Private and Confidential

T3 Index

Bitcoin Volatility Index

T3 Index Pty Ltd.

Suite 504, Level 5, 165 Phillip Street, Sydney NSW 2000, Australia.

T. +61 2 9231 5767 E. sho@t3index.com W. t3index.com

July 8, 2020

1. General Formula

Bitcoin 30-day volatility index is constructed using BTC option prices, by linearly interpolating between the expected variances of two expirations closest to the 30-day time point, as follows:

$$\sigma = 100 \times \sqrt{\frac{t_1}{t_M}\frac{t_2 - t_M}{t_2 - t_1}\sigma_1^2 + \frac{t_2}{t_M}\frac{t_M - t_1}{t_2 - t_1}\sigma_2^2} \tag{1}$$

Here t_1 and t_2 are times to the option contract settlements (in seconds), and t_M is the number of secons in 30 days.

The variances $\sigma_{1,2}^2$ are calculated using simple variance swap approximation:

$$\sigma_n^2 = \frac{1}{T_n F_n^2}\left[2\sum_i \Delta K_{n,i} p_{n,i} - (F_n - K_{\mathrm{ATM}_n})^2\right] \tag{2}$$

where F is the corresponding forward price (see deatails below), T is time to options settlement (expressed in years); K_{ATM} is at-the-money strike (see details below); K_i and p_i are selected options' strikes and prices (puts with strikes below K_{ATM}, calls with strikes above K_{ATM}, and ATM strike, for which an average between put and call prices is used); ΔK_i is average distance from the strike K_i to the two nearest selected options' strikes (or, in the case of the highest and the lowest strikes, distance to the nearest selected strike).

The options expirations to be used in the calculation are selected as the two subsequent monthly expirations, at least two full days ahead in time, which are 1st and 2nd closest to the point 30 days in the future.

2. Option and future prices

Option and future reference prices p are determined using "price dragging" technique, and are tracked 24/7.

- Initiate all listed options' and corresponding futures prices at 0.
- For each new trade, set reference price at the price of the trade.

- For each new bid b, if $b > p$, set $p = b$, otherwise p remains unchanged.
- For each new ask a, if $a < p$, set $p = a$, otherwise p remains unchanged.

3. Forward and ATM strike

For each of the expirations, the forward price F and K_{ATM} are then found. For this procedure, only strikes for which both call and put prices are above zero are used.

In case if the options with given expiration settle into the corresponding future, set F as the future price determined above using price dragging. K_{ATM} is then set to the strike closest to F. In case of a tie, the lower strike is selected.

Otherwise, proceed to find K_{ATM} and forward price as follows:

- Proceeding from lower to higher strikes, find the sign of a difference between call and put price (considering equal price as positive).
- For each strike at which a change in sign occurs, keep the strike with lower absolute price difference between call and put (in case of a tie, select the higher strike). Accumulate all the strikes found this way in a $\{K_{\pm}\}$ set.[1]
- Select K_{ATM} from $\{K_{\pm}\}$ depending on the number of strikes in the set n:
  - If $n = 1$, the only strike in the set is K_{ATM}.
  - If $n = 0$[2], set K_{ATM} to the lowest available strike value if the price difference is nonnegative, or to the highest available strike otherwise.
  - If $n > 1$, select the strike value closest to the current BTC spot value. In case of a tie, choose the higher strike.
- Forward price $F = K_{\text{ATM}} + (p_C - p_P) * s$, where s is the current BTC spot price in USD.

4. Options Selection

For each of the expirations, the options to be used in the calculation are then selected, by removing in-the-money and far out-of-money options. The procedure is as follows:

- Select call options with strikes above or equal to K_{ATM} and put options with strikes below or equal to K_{ATM}.
- Discard all options with zero prices.
- When moving from K_{ATM}, inclusive, towards higher (lower) strikes, remove all the call (put) options after the point when two strikes with price below $10 are encountered.

Options selected this way for each expiration are then used in formula (2).

[1] Typically, this would yield one value. However, this procedure takes into account a possibility of extremely volatile market with more than one (or none) intersection(s) between put and call price curves.

[2] An unlikely scenario when either the lowest strike is above ATM, or the highest strike is below ATM

DISCLAIMER

This document is prepared by T3 Index Pty Ltd.

The information provided in this document is not investment advice. It is of a general nature only and has been prepared without taking into account your objectives, financial situation or needs. Before making an investment decision, you should consider whether trading derivatives is appropriate given your objectives, financial situation or needs. If you require advice that takes into account your personal circumstances, you should consult a licensed or authorised financial advisor.

T3 Index gives no representation or warranty as to the reliability, completeness or accuracy of the information contained in this document. All opinions and estimates included in this newsletter constitute judgments of T3 Index as at the date of this document and are subject to change without notice. Past performance is not a reliable indicator of future performance.