

Research Report Plan: Trading Polymarket's 5-Minute Bitcoin Up/Down Markets

Prepared for a quantitative investing class | February 13, 2026

Purpose. Turn a simple trading heuristic into a rigorous empirical report. Estimate a model-implied probability that the contract resolves *Up* and test whether Polymarket prices deviate in a tradable way after accounting for spreads and fees.

Framing. The 5-minute Up/Down contract is analogous to a digital option on the sign of BTC's return over a very short horizon. Your report can study both *market efficiency* (calibration) and *strategy performance* (net of costs).

1. Market Mechanics (state these clearly)

- Settlement reference: resolves using the Chainlink BTC/USD feed; Up if end-of-window price \geq start-of-window price, else Down.
- Contract price interpretation: price in $[0,1]$ can be treated as an implied probability of Up (before costs).
- Execution: Polymarket uses a central limit order book (CLOB); spreads, depth, and fill assumptions dominate at 1–2 minutes to expiry.

2. Data Plan

- For each 5-minute market: start/end timestamps, market id, and final outcome (Up/Down).
- High-frequency market snapshots (e.g., every 5–10 seconds): best bid/ask (Up and Down), mid, spread, and (optionally) depth/imbalance and trades.
- A price series aligned to the settlement reference (prefer Chainlink; if using exchange prices, quantify basis/latency vs Chainlink).
- Record frictions: bid/ask spread and any fees; document taker vs maker assumptions.

Key modeling idea (upgrade of the original heuristic)

Compare the *distance to the start price* to *remaining-time volatility*. A practical rule is: compute p_{model} for Up and trade only when p_{model} exceeds the executable market price by an edge threshold.

Rule-of-thumb fix: compare distance to $k \times \text{standard deviation}$ (not variance), and scale by remaining time via $\text{sqrt}(\Delta t)$.

3. Suggested Dataset Schema (per snapshot)

Field	Example / Notes
timestamp	UTC time; consistent across data sources
market_id	Identifier for the 5-minute window
t_remaining_sec	Seconds to expiry
up_bid / up_ask / up_mid	Best bid/ask and mid for Up
down_bid / down_ask / down_mid	Best bid/ask and mid for Down
spread_up / spread_down	ask - bid
depth_up / depth_down (opt.)	Top-of-book depth or within a price band
imbalance (opt.)	(bid depth - ask depth) / total depth
S0, St	Reference price at window start and current aligned price
label_up	1 if resolved Up else 0

4. Modeling: From ‘distance vs volatility’ to fair probability

Let S_0 be the settlement reference price at the start of the 5-minute window, S_t the current reference price, and T the expiry time. Define $x = \ln(S_t / S_0)$. Under a short-horizon lognormal model with zero drift, $\ln(ST / S_t) \sim \text{Normal}(0, \sigma^2 \Delta t)$, where Δt is time remaining. Then:

$$P(\text{Up} | S_t) = 1 - \Phi(-x / (\sigma \cdot \sqrt{\Delta t}))$$

- Estimate σ from very recent returns (e.g., last 1–5 minutes) and scale to remaining time with $\sqrt{\Delta t}$.
- Compute p_{model} and compare to executable prices (use ask if buying). Trade only when $(p_{\text{model}} - p_{\text{exec}}) > \tau$.
- Start with $\mu = 0$ (zero drift). Add drift or microstructure features only after the baseline is working.

5. Strategies to Test (report-friendly set)

- **S0 (baseline):** always buy Up (or Down) at a fixed time-to-expiry; checks for bias.
- **S1 (volatility-scaled edge):** enter at $T - 120s$ (or similar). Buy Up when $p_{\text{model}} - \text{ask(Up)} > \tau$; buy Down when $(1 - p_{\text{model}}) - \text{ask(Down)} > \tau$. Hold to settlement.
- **S2 (implied vs realized volatility):** invert prices to infer σ_{imp} ; test whether σ_{imp} differs from realized σ and whether deviations predict returns or errors.
- **S3 (microstructure classifier):** logistic regression using features like short-term momentum, realized vol, spread, depth/imbalance, and trade intensity; trade on probability edge vs executable prices.

6. Empirical Tests and Metrics

- Calibration: probability buckets; predicted vs realized Up frequency; Brier and log scores.
- Efficiency vs time-to-expiry: spread, mispricing, and model error as functions of remaining time.
- Backtest: average edge, hit rate, P&L; per contract, turnover, drawdown; report gross and net of assumed costs.
- Robustness: walk-forward/out-of-sample; sensitivity to entry time, lookback window, and τ .

7. Extensions (what else can be done)

- Compare horizons (5-min vs 15-min vs 1-hour): does mispricing increase as horizon shrinks?
- Event studies: do pricing errors cluster around scheduled macro releases or high-volatility regimes?
- Maker vs taker: quantify spread capture vs adverse selection near expiry using order book features.
- Chainlink vs exchange basis: measure systematic lag/basis; test if Polymarket tracks the settlement reference more tightly near expiry.
- Ensembles: combine volatility-threshold, momentum, and microstructure signals into a single probability forecast.

8. Recommended Report Outline (deliverable-ready)

- 1 Introduction & motivation
- 2 Market mechanics and settlement definition
- 3 Data and preprocessing (including alignment to settlement reference)
- 4 Descriptive statistics (liquidity, spreads, and probability distribution vs time-to-expiry)
- 5 Modeling fair probability (baseline + volatility-scaled; optional microstructure model)
- 6 Backtest design and execution assumptions
- 7 Results (calibration + profitability net of costs) and robustness
- 8 Discussion (limits, scalability, and what would invalidate findings)
- 9 Conclusion and next steps

References (rules & APIs)

- Polymarket BTC Up/Down 5-minute market rules and settlement reference:
<https://polymarket.com/event/btc-updown-5m-1771002000>
- Polymarket CLOB developer documentation: <https://docs.polymarket.com/developers/CLOB/introduction>
- Polymarket fees overview: <https://docs.polymarket.com/polymarket-learn/trading/fees>
- Background article on 5-minute BTC markets launch (context only): <https://coinmarketcap.com/academy/article/poly-market-debuts-5-minute-bitcoin-prediction-markets-with-instant-settlement>

Note: This document summarizes a project plan and research ideas, not financial advice.