FT Wilshire

Digital Asset Pricing & Index Methodology

1 Blended Prices Benchmarks

1.1 FT Wilshire Digital Asset Blended Price

The FT Wilshire Digital Asset Blended Price (FTWBP) is the underlying input to all FT Wilshire digital asset products.

The FTWBP is volume weighted average price calculated for all digital assets which satisfy the minimum criteria for inclusion in an index (Section 3.1) using price and volume data from the contributing digital asset exchanges. Eligibility of contributing exchanges is detailed in Section 2.3.

Prices are updated on a trade-by-trade basis (tick frequency), and they are designed to be robust against both market outages/downtime and disruption, incorporating filters for outliers, stale prices and other deleterious data.

The FTWBP represents the index for an individual digital asset. For example, the FTWBP for Bitcoin is the FT Wilshire Bitcoin Blended Price Index.

1.1.1 Input Trade Data

The FTWBP is calculated every time a new trade is executed on a contributing exchange. The necessary data required to update the FTWBP are: Price in USD, traded volume, transaction time, exchange.

Currently, inclusion of traded price and volume data is restricted to trades made directly in USD.

An extension to the methodology to include digital assets which trade in fiat currencies other than USD or in other digital assets such as fiat stable coins may be considered in the future.

1.1.2 Exchange Weighting

The weight (importance) of an exchange in the FTWBP is determined using an exponential weighted average (EWA) of the previous 24 cumulative hourly volume, traded on this exchange. This ensures that those exchanges with high turnover have a greater weight than those exchanges with less traded volume. Additionally, it places an emphasis on more recent traded volume allowing for daily and regional effects on liquidity in the market to be captured.

At hour h (where $h \in [1, 24]$), the hourly cumulative volume on exchange e is the sum over the hour up to $t=T$ of the traded volume in that hour, where the cumulative volume of each separate exchange is updated on a rolling minute-by-minute basis. The volume included is only the volume deemed legitimate during the previous 24 hours, i.e., it excludes outlier volume or stale volume data (see Section 1.1.3). Note, at initiation no filtered data is available, meaning there is a run-in time of approximately 24 hours before the exchange weights are determined using data filtered for outliers.

The cumulative volume in any one hour period, $CV_{e,h}$ is:

$$CV_{e,h} = \sum\sum V_{e,t,m} \; ; \; t \in (T\text{-}1, T]^{1} \, , \, m \in [1, 60]$$

where $V_{e,t,m}$ is the volume associated with the trade at time t in the one minute interval, m.

The EWA of the hourly cumulative volume for each exchange e is then calculated as:

$$EV_e = EWA(CV_e) = \alpha \cdot CV_{e,h} + (1 - \alpha) \cdot EWA(CV_{e,h-1})$$

where EV_e is the EWA for exchange e. The variable α is defined so that $\sum w_h \approx 0.9999$, i.e., 99.99% of the weight is captured by the 24 observations:

$$\alpha = 1 - Exp(Log(0.0001)/24) \approx 0.31871$$

and the exponential weights are: $w_{h-i} = \alpha \cdot (1 - \alpha)^i, \; i \in [0, 23]$

The weight each exchange contributes to the FTWBP during the minute to $t \in (T, T+1]$ is:

$$w_T = \gamma_e \cdot EV_e \; / \sum \gamma_e \cdot EV_e$$

[1] $t \in (T\text{-}1, T]$ should be read as $T\text{-}1 < t \leq T$, where T represents an actual clock minute, e.g. 13:59:00.000,

where $\gamma_e \in [0, 1]$ is a trust parameter for exchange e used to include or exclude an exchange depending on the validity of a trade observed at $t>T$. The trust parameter is defined in section 1.1.3.1.

1.1.3 Data Filtering

In general tick level data requires cleansing of deleterious values. For example, there are stale price and volume data. These are data that have not been updated recently such that they may no longer be representative of the wider market. This is common on low volume or illiquid exchanges. There are also outlier data. These data are the result of exchange disruption, market dislocation, incorrect data entry ("fat-finger" errors) and the like. Such data problems need correctly accounted for if an aggregate price which is robust to such events is to be determined. There are three data cleansing categories considered in this methodology:

1. Data bounds – negative prices, zero volumes etc., future time stamps, trade duplicates
2. Price level – "fat-finger" errors (e.g., 10x larger/smaller), stale (old) data
3. Outliers – change from one tick to the next is outside an expected range

The process of filtering occurs with each new trade on an eligible exchange, before the FTWBP is calculated.

1.1.3.1 Trust Parameter

The trust parameter $\gamma_e = 1$ for each exchange e unless for any traded volume and price pair (V_t, Q_t), any of the conditions outlined below are held. Under such conditions with $\gamma_e = 0$ the price and volume pair (V_t, Q_t) is thus excluded from the FT Wilshire Digital Asset Blended Price.

a. Trades with time stamps in the future. Clearly, any new trade will have a time stamp after the current price stamp time stamp, but before the current clock time. For simplicity future trades are those with a time stamp one minute in the future, i.e., $t > T+1$, where T is the clock minute of the previous exchange weight update (see 1.1.2)
b. Trades with time stamps in the past. These are newly received trades on a given exchange with a time stamp that occurs before the most recent trade on the exchange. Note this is not the same as stale trade data discussed below.
c. Duplicate trades, i.e., trades with the same trade ID, time stamp, volume, and price
d. Negative volumes $V_t \leq 0$ and/or prices $Q_t \leq 0$
e. Price data entry errors, $Q_t > 10 \times Q_{t'}$ or $Q_t > 10 \times Q_{t'}$
f. For digital assets which trade on more than three exchanges it is possible to incorporate additional outlier filtering on newly received trades. The trade Q_t is compared to the current valid set of cross-sectional exchange prices (at the previous tick, t') and to the current price volatility. If the trade is deemed to be an outlier in both tests the trade is excluded (i.e. the trust parameter for this exchange is set to zero, $\gamma_e = 0$). That is if:

$$Q_t > UQ_{t'} + 1.6 \times IQR_{t'} \text{ OR } Q_t < LQ_{t'} - 1.6 \times IQR_{t'}$$

where $IQR_{t'}$ is the interquartile range (the difference between upper quartile, $UQ_{t'}$ and lower quartile, $LQ_{t'}$) at the previous tick, t'. The multiplier of 1.6 equates to approximately 2.835 standard deviations, which gives outlier thresholds of ~0.25% and ~99.75%.

AND

$$|dQ_t| > 2.835 \times EWA(\sigma_{t-1})$$

The term σ_t is the return volatility of the FTWBP series P and dQ_t is the return or difference of Q_t to $P_{t'}$ in time $\Delta t = t - t'$, where t' is the time of the last FTWBP in milliseconds (UNIX time). Since Δt is irregular from tick-to-tick, the return must be regularized so it is measured over the same time scale as the volatility is calculated. We therefore define the time-regularized return as:

$$dQ_t = dt/P_{t'} \cdot (Q_t - P_{t'}) / \Delta t$$

where dt is the time scale of interest and can be any positive value. Without loss of generality dt is set to 10 (milliseconds)[2].

[2] The value of dt is arbitrary. By setting dt=1, as $\Delta t \to 1$, $dQ_t \to (Q_t - P_{t'})/P_{t'}$

The volatility σ_t can be determined using the time-regularized returns on the FTWBP:

$$dP_t = dt/P_{t'} \cdot (P_t - P_{t'}) / \Delta t'$$

where $\Delta t'$ is the time between P_t and $P_{t'}$ in milliseconds. The volatility σ_t is determined as the standard deviation of dP_t over the previous 30 minutes using all P_t during the 30-minute period. The volatility and the EWA of the volatility are updated on a minute-by-minute basis. The EWA is determined using:

$$EWA(\sigma_t) = \alpha \cdot \sigma_t + (1 - \alpha) \cdot EWA(\sigma_t\text{-}1)$$

For simplicity the parameter $\alpha = 2/(N+1)$. Choosing $N=30$ gives $\alpha \approx 0.06452$ and approximately half the averaging weight is in the previous 10 minutes, i.e., the 10 most recent volatility observations.

Stale Price Data

After the application of (a) to (f) the volume and price pair (V_t , Q_t) can still be excluded if it is deemed to be stale. The importance of price and volume pairs (V_t , Q_t) on an exchange diminishes with time such that after a specified interval the data is deemed stale and is removed from the calculation of the FTWBP. This is achieved by adjusting the trust parameter such that $\gamma_e \in [0, 1)$. The trust parameter is reduced from an initial $\gamma_e = 1$ to $\gamma_e = 0$ incrementally depending on the time elapsed since the last valid trade on the exchange used in the calculation of the FTWBP. The scaling of the trust parameter is:

$\gamma_e = 1.0;\ 0 \leq \tau_e < 3$

$\gamma_e = 0.8;\ 3 \leq \tau_e < 6$

$\gamma_e = 0.6;\ 6 \leq \tau_e < 9$

$\gamma_e = 0.4;\ 9 \leq \tau_e < 12$

$\gamma_e = 0.2;\ 12 \leq \tau_e < 15$

$\gamma_e = 0.0;\ 15 \leq \tau_e$

where τ_e is the time elapse in minutes since the last valid trade on exchange e.

Multiple Price Data

On highly liquid exchanges multiple valid trades can occur with the same time stamp. For exchange e, newly received price and volume pairs (V_t , Q_t) with time stamp t, only the last received trade is included in the calculations.

Under certain circumstances the conditions may be such that all prices are filtered out. In this instance the FTWBP is not calculated and the previous value is retained.

2 Settlement Prices Fixings

2.1 FT Wilshire Digital Asset Settlement Price

Settlement prices are often determined as a volume weighted average of trades over a short period of time (30 seconds to a few minutes) at the end of trading. However, the high volatility and price reversals observed in the digital asset markets mean a wider time frame for the settlement process is important in mitigating against unwanted effects when a stable estimate is desirable.

The FT Wilshire Digital Asset Blended Price is updated tick-by-tick and ticks occur at irregular times. For the settlement process a homogeneous time series is created, the FT Wilshire Digital Asset Blended Average.

2.1.1 FT Wilshire Digital Asset Blended Average

The FT Wilshire Digital Asset Blended Average (FTWBA) is the volume weighted average price (VWAP) calculated over a period of one minute using the FT Wilshire Digital Asset Blended Prices and their associated cumulative volume taken across all contributing exchanges in the given one-minute period.

For all $t \in (T\text{-}1, T]$ calculate the FT Wilshire Digital Asset Blended Average A_T using all volume and price pairs (V_t , P_t) available in the specified period as:

$$A_T = \sum w_t \cdot P_t$$

For all $t \in (T-1, T]$

where $w_t = V_t / \sum V_t$ is the volume weight, where the volume Vt is the total volume traded across all contributing exchanges associated with FTWBP, P_t .

If in any one-minute period $(T-1, T]$ there are no published FTWBP, the previous value of A_T is used.

2.1.2 FT Wilshire Digital Asset Settlement Price Calculation

The FT Wilshire Digital Asset Settlement Price (FTWSP) is calculated as the exponentially weighted average (EWA) of the FT Wilshire Digital Asset Blended Average (FTWBA), where the exponential weights are determined by:

$$w_{t-i} = \alpha \cdot (1 - \alpha)^i, \; i \in [0, 59]$$

The variable α is set so approximately 50% of the weight occurs in the last 15 minutes of observations before the settlement time of interest. That is:

$$\alpha = 1 - 0.51/15 \approx 0.04516$$

The weights w_{T-i} are renormalised to ensure $\sum w_{T-i} = 1$ and the FT Wilshire Settlement Price at time T is:

$$S_t = \sum w_{t-i} \cdot A_{t-i}$$

where S_T is the FT Wilshire Digital Asset Settlement Price at time t, A_t is the Wilshire Digital Asset Blended Average at time t, where $t \in (T-60, T]$.

The EWA can be tuned to lengthen or shorten the period of time in which price observations are important to the average. As the digital asset market matures or in cases where volatility is low the variable α can be increased, such that when $\alpha=1$, the FT Wilshire Digital Asset Settlement Price S_T is equal to the most recent FT Wilshire Digital Asset Blended Average A_T. In this instance the determination of the settlement price corresponds to the practice seen in other markets.

2.2 Closing and Fixing Times

There is no concept of a closing time for digital assets. Digital assets trade continuously 24/7/365. However, a single closing time is useful for multiple reasons, so too are multiple official fixing times.

Multiple fixings for different regions are useful for mark-to-marketing, derivatives listing and regulatory reasons (NAVs).

At each fixing time the last known index level (“last”) and a formal settlement price are published. This is analogous to the derivatives market where the last price is separate from the official fixing (settlement) price.

2.2.1 Multiple Digital Asset Indexes

The following index fixing times are considered:

NY – 1700 (GMT - 5)

UK – 1600 (GMT) - official close

UAE – 1400 (GMT + 4)

SI/HK – 1700 (GMT + 8)

NZ – 1600 (GMT + 12)

Index close times are in local time and are adjusted for daylight savings.

2.2.2 Single Digital Asset Indexes

An hourly settlement fixing using the outlined methodology is provided as a service analogous to the hourly FX market fixings.

2.3 Contributing Exchange Eligibility

All exchanges rated AA in the CryptoCompare Exchange Benchmark are conditionally eligible for selection as a contributing price source.

Additionally, high quality A rated exchanges are also eligible for selection. These are exchanges with Total Score of at least a 70% in the CryptoCompare Exchange Benchmark.

Selection as a contributing exchange requires the above criteria to be satisfied in both the current and previously published CryptoCompare Exchange Benchmark. Exchanges are monitored by CryptoCompare on a regular basis to ensure they continue to meet the desired standards and that pricing fidelity is maintained.

The CryptoCompare Exchange Benchmark is published twice a year. Unless there are extenuating circumstances (e.g., serious breach of security or prolonged down time) exchanges are promoted/demoted as price contributors on a semi-annual basis in conjunction with any periodic review of Indexes.

3 Index Products

3.1 Minimum Criteria for Digital Asset Inclusion

Individual digital assets are required to meet several criteria before they are included in an index.

3.1.1 Sufficient Price Sources

To ensure robustness in pricing, the calculation of the FTWBP for a digital asset should include prices from at least two of the selected eligible exchanges.

If the number of contributing exchanges to the FTWBP of a digital asset drops to one, the asset should be retained in any index until the next periodic review, where the problem may be rectified by the promotion of another exchange. If not, the asset is removed from any index.

If the number of contributing exchanges drops to zero, the digital asset is removed from any index on t+2 basis (see also Intra-review Additions and Deletions in Section 3.2.4).

3.1.2 Suitable Custody

Whilst self-custody is an option this is not always convenient or practicable. Digital assets with a FTWBP should have available custody.

3.1.3 Compliance

A digital asset will not be included in any index if there is regulatory/legal action against the digital asset or it is identified as a known scam/fraud.

A digital asset currently in an index will be removed on a t+2 basis if it is identified as in breach of this criterion.

3.2 Indexes

3.2.1 Single Digital Asset Indexes

Single digital asset Indexes are represented by the FT Wilshire Digital Asset Blended Price. All eligible digital assets are available as a single digital asset index, however, only the following ten single digital asset Indexes are published initially:

FT Wilshire Bitcoin Blended Price Index

FT Wilshire Ethereum Blended Price Index

FT Wilshire Dogecoin Blended Price Index

FT Wilshire Cardano Blended Price Index

FT Wilshire Chainlink Blended Price Index

FT Wilshire Uniswap Blended Price Index

FT Wilshire Bitcoin Cash Blended Price Index

FT Wilshire Uniswap Protocol Blended Price Index

FT Wilshire Solana Blended Price Index

FT Wilshire Litecoin Blended Price Index

3.2.2 Multiple Digital Asset Indexes

In addition to the single digital asset Indexes (i.e., the FTWBP) three multiple digital asset indexes are available. Included assets are selected from the ten digital assets listed above:

FT Wilshire Top 5 Index – The largest five digital assets by circulating value eligible for inclusion

FT Wilshire ex Bitcoin Index – The largest five digital assets excluding Bitcoin by circulating value eligible for inclusion

FT Wilshire Bitcoin & Ethereum Index – Bitcoin and Ethereum only

3.2.3 Periodic Review of Indexes

At the UK close (see Section 2.2) of the first business day of each quarter (March, June, September, December) (the data date) determine the circulating value (market cap) of all eligible digital assets (Section 2.3 and Section 3.1) excluding any stablecoins and "wrapped" variants.

1. For the FT Wilshire Top 5 Digital Asset Index, select the largest 5 digital assets by circulating value and equally weight the selected digital assets.
2. For the FT Wilshire ex Bitcoin Digital Asset Index, select the largest 5 digital assets by circulating value excluding Bitcoin and equally weight the selected digital assets.
3. The FT Wilshire Bitcoin and Ethereum Digital Asset Index consists of only BTC and ETH, equally weighted

New constituents and weights are effective at the open two business days (t+2) after the data date. The opening time is defined as the first tick after the UK close (see 2.2.1).

Note, implementation differs from often seen quarter-end schedules. The reason being that a December end review could be difficult to implement (Christmas, New Year holidays), hence it is better to shift everything back to 1st business day of March, June, September, December for the price date and be affected 2 business days after this.

To avoid whip-sawing of eligible constituents, the smallest eligible constituent is only replaced if its size is 10% smaller than the replacement asset.

3.2.4 Intra-review additions and deletions

In the event a constituent becomes ineligible for inclusion in an index (Section 2) it should be removed from any index for which it is a member. Deletion should be two business days after the announcement to remove the asset is made. Deletion is made at the index close at the closing price or last known available price.

Since the indexes are small with only 5 constituents the deleted constituent is replaced. The replacement digital asset is the next largest eligible digital asset at the last periodic review and is included at a like-for-like weight.

3.2.5 Historical Reviews of Indexes

The multiple digital asset indexes were reviewed historically using historical information. Some historical constituents are not included in the ten single digital assets available in 3.2.1.

3.3 Network Events

Network events occur in several forms.

3.3.1 Hard Forks

Where a material change to a digital asset's operation occurs such that the blockchain separates at a given block (e.g., perhaps due to a change in consensus mechanism). This can result in an entirely new coin being created. E.g., Ethereum -> Ethereum Classic (the original version) and Ethereum (the hard forked version). New digital assets that are a result of hard forks are eligible for inclusion in an index at the next periodic review if they satisfy the criteria in Section 2.3 & Section 3.1.

3.3.2 Soft Forks

A change in the software/network that (typically) does not result in the generation of a new digital asset. Soft Forks are included automatically without any operational overhead provided the digital asset continues to satisfy the criteria in Section 2.3 & Section 3.1.

3.3.3 Capital Distributions

There are several mechanisms whereby capital distributions can occur.

- Air drops – rewards to holders of digital assets. Usually on an ad hoc basis. Infrequent, irregular and generally small in value. Airdrops are not included.
- Mining rewards – transaction verification via "mining" resulting in a payment. In the case of Proof-of-Work rewards are related to computer hardware and are not included.
- Emissions – holders are rewarded for maintaining a node/active balance on the network
- Staking Rewards – holders who stake digital assets for transaction verification are rewarded for doing so.

Whilst emissions and Staking rewards can provide a regular yield, are directly related to a digital asset balance and therefore an index weight, they are not currently considered.

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