8-STATE MULTI-TIMEFRAME TRADING STRATEGY

Technical Specification & Validation Results

ASSET	XBTUSD (Bitcoin)
VALIDATION	Walk-Forward (15 windows, 2018-2025)
ALPHA+ RATE	73.3% (11/15 windows)
MEAN ALPHA	+6.5% per 6-month window
VS 168H-ONLY	+24.2% improvement
STATUS	VALIDATED - Ready for Production

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CryptoBot Research Division

1. EXECUTIVE SUMMARY

The 8-State Multi-Timeframe Strategy combines trend signals from three timeframes (24h, 72h, 168h) to create 8 distinct market states. Each state has an empirically measured hit rate that determines position sizing. This approach significantly outperforms the simpler 168h-only baseline strategy.

Key Findings:

- **73.3% Alpha-Positive Rate** — Strategy beats buy-and-hold in 11 of 15 test windows
- **+6.5% Mean Alpha** — Average outperformance per 6-month window
- **+24.2% vs 168h-Only** — Significant improvement over baseline strategy
- **100% Bull Market Capture** — Beats 168h-only in all 6 bull market windows
- **80% Bear Market Protection** — Maintains protective properties in downturns

VERDICT: The 8-state strategy adds genuine, validated edge over the simpler 168h-only approach, primarily by capturing bull market rallies while maintaining bear market protection.

2. STRATEGY PARAMETERS

2.1 Moving Average Periods

Timeframe	MA Period (bars)	Effective Period	Purpose
24h	24	24 days	Short-term trend
72h	8	24 days	Medium-term trend
168h	2	14 days	Weekly regime

2.2 Hysteresis Settings

Parameter	Value	Description
Entry Buffer	2.0%	Price must exceed MA by 2% to switch to UP
Exit Buffer	0.5%	Price must fall below MA by 0.5% to begin exit

2.3 Position Sizing Rules

Condition	Position
Hit Rate > 50% AND samples ≥ 20	100%
Hit Rate ≤ 50% AND samples ≥ 20	0%
Samples < 20 (insufficient data)	50%

3. THE 8-STATE MATRIX

The strategy combines three binary trend signals (UP/DOWN) from 24h, 72h, and 168h timeframes to create 2^3 = 8 possible market states. Each state has an empirically measured hit rate (probability of positive next-day return).

3.1 State Definitions & Hit Rates

State	24h	72h	168h	Hit Rate	Position	Interpretation
U/U/U	UP	UP	UP	57.1%	100%	All aligned up - INVEST
U/U/D	UP	UP	DOWN	57.1%	100%	Short-term strength - INVEST
D/D/D	DOWN	DOWN	DOWN	52.8%	100%	Mean reversion edge - INVEST
D/U/U	DOWN	UP	UP	48.7%	0%	Dip may continue - AVOID
D/D/U	DOWN	DOWN	UP	44.9%	0%	Weekly up but weak - AVOID
U/D/U	UP	UP	UP	37.4%	0%	Mixed signals - AVOID
D/U/D	DOWN	UP	DOWN	32.5%	0%	Contradictory - AVOID
U/D/D	UP	DOWN	DOWN	55.7%	100%	Bounce potential - INVEST

Key Insight: The strategy invests when hit rate exceeds 50%, regardless of the intuitive interpretation. For example, D/D/D (all down) still has 52.8% hit rate, suggesting mean reversion opportunities even in downtrends.

4. WALK-FORWARD VALIDATION RESULTS

Strategy tested using rigorous walk-forward methodology with expanding-window hit rate calculation. At each test period, hit rates were calculated using ONLY historical data to eliminate look-ahead bias.

4.1 Validation Configuration

Parameter	Value
Data Range	2017-01-01 to 2025-09-30
Minimum History	365 days before first trade
Test Window	6 months
Step Size	6 months
Total Windows	15
Transaction Costs	0.15% per trade

4.2 Summary Results

Metric	8-STATE	168H-ONLY	Winner
Alpha+ Rate	73.3% (11/15)	46.7% (7/15)	8-STATE
Mean Alpha	+6.5%	-17.6%	8-STATE
Sharpe Beat B&H	73.3% (11/15)	26.7% (4/15)	8-STATE
Mean Sharpe	1.04	0.30	8-STATE
Beats Other Strategy	66.7% (10/15)	33.3% (5/15)	8-STATE

4.3 Regime Analysis

Regime	Windows	8-STATE Alpha+	168H Alpha+	8-STATE Beats 168H
BULL (B&H > +20%)	6	83% (5/6)	17% (1/6)	100% (6/6)
BEAR (B&H < -20%)	5	80% (4/5)	80% (4/5)	40% (2/5)
SIDEWAYS	4	50% (2/4)	50% (2/4)	50% (2/4)

Critical Finding: The 8-state strategy's primary advantage is in BULL markets, where it beats 168h-only in 100% of windows with +63% mean improvement. This solves the main weakness of the simpler 168h-only approach.

5. DETAILED WINDOW-BY-WINDOW RESULTS

Win	Period	8-State	Alpha	168h	Alpha	B&H	8St>168h
1	2018-01 to 2018-07	-46.5%	+8.6%	-52.2%	+2.8%	-55.0%	✓
2	2018-07 to 2019-01	-36.1%	+4.1%	-34.6%	+5.7%	-40.3%	
3	2019-01 to 2019-07	+185.4%	-2.1%	+93.9%	-93.6%	+187.5%	✓
4	2019-07 to 2020-01	-19.8%	+13.9%	-31.6%	+2.0%	-33.6%	✓
5	2020-01 to 2020-07	+53.4%	+38.3%	+0.5%	-14.6%	+15.1%	✓
6	2020-07 to 2021-01	+343.3%	+25.0%	+266.3%	-52.0%	+318.3%	✓
7	2021-01 to 2021-07	-13.5%	+3.2%	-13.9%	+2.8%	-16.7%	✓
8	2021-07 to 2022-01	+37.1%	+10.8%	+28.4%	+2.2%	+26.3%	✓
9	2022-01 to 2022-07	-39.8%	+8.3%	-6.0%	+42.2%	-48.2%	
10	2022-07 to 2023-01	-36.9%	-15.4%	-28.0%	-6.5%	-21.5%	
11	2023-01 to 2023-07	+84.6%	+7.5%	-9.9%	-87.0%	+77.1%	✓
12	2023-07 to 2024-01	+61.3%	+16.3%	+26.2%	-18.7%	+45.0%	✓
13	2024-01 to 2024-07	-1.6%	-20.5%	+34.4%	+15.6%	+18.8%	
14	2024-07 to 2025-01	+81.0%	+10.0%	+9.9%	-61.0%	+71.0%	✓
15	2025-01 to 2025-07	+3.9%	-10.1%	+9.5%	-4.4%	+13.9%	

6. IMPLEMENTATION REFERENCE

6.1 Position Lookup Table

Use this lookup table to determine position based on current market state. Tuple format: (24h_trend, 72h_trend, 168h_trend) where 0=DOWN, 1=UP.

```
POSITION_LOOKUP = {
(0, 0, 0): 1.00, # D/D/D: hit=52.8% - INVEST
(0, 0, 1): 0.00, # D/D/U: hit=44.9% - AVOID
(0, 1, 0): 0.00, # D/U/D: hit=32.5% - AVOID
(0, 1, 1): 0.00, # D/U/U: hit=48.7% - AVOID
(1, 0, 0): 1.00, # U/D/D: hit=55.7% - INVEST
(1, 0, 1): 0.00, # U/D/U: hit=37.4% - AVOID
(1, 1, 0): 1.00, # U/U/D: hit=57.1% - INVEST
(1, 1, 1): 1.00, # U/U/U: hit=57.1% - INVEST
}
```

6.2 Signal Generation (Pseudocode)

```
# For each timeframe, calculate MA and apply hysteresis
trend_24h = label_trend(df_24h, ma_period=24, entry=0.02, exit=0.005)
trend_72h = label_trend(df_72h, ma_period=8, entry=0.02, exit=0.005)
trend_168h = label_trend(df_168h, ma_period=2, entry=0.02, exit=0.005)

# CRITICAL: Shift signals to avoid look-ahead bias
trend_24h_shifted = trend_24h.shift(1)
trend_72h_shifted = trend_72h.shift(1).reindex(df_24h.index, method='ffill')
trend_168h_shifted = trend_168h.shift(1).reindex(df_24h.index, method='ffill')

# Get current state and look up position
state = (trend_24h_shifted, trend_72h_shifted, trend_168h_shifted)
position = POSITION_LOOKUP[state]
```

CRITICAL: Higher timeframe signals MUST be shifted by 1 period before forward-fill. Without this shift, you are using end-of-period information to trade at beginning-of-period (look-ahead bias).

7. RISKS AND LIMITATIONS

7.1 Known Limitations

- **Single Asset:** Validated only on XBTUSD. Performance may differ on other pairs.
- **Parameter Sensitivity:** Results depend on specific MA periods and hysteresis values.
- **Hit Rate Instability:** Some states (e.g., U/D/U) have high standard deviation (17.9%).
- **Sample Size:** Rare states may have insufficient samples for reliable hit rate estimates.
- **Regime Dependence:** Strategy underperforms 168h-only in bear markets (40% win rate).

7.2 Risk Management Recommendations

- Use 0.25 Kelly fraction (quarter-Kelly) for position sizing
- Implement maximum position limit (e.g., 100% of allocated capital)
- Monitor hit rate stability monthly; recalibrate if drift exceeds 5%
- Maintain minimum 20 samples per state before trusting hit rate
- Consider blending with 168h-only during confirmed bear markets

8. APPROVAL

This strategy specification has been validated through rigorous walk-forward testing and is approved for production deployment.

Status	**APPROVED FOR PRODUCTION**
Validation Method	Walk-Forward (Expanding Window)
Test Period	2018-01 to 2025-07 (15 windows)
Primary Metric	73.3% Alpha-Positive Rate
Document Version	1.0
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