Funding Rate Volatility Index (FRVI)

Yi-Chung

September 5, 2025

Contents

1 Introduction

Perpetual futures contracts on cryptocurrency exchanges use a funding mechanism to tether derivative prices to the underlying spot. The periodic payment exchanged between long and short holders—the funding rate—can itself exhibit sharp, short-lived swings during episodes of extreme flows or liquidity drought. Traders and risk managers require a concise metric to detect when funding rates are unstable. The FRVI addresses this need by combining two orthogonal drivers of funding volatility:

1. *Positioning Skew Velocity*—how quickly the net long/short open interest imbalance is changing.
2. *Liquidity Fragility*—how brittle the top of the order book is, measured by the ratio of the bid–ask spread to average depth.

2 Mathematical Definition

At each discrete time t, we observe:

- $OI_{\text{long},t}$ and $OI_{\text{short},t}$: total open interest on long and short perpetual-futures positions.
- A top-N order book snapshot:

$$\{(p_{bid,i,t}, v_{bid,i,t})\}_{i=1}^{N}, \quad \{(p_{ask,i,t}, v_{ask,i,t})\}_{i=1}^{N}.$$

2.1 Normalized Imbalance

Define the normalized skew

$$S_t \;=\; \frac{OI_{\text{long},t} - OI_{\text{short},t}}{OI_{\text{long},t} + OI_{\text{short},t}} \quad \in [-1, 1].$$

The first term of the FRVI captures the velocity of this skew:

$$\Delta S_t \;=\; S_t - S_{t-1}.$$

Large $|\Delta S_t|$ signals a sudden shift in market positioning pressure, which often precipitates funding-rate changes.

2.2 Liquidity Fragility Metric

We measure top-of-book liquidity by

$$\text{Spread}_t \;=\; p_{ask,1,t} - p_{bid,1,t}, \quad \text{Depth}_t \;=\; \frac{1}{2N} \sum_{i=1}^{N} \big(v_{bid,i,t} + v_{ask,i,t}\big).$$

The ratio

$$L_t = \frac{\text{Spread}_t}{\text{Depth}_t}$$

quantifies how thin or brittle the best-of-book is: a high L_t indicates that even small market orders can trigger large price moves, often coinciding with funding-rate turmoil.

2.3 FRVI Formula

Combining these two drivers in a Euclidean norm yields the FRVI:

$$\boxed{\mathrm{FRVI}_t = \sqrt{(\Delta S_t)^2 + L_t^2} = \sqrt{\left(S_t - S_{t-1}\right)^2 \; + \; \left(\tfrac{\mathrm{Spread}_t}{\mathrm{Depth}_t}\right)^2}.}$$

This construction ensures that both rapid skew changes and fragile liquidity contribute symmetrically to the volatility score.

3 Component Analysis

3.1 Properties of S_t and ΔS_t

- Range: $S_t \in [-1, 1]$, so $\Delta S_t \in [-2, 2]$.
- Scale: A 0.1 move in S_t corresponds to a 10% shift in net open interest balance.
- Sign: $\Delta S_t > 0$ indicates net-long pressure building; $\Delta S_t < 0$ shows net-short dominance.

3.2 Behavior of L_t

- Unbounded above: As depth $\to 0$, $L_t \to \infty$—ultra-fragile market.
- Dimensionally, L_t has units of price per contract volume, but FRVI is interpreted unitlessly via the norm.

4 Interpretation Regimes

Empirically, users can classify FRVI scores into regimes:

FRVI_t Range	Volatility Regime	Typical Funding Behavior
0.00–0.02	Very Low	Stable, near-zero funding
0.02–0.05	Low	Occasional mild spikes
0.05–0.10	Moderate	Clear swings; watch closely
0.10–0.20	High	Frequent funding flash
> 0.20	Extreme	Critical, risk of funding anomalies

Table 1: FRVI Regimes and Funding-Rate Implications

5 Algorithmic Implementation

The following pseudo-code outlines the real-time computation:

6 Implementation Considerations

- **Sampling Frequency:** 1–5 s for high-frequency monitoring, 30–60 s for broader risk dashboards.

Algorithm 1 FRVI Real-Time Update

Require: Last skew S_{t-1}, new data $(OI_{\text{long},t}, OI_{\text{short},t}, \text{bids}, \text{asks})$

Compute $S_t \leftarrow \frac{OI_{\text{long},t} - OI_{\text{short},t}}{OI_{\text{long},t} + OI_{\text{short},t}}$

$\Delta S_t \leftarrow S_t - S_{t-1}$ ▷ If first tick, set $\Delta S_t \leftarrow 0$

$\text{Spread}_t \leftarrow ask_{1,t} - bid_{1,t}$

$\text{Depth}_t \leftarrow \frac{1}{2N} \sum_{i=1}^{N} (v_{bid,i,t} + v_{ask,i,t})$

$L_t \leftarrow \text{Spread}_t / \text{Depth}_t$

$\text{FRVI}_t \leftarrow \sqrt{(\Delta S_t)^2 + L_t^2}$

Update state: $S_{t-1} \leftarrow S_t$

Ensure: FRVI_t

- **Choice of N:** $N = 5$–10 captures top-of-book liquidity. Larger N smooths microstructure noise but may underweight immediate fragility.
- **Data Quality:** Use redundant API sources to guard against stale feeds or micro-outages.
- **Numerical Stability:** Cap L_t at a large finite value to avoid overflow when depth ≈ 0.