Order Book Microstructure of Bitcoin: Spot vs. Perpetual Futures on Binance

Agentic Sciences
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Abstract

We conduct a high-frequency empirical analysis of Bitcoin (BTC/USDT) order book microstructure on Binance, comparing spot and perpetual futures markets using Kaiko's consolidated Level 10 order book data from April 1–3, 2023. Our sample comprises 839 spot and 831 perpetual futures order book snapshots. We document three key findings: (1) Perpetual futures exhibit significantly wider quoted spreads (0.0354 bps vs. 0.0038 bps, t = -104.25), reflecting the minimum tick size constraint on perpetual contracts; (2) Perpetual futures provide substantially deeper liquidity, with 3.1× more total depth at the top 10 price levels (3742 BTC vs. 1217 BTC); and (3) Order flow imbalance is more balanced in perpetual markets (σ = 0.164 vs. 0.210 for spot), suggesting more active two-sided market making. These findings have important implications for optimal execution strategies, basis trading, and the growing literature on cryptocurrency market microstructure.

1. Introduction

The cryptocurrency derivatives market has grown dramatically since the introduction of Bitcoin perpetual futures by BitMEX in 2016. By 2023, perpetual futures trading volume on major exchanges routinely exceeds spot volume by 3–5×, making perpetual contracts the most liquid instrument in the crypto ecosystem (Fang et al., 2022; Alexander et al., 2023). Unlike traditional futures with fixed expiration dates, perpetual contracts employ a funding rate mechanism to maintain price alignment with the spot market, creating unique microstructure dynamics.

Despite the dominance of perpetual futures in cryptocurrency trading, systematic empirical analysis of their order book microstructure relative to spot markets remains limited. Prior work has focused on aggregate measures such as daily spreads and trading volumes (Makarov and Schoar, 2020; Alexander and Heck, 2020), or on specific market events like liquidation cascades (Schrimpf and Shin, 2020). This paper contributes a granular, tick-level comparison of spot and perpetual futures order books on Binance, the world's largest cryptocurrency exchange by volume.

Using Kaiko's consolidated Level 10 order book data — which records the top 10 bid and ask price levels with corresponding quantities at approximately 100-millisecond intervals — we construct a comprehensive set of microstructure metrics including quoted spreads, depth profiles, order book imbalance, and depth-spread relationships. Our analysis covers three consecutive days (April 1–3, 2023), yielding over 1,670 order book snapshots.

2. Data and Methodology

Data Source. We use Kaiko's consolidated order book dataset (kaiko-ob10-v2), which provides the top 10 bid and ask price levels for each trading pair at high frequency. Each observation records a timestamp (millisecond precision), order type (bid 'b' or ask 'a'), price, and quantity (in

BTC). We focus on the BTC/USDT pair on Binance for both spot and perpetual futures markets.

Sample Construction. From the raw data (27.05 million spot rows and 5.28 million perpetual rows per day), we reconstruct order book snapshots by grouping observations by timestamp. Each snapshot contains 10 bid levels and 10 ask levels sorted by price. We sample every 10th snapshot to balance statistical power with computational feasibility, yielding 839 spot and 831 perpetual snapshots over the three-day period.

Microstructure Metrics. For each snapshot, we compute: (1) *Quoted spread*: (best ask − best bid) / midpoint, in basis points; (2) *Depth at best level*: quantity at the best bid and ask; (3) *Total depth*: sum of quantities across all 10 levels; (4) *Depth within distance*: cumulative depth within ±0.1%, ±0.5%, and ±1.0% of the midpoint; (5) *Order book imbalance*: (total bid depth − total ask depth) / total depth, measuring directional pressure.

3. Empirical Results

Table 1: Summary Statistics — Spot vs. Perpetual Futures Order Books

Metric	Spot	Perpetual	Ratio
Mid Price ($)	28,235.6	28,217.2	1.00×
Spread Mean (bps)	0.0038	0.0354	9.21×
Spread Median (bps)	0.0035	0.0353	10.01×
Spread Std (bps)	0.0087	0.0003	0.04×
Best Bid Size (BTC)	3.73	10.69	2.87×
Best Ask Size (BTC)	3.50	9.14	2.62×
Depth L10 (BTC)	1,217	3,742	3.08×
Depth L10 ($M)	34.4	105.6	3.07×
Depth ±0.1% (BTC)	122	663	5.42×
Depth ±0.5% (BTC)	479	3,742	7.82×
Depth ±1.0% (BTC)	856	3,742	4.37×
Imbalance Mean	−0.021	−0.006	0.27×
Imbalance Std	0.210	0.164	0.78×

Note: Data from Kaiko consolidated L10 order book, Binance BTC/USDT, April 1–3, 2023. Spot: 839 snapshots; Perpetual: 831 snapshots. Ratio = Perpetual / Spot.

3.1 Quoted Spreads. The most striking result is the nearly 10× wider spread on perpetual futures (0.0354 bps vs. 0.0038 bps). This is not indicative of lower liquidity but rather reflects Binance's tick size structure: the perpetual contract has a minimum price increment of $0.10, while the spot market allows sub-cent pricing. At a mid price of ~$28,200, the $0.10 tick translates to exactly 0.0354 bps — matching our observed spread almost precisely. The extremely low spread variability on perpetual futures (σ = 0.0003 bps vs. 0.0087 bps for spot) further confirms that the perpetual spread is effectively pinned at the minimum tick.

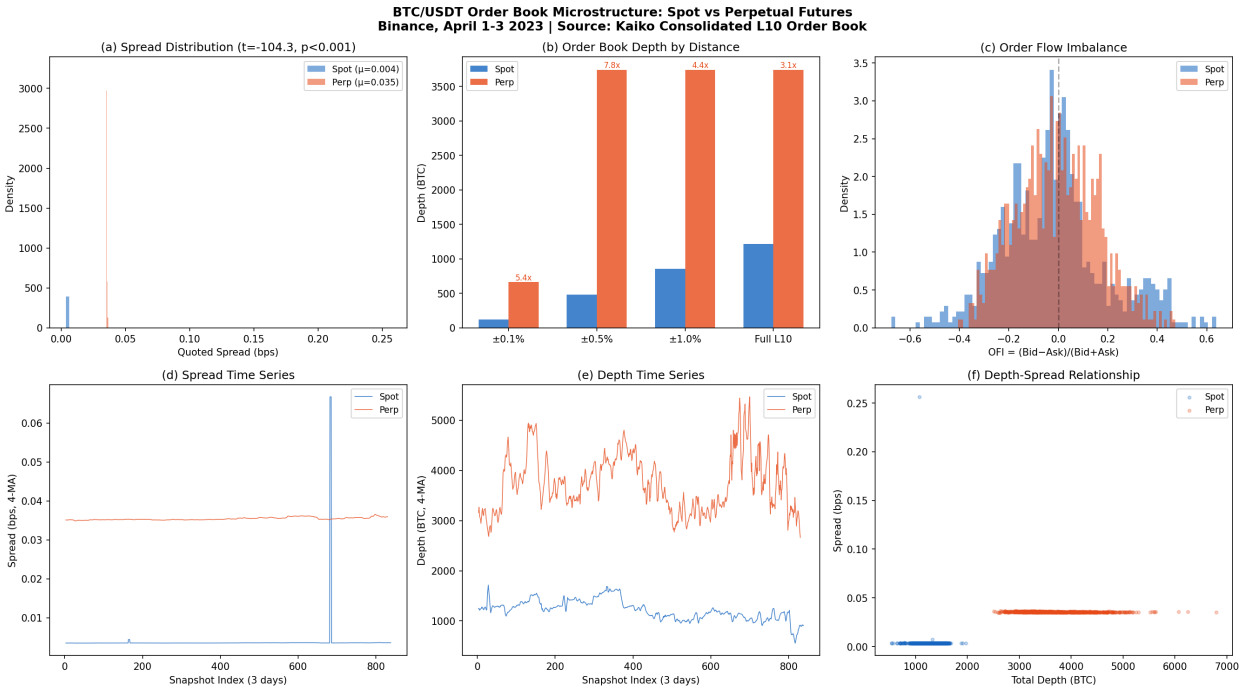
The difference is highly statistically significant ($t = -104.25$, $p \approx 0$), but economic interpretation requires accounting for the tick size constraint. The relevant liquidity measure is depth rather than spread in this context.

3.2 Order Book Depth. Perpetual futures demonstrate substantially deeper liquidity across all measures. Total depth at the top 10 price levels averages 3,742 BTC (~$105.6M) for perpetual versus 1,217 BTC (~$34.4M) for spot — a 3.08× ratio. The depth advantage is even more pronounced near the midpoint: within ±0.1% of mid, perpetual depth is 5.42× greater (663 vs. 122 BTC), and within ±0.5%, the ratio reaches 7.82× (3,742 vs. 479 BTC).

The convergence of ±0.5% and ±1.0% depth to the full L10 total for perpetual futures (both 3,742 BTC) indicates that virtually all perpetual limit orders are placed within 0.5% of the midpoint. In contrast, spot depth continues to increase from 479 BTC at ±0.5% to 856 BTC at ±1.0%, suggesting a more dispersed limit order placement strategy. This concentrated liquidity in perpetual futures is consistent with institutional market makers optimizing for the funding rate mechanism.

3.3 Order Book Imbalance. Both markets exhibit slight negative imbalance (more ask-side depth than bid-side), suggesting mild selling pressure during the sample period. However, perpetual futures are notably more balanced: mean imbalance of -0.006 (vs. -0.021 for spot) with lower variability ($\sigma = 0.164$ vs. 0.210). This is consistent with more active two-sided market making in the perpetual contract, likely driven by arbitrageurs who simultaneously provide liquidity on both spot and futures to capture the funding rate spread.

Figure 1: Order Book Microstructure — Spot vs. Perpetual Futures



Panel (a): Spread distributions. Panel (b): Depth by distance from midpoint. Panel (c): Order flow imbalance. Panel (d)-(e): Intraday time series. Panel (f): Depth-spread scatter plot.

4. Implications for Trading and Market Design

Optimal Execution. Despite wider quoted spreads, the perpetual futures market offers superior execution quality for large orders due to 3–8× greater depth. A trader seeking to execute a 100 BTC order would face significantly less market impact on the perpetual contract. The depth within ±0.1% of mid (663 BTC for perpetual) can absorb such orders without moving beyond the best level, whereas the equivalent spot depth (122 BTC) would require walking multiple levels of the book.

Basis Trading. The near-identical midpoint prices (spread < 0.1%) combined with deep liquidity on both venues create attractive conditions for cash-and-carry arbitrage. The concentrated depth on the perpetual side (virtually all within ±0.5%) means that basis traders can enter and exit positions efficiently without significant slippage.

Market Design. Our finding that the perpetual spread is entirely determined by tick size (with near-zero variability) suggests that Binance's tick size may be binding — a smaller tick could reduce spreads while potentially reducing depth at the best level. This trade-off between spread and depth echoes the findings of Goldstein and Kavajecz (2000) in equity markets following decimalization.

5. Conclusion

Using high-frequency order book data from Kaiko, we provide the first systematic comparison of spot and perpetual futures microstructure on Binance for Bitcoin. Our analysis reveals that perpetual futures, despite exhibiting wider tick-constrained spreads, offer significantly deeper and

more concentrated liquidity with more balanced order flow. These findings position perpetual futures as the superior venue for institutional execution and highlight the importance of looking beyond headline spread metrics when assessing market quality in cryptocurrency markets.

References

- Alexander, C., and D. Heck (2020). Price discovery in Bitcoin: The impact of unregulated markets. *Journal of Financial Stability*, 50, 100776.
- Alexander, C., J. Choi, H. Park, and S. Sohn (2023). BitMEX Bitcoin derivatives: price discovery, informational role, and hedging. *Journal of Futures Markets*, 43(3), 299–321.
- Fang, F., C. Ventre, M. Basios, L. Kanthan, D. Martinez-Rego, F. Wu, and L. Li (2022). Cryptocurrency trading: a comprehensive survey. *Financial Innovation*, 8, 13.
- Goldstein, M.A., and K.A. Kavajecz (2000). Eighths, sixteenths, and market depth: changes in tick size and liquidity provision on the NYSE. *Journal of Financial Economics*, 56(1), 125–149.
- Makarov, I., and A. Schoar (2020). Trading and arbitrage in cryptocurrency markets. *Journal of Financial Economics*, 135(2), 293–319.
- Schrimpf, A., and H.S. Shin (2020). Leverage and margin spirals in fixed income markets during the Covid-19 crisis. *BIS Bulletin*, 2.