with each time interval spanning a period of one minute. The first one-minute time interval begins 60 minutes before the Calculation Time and the last one-minute time interval begins at the Calculation 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) or Ethereum (ETH).

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:



4.5 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.

4.6 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 reference rate. 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.

5 Recalculations

If errors are discovered in the calculation process subsequent to the publication of the reference rate, a recalculated reference rate may be published. Such errors can include the following events:

1. A constituent market begins trading at a spread against other constituent markets due to a temporary halting of withdrawals or deposits or an increase in solvency risk for a specific exchange
2. A constituent market is temporarily halted due to unplanned exchange maintenance
3. Data from constituent markets is interrupted due to network delays or instability
4. Data from constituent markets is interrupted due to an unplanned change in an exchange's API
5. Suspected trade manipulation is observed on a constituent market
6. A ticker change or token swap for a constituent market is missed or misapplied
7. Calculation methodology is incorrectly applied

Recalculations to the reference rates are assessed on a case-by-case basis in consultation with the Oversight Committee. Decisions regarding recalculations take into consideration all the available data and the potential negative impact or disruption involved in a recalculation. All recalculations are announced simultaneously to all clients.

6 Administration

Coin Metrics serves as the administrator for the Reference Rates and has primary responsibility for all aspects of the Reference Rates determination process, including the development, definition, determination, dissemination, operation, and governance of the Reference Rates. All aspects of the production of the

Reference Rates are carried out by Coin Metrics, and Coin Metrics does not rely on any third parties for the determination of the Reference Rates.

Coin Metrics ensures that transparency regarding significant decisions and associated rationale are published and made available to external stakeholders. Data contingency and data exclusion rules are in place to handle certain extraordinary circumstances and external factors beyond the control of Coin Metrics. The Oversight Committee reviews and provides challenge on the Reference Rates production process.

7 Internal Oversight

The Oversight Committee provides independent oversight over the production of the Reference Rates. The Oversight Committee's responsibilities include regular reviews of the Reference Rate production process, the Reference Rate definition and calculation methodology, the selection of data sources and data inputs, any uses of expert judgment or non-standard procedures, conflicts of interest, material changes to or termination of the Reference Rates, reviewing the results of external and internal audits, and any complaints or questions regarding the Reference Rates from external stakeholders. Additional information regarding the responsibilities and membership of the Oversight Committee can be found in the Coin Metrics Oversight Committee Charter document.

8 Conflicts of Interest

Coin Metrics enforces policies and procedures relating to conflicts of interest in connection with the production of the Reference Rates. The conflicts of interest policy addresses the identification, disclosure, management, and mitigation of conflicts of interest. These policies and procedures are periodically reviewed by the Oversight Committee. Coin Metrics is committed to disclosing any material conflicts of interest to external stakeholders and to regulatory authorities.

9 Material Changes or Termination

Coin Metrics may initiate material changes to or terminate a reference rate due to certain extraordinary market circumstances or external factors. These circumstances or external factors include, but are not limited to:

1. The reference rate no longer serves, and could not be modified to serve, as a transparent and independent pricing source for the underlying asset

2. The market liquidity in the underlying asset declines to an extent that the input data sources no longer function as active markets
3. The underlying asset experiences a contentious hard fork in which both forks survive

In such circumstances, Coin Metrics will review the Reference Rates to ensure the Reference Rates are properly reflecting their underlying assets, and if necessary, make changes to the methodology or definition of the Reference Rates to properly account for changing market structure, circumstances, and industry conventions in the underlying asset. Any such change or termination will be reviewed and approved by the Oversight Committee. Any approved change or termination will be publicly disclosed to external stakeholders with a detailed explanation of the rationale. In a manner appropriate to the circumstances, Coin Metrics will develop a plan to notify, solicit comments from, and consult with external stakeholders before implementing any material change or termination. Any change or termination will include a timeline explaining the timing of changes or termination and include steps to mitigate any negative effects on external stakeholders.

10 Internal Controls

Coin Metrics has implemented internal controls to protect the integrity of the Reference Rates. These controls cover the selection of input data sources, the collection of data from input data sources, and maintaining the integrity of collected data. Staff involved with the production of the Reference Rates have been trained in the proper usage of the data and maintain proper segregation of responsibilities. Any exercise of expert judgment or non-standard procedures is subject to dual approval by staff members, and is logged and reported to the Oversight Committee which periodically reviews any incidents. In addition, Coin Metrics maintains a whistleblowing mechanism to facilitate the reporting of any potential misconduct.

11 Complaints

Complaints about the calculation methodology of the Reference Rates or the value of a published reference rate should be submitted in writing to `support@coinmetrics.io`. Coin Metrics will investigate any complaints and respond to the complainant in a fair and timely manner. Any investigation of the complaint will adhere to the following procedures:

1. The personnel receiving and investigating the complaint will be independent of any personnel who may have been involved in the subject of the complaint.

2. All records and documents submitted by the complainant and related to the investigation into the complaint will be retained for a period of at least five years and submitted to the Oversight Committee for review.

3. Any complaint that results in a change in the determination of the Reference Rates, its calculation methodology, or its policies will be publicly disclosed and will explain the action taken.

12 Record Retention

Coin Metrics retains records, for at least five years, on the following items:

1. All market data that is collected and used in the calculation of the Reference Rates

2. Any use of expert judgment in the calculation of the Reference Rates

3. Any use of non-standard procedures in the calculation of the Reference Rates

4. The identities of staff responsible for the calculation of the Reference Rates

5. Any responses, questions, or complaints received in connection with the calculation of the Reference Rates

13 Compliance

Coin Metrics maintains records and has processes in place to comply with requests for information from regulatory authorities. Coin Metrics commits to full cooperation with any regulatory authority in carrying out their regulatory or supervisory duties.

14 Change Log

1. **Version 2.13 on September 13, 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`. The publication of reference rates is termintaed for the following assets: `ramp`, `grs`, `ppt`, `nav`, `itc`. Minor changes to internal audit section.

2. **Version 2.12 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.

3. **Version 2.11 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.

4. **Version 2.10 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.

5. **Version 2.9 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.

6. **Version 2.8 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.

7. **Version 2.7 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.

8. **Version 2.6 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.

9. **Version 2.5 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.

10. **Version 2.4 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.

11. **Version 2.3 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.

12. **Version 2.2 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).

13. **Version 2.1 on December 9, 2019**: The coverage universe is expanded to include the following assets: algo and beam.

14. **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.

15. **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.

16. **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.

17. **Version 1.0 on May 13, 2019**: Initial publication of Reference Rates Methodology.

15 Appendix A

The following table lists the current coverage universe:

Name	Ticker
Bitcoin	btc
Bitcoin Cash	bch
Litecoin	ltc
Euro	eur
XRP	xrp
Ethereum	eth
Ethereum Classic	etc
British Pound	gbp
Zcash	zec
Monero	xmr
Dash	dash
Japanese Yen	jpy
IOTA	miota
EOS	eos
OMG Network	omg
Neo	neo
Metaverse ETP	etp
Qtum	qtum
Aventus	avt
Bitcoin Gold	btg
Streamr	data
QASH	qash
Status	snt
Basic Attention Token	bat
Decentraland	mana
FUNToken	fun
0x	zrx
Time New Bank	tnb
TRON	trx
iExec RLC	rlc

Name	Ticker
Augur	rep
aelf	elf
IOST	iost
Aion	aion
Request	req
Loopring	lrc
WAX	waxp
Aragon	ant
Mithril	mith
Storj	storj
Stellar	xlm
Verge	xvg
Lympo	lym
Maker	mkr
VeChain	vet
Kyber Network Crystal	knc
Utrust	utk
Ripio Credit Network	rcn_ripiocreditnetwork
Polymath	poly
Nitro Network	ncash
Cortex	ctxc
Project Pai	pai
DATA	dta
Zilliqa	zil
Bancor	bnt
MonaCoin	mona
NEM	xem
BNB	bnb
Gas	gas
Tether	usdt
OAX	oax
district0x	dnt
Waltonchain	wtc
Chainlink	link
Moeda Loyalty Points	mda
Metal	mtl_metal
AirSwap	ast
Viberate	vib
Powerledger	powr
Ark	ark
Enjin Coin	enj
Komodo	kmd
NULS	nuls
Ambrosus	amb

Name	Ticker
Quantstamp	qsp
BitShares	bts
Lisk	lsk
Bitcoin Diamond	bcd
Ambire AdEx	adx
Cardano	ada
CyberMiles	cmt
Waves	waves
ICON	icx
PIVX	pivx
OST	ost
ChatCoin	chat
Civic	cvc
Steem	steem
Nano	nano
Bluzelle	blz
Aeternity	ae
Ontology	ont
Wanchain	wan
Syscoin	sys
Ardor	ardr
Holo	hot_holo
Loom Network	loom
Bytecoin	bcn
TrueUSD	tusd
Horizen	zen
Theta Network	theta
IoTeX	iotx
QuarkChain	qkc
SelfKey	key
Hifi Finance	mft
Siacoin	sc
Nebulas	nas
Dent	dent
Dock	dock
Gnosis	gno
Canadian Dollar	cad
Enzyme	mln
Dogecoin	doge
Bytom	btm
BitKan	kan
Arcblock	abt
CyberVein	cvt
Decred	dcr

Name	Ticker
DigiByte	dgb
Cred	lba
Measurable Data Token	mdt
Molecular Future	mof
TenX	pay
Revain	rev
Ren	ren
Nxt	nxt
Odyssey	ocn
Huobi Token	ht
Elastos	ela
WaykiChain	wicc
SIRIN LABS Token	srn
DeepBrain Chain	dbc
Propy	pro
Bibox Token	bix
HyperCash	hc_hypercash
MaidSafeCoin	maid
Amp	amp
Pluton	plu
Tezos	xtz
Stacks	stx
Ignis	ignis
PolySwarm	nct
Kin	kin
SwissBorg	chsb
CENNZnet	cennz
OriginTrail	trac
Nexo	nexo
Telcoin	tel
Crypterium	crpt
IHT Real Estate Protocol	iht
VeThor Token	vtho
DxChain Token	dx
CEEK VR	ceek
UNUS SED LEO	leo
Factom	fct
Vertcoin	vtc
Game.com	gtc_gamecom
MediBloc	med
Creditcoin	ctc
NKN	nkn
Uquid Coin	uqc
Korean won	krw

Name	Ticker
Ravencoin	rvn
LBRY Credits	lbc
ReddCoin	rdd
Numeraire	nmr
Russian Ruble	rub
Ukrainian Hryvnia	uah
Turkish Lira	try
Aurora	aoa
Australian Dollar	aud
Brazilian Real	brl
Swiss Franc	chf
Ethernity	ern
Hong Kong Dollar	hkd
Singapore Dollar	sgd
OpenDAO	sos
Dragonchain	drgn
Kleros	pnk
USD Coin	usdc
KuCoin Token	kcs
Paxos Standard	pax
Gemini Dollar	gusd
Constellation	dag
Nimiq	nim
GoChain	go
Electroneum	etn
Bitcoin SV	bsv
ZB	zb
Qcash	qc
MXC	mxc
TomoChain	tomo
Livepeer	lpt
RSK Infrastructure Framework	rif
v.systems	vsys
Grin	grin
Seele	seele
HUSD	husd
Lambda	lamb
Huobi Pool Token	hpt
Dora Factory	dora
Beam	beam
Unibright	ubt
FTX Token	ftt
Kryll	krl
Fetch.ai	fet

Name	Ticker
Ontology Gas	ong_ontologygas
Ankr	ankr
Metadium	meta
Haven Protocol	xhv
Quant	qnt
SOLVE	solve
Aergo	aergo
Circuits of Value	coval
Cronos	cro
Hxro	hxro
Cosmos	atom
Orbs	orbs
Theta Fuel	tfuel
BORA	bora
Function X	fx
IRISnet	iris
Celer Network	celr
ABBC Coin	abbc
Wrapped Bitcoin	wbtc
Polygon	matic
Fantom	ftm
Algorand	algo
Dusk Network	dusk
XYO	xyo
Ocean Protocol	ocean
Celsius	cel
Synthetix	snx
ThunderCore	tt
Reserve Rights	rsr
STP	stpt
Harmony	one_harmony
ARPA Chain	arpa
WINkLink	win_wink
Binance USD	busd
Dai	dai
Tether Gold	xaut
PAX Gold	paxg
OKB	okb
Hedera	hbar
Nervos Network	ckb
SXP	sxp
Terra	luna
Chiliz	chz
Orchid	oxt

Name	Ticker
LCX	lcx
USDK	usdk
WazirX	wrx
Band Protocol	band
Kusama	ksm
Hive	hive
Energi	nrg
GateToken	gt
Kava	kava
MX TOKEN	mx
Arweave	ar
Compound	comp
NuCypher	nu
Keep Network	keep
Origin Protocol	ogn
Render Token	rndr
DREP	drep
LTO Network	lto
COTI	coti
Solana	sol
Cartesi	ctsi
Chromia	chr
StormX	stmx
BIDR	bidr
Polkadot	dot
Celo	celo
Filecoin	fil
sUSD	susd
Travala.com	ava
Wirex Token	wxt
Syntropy	noia
Akropolis	akro
Ampleforth	ampl
DigitalBits	xdb
Neutrino USD	usdn
Energy Web Token	ewt
yearn.finance	yfi
UMA	uma
renBTC	renbtc
Avalanche	avax
BOSAGORA	boa
JUST	jst
DIA	dia
Green Satoshi Token	gst

Name	Ticker
Helium	hnt
IDEX	idex
Kadena	kda
Klaytn	klay
mStable Governance Token: Meta (MTA)	mta
NEST Protocol	nest
MANTRA	om
Orion Protocol	orn
Prom	prom
THORChain	rune
ShareToken	shr
Serum	srm
SUKU	suku
Tellor	trb
BiLira	tryb
Curve DAO Token	crv
Velas	vlx
Wrapped NXM	wnxm
DFI.Money	yfii
Balancer	bal
SushiSwap	sushi
Swerve	swrv
Cream Finance	cream
Sun Token	sun
Elrond	egld
Uniswap	uni
Alchemy Pay	ach
Aleph.im	aleph
Bella Protocol	bel
Frontier	front
TrustSwap	swap
TerraUSD	ust
Handshake	hns
Ultra	uos
BakeryToken	bake
Aavegotchi	ghst
Rarible	rari
Aave	aave
PancakeSwap	cake
DODO	dodo
Harvest Finance	farm
Polkastarter	pols
Secret	scrt
Venus	xvs

Name	Ticker
Ergo	erg
MATH	math
NEAR Protocol	near
DeFiChain	dfi
Audius	audio
Axie Infinity	axs
Conflux	cfx
Shentu	ctk
Injective	inj
Keep3rV1	kp3r
mStable USD	musd
Smooth Love Potion	slp
Stafi	fis
Flamingo	flm
Oasis Network	rose
TrueFi	tru
Unifi Protocol DAO	unfi
Golem	glm
API3	api3
Badger DAO	badger
MobileCoin	mob
Synapse	syn
Virtua	tvk
The Graph	grt
1inch	1inch
Alpha Venture DAO	alpha
OctoFi	octo
saffron.finance	sfi
Perpetual Protocol	perp
BarnBridge	bond
Bonfida	fida
Frax	frax
Frax Share	fxs
Linear	lina
Mdex	mdx
Mirror Protocol	mir
Marlin	pond
REVV	revv
Rook	rook
Trust Wallet Token	twt
ZKSpace	zks
Flow	flow
Stratis	strax
Reef	reef

Name	Ticker
Bitcoin Standard Hashrate Token	btcst
The Sandbox	sand
SafePal	sfp
SKALE Network	skl
Phala Network	pha
WOO Network	woo
Raydium	ray
Alchemix	alcx
DAO Maker	dao
DerivaDAO	ddx
Inverse Finance	inv
MAPS	maps
Mask Network	mask
BENQI	qi
Radicle	rad
Rally	rly
SuperFarm	super
Tornado Cash	torn
AIOZ Network	aioz
Alpaca Finance	alpaca
Anchor Protocol	anc
Boson Protocol	boson
Cope	cope
Fei USD	fei
Flux	flux
Project Galaxy	gal
Illuvium	ilv
JasmyCoin	jasmy
Rai Reflex Index	rai
Alien Worlds	tlm
Tribe	tribe
Symbol	xym
Internet Computer	icp
Shiba Inu	shib
Somnium Space Cubes	cube
Dogelon Mars	elon
Ampleforth Governance Token	forth
Gitcoin	gtc
Liquity	lqty
Media Network	media
APENFT	nft
QuickSwap	quick
Rari Governance Token	rgt
Songbird	sgb

Name	Ticker
Persistence	xprt
Liquidity USD	lusd
Lido DAO	ldo
BitDAO	bit
Coin98	c98
CLV	clv
Covalent	cqt
Convex Finance	cvx
Dvision Network	dvi
Gala	gala
Goldfinch	gfi
Moonriver	movr
PlayDapp	pla
SuperRare	rare
StarLink	starl
Wrapped NCG	wncg
eCash	xec
Yield Guild Games	ygg
Pax Dollar	usdp
My Neighbor Alice	alice
ASD	asd
XDC Network	xdc
Mina	mina
Adventure Gold	agld
Star Atlas DAO	polis
dYdX	dydx
Spell Token	spell
Assemble Protocol	asm
AstroSwap	astro
Star Atlas	atlas
BinaryX	bnx
Braintrust	btrst
Gods Unchained	gods
Highstreet	high
JOE	joe
Moss Carbon Credit	mco2
Marinade Staked SOL	msol
Olympus	ohm
Orca	orca
Ribbon Finance	rbn
Samoyedcoin	samo
Saber	sbr
Wrapped Centrifuge	wcfg
Mines of Dalarnia	dar

Name	Ticker
Ethereum Name Service	ens
GYEN	gyen
Immutable X	imx
Boba Network	boba
Merit Circle	mc
Maple	mpl
ConstitutionDAO	people
Casper	cspr
Automata Network	ata
ApeCoin	ape
LooksRare	looks
Moonbeam	glmr
Tulip Protocol	tulip
STEPN	gmt
Biconomy	bico
Astar	astr
Optimism	op
Stargate Finance	stg
Acala Token	aca
Bounce Finance Governance Token	auction
League of Kingdoms Arena	loka
MetisDAO	metis
Ooki Protocol	ooki
Pundi X	pundix
Voyager Token	vgx
USDD	usdd
Chia	xch
Staked Ether Lido	steth
poundtoken	gbpt

16 Appendix B

The following table lists the weights applied to each one-minute time interval described in Section 5.4 Calculation Algorithm.

Time Interval	Weight
0	0.000000
1	0.000526
2	0.001052
3	0.001578
4	0.002104

Time Interval	Weight
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
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

Time Interval	Weight
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