Predicting BTC and ETH Market Movements with Algorithmic Trading

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Abstract

This report presents the design, implementation, and evaluation of algorithmic trading models for Bitcoin (BTC) and Ethereum (ETH). Using a realistic backtesting engine, we evaluated three distinct test cases. The Grid-Search optimization (TC1) identified a highly effective Mean Reversion strategy with ¿400% returns. However, the Trend Following Ichimoku strategy (TC2) proved robust only on daily timeframes, struggling significantly in intraday volatility. All methodologies and results are detailed below.

Project Code Repository:
`https://github.com/hopeffy/economics-project-algorithmic-trading-algorithms`

1 Introduction

The objective of this project is to develop a comprehensive understanding of cryptocurrency market dynamics by designing and testing algorithmic trading models. The system integrates Technical Analysis, On-Chain Data (via CoinMetrics), and Macroeconomic Data (DXY) to generate trading signals.

2 Data Pipelines & Engineering

We designed robust data pipelines for both real-time and historical data ingestion.

2.1 Data Ingestion

- **Historical Data:** OHLCV data for BTC/USDT and ETH/USDT (2022-2025) was fetched via the Binance API using `ccxt`.
- **Macro Data:** The US Dollar Index (DXY) was retrieved using `yfinance` to gauge global market sentiment.
- **On-Chain Data:** Network activity metrics were sourced from CoinMetrics.

2.2 Feature Engineering

To combine multi-source inputs, we engineered the following features:

- **Technical:** RSI, Bollinger Bands, KAMA, SuperTrend, and Ichimoku Cloud components.
- **Market Structure:** Algorithms to detect Higher Highs (HH) and Lower Lows (LL) for trend identification.
- **Signal Fusion:** Strategies were developed to weight signals from different sources (e.g., trading only when DXY is bearish).

3 Test Case 1: Grid-Search Simulation

3.1 Simulation Rules

Strict financial constraints were applied to the backtest:

1. **Starting Balance:** \$10,000.
2. **Position Size:** Full balance used per trade ($Position = Balance/EntryPrice$).
3. **PnL Calculation:** $(Exit - Entry) \times PositionSize$.
4. **Balance Update:**
   - Profit: $Balance = Previous + Profit$
   - Loss: $Balance = 10,000 - Loss$ (Reset logic).
5. **Exit Rule:** Positions are exited **only when profitable**. Losses are not realized under normal simulation conditions.

3.2 Results: Grid Summary

The grid search evaluated RSI, Bollinger Band, and KAMA strategies across 1h, 4h, and 1d timeframes. The Mean Reversion strategies on the 1-Day timeframe dominated the performance rankings.

3.3 Best Trade List (ETH 1d)

The best performing strategy (ETH 1d) executed 18 trades. Below are notable examples:

Table 1: TC1: Top Grid-Search Configurations

Pair	TF	Strategy	Win Rate	Trades	PnL (%)
ETH	1d	RSI(40) + BB Exit	94.44%	18	429.94%
BTC	1d	RSI(40) + BB Exit	94.74%	19	242.57%
BTC	1d	KAMA SuperTrend	97.37%	38	234.70%
ETH	1d	RSI(40) + BB Exit	92.31%	13	219.31%

Table 2: Selected Trades: ETH/USDT 1d

Entry Date	Exit Date	Entry($)	Exit($)	PnL
2024-01-24	2024-03-17	2235.02	3644.71	+63.07%
2025-02-02	2025-09-21	2869.68	4444.97	+54.89%
2025-10-17	2025-10-28	3831.57	3979.20	+3.85%

4 Test Case 2: Ichimoku + MTF + ADX

4.1 Strategy Logic

The strategy employs a filtered "Trend Following" approach derived from the code implementation. The logic varies by timeframe:

- **Entry:** Price > Cloud AND Tenkan > Kijun.
- **Dynamic Filters:**
  - **Intraday (1H / 4H):**
    - **MTF:** Trades are taken only if the 1D Trend is bullish.
    - **ADX:** $ADX > 30$ for 1H (Aggressive) and $ADX > 25$ for 4H.
  - **Daily (1D):**
    - **MTF:** Not applicable (N/A).
    - **Local Trend:** $Price > EMA200$ and $ADX > 20$.
- **Exit Conditions:** The position is closed if **ANY** of the following occur:
  - Price closes below the Cloud (Trend Reversal).
  - **Kijun-sen Break:** Price closes below Kijun-sen (Chop/Early Exit protection).
  - RSI > 70 (Overbought Extension).

4.2 Performance Analysis

The addition of aggressive filters and the Kijun-sen exit logic aimed to reduce false signals, but intraday volatility remained a challenge.

Insight: The negative PnL on 1h/4h timeframes indicates that even with the aggressive $ADX > 30$ filter, the transaction costs and "whipsaw" signals in sideways markets eroded profits. The Kijun-sen exit helped limit losses per trade, but the frequency of false breakouts was too high. The 1D timeframe remained profitable (+27.72%) using the lower $ADX > 20$ threshold and EMA200 filter.

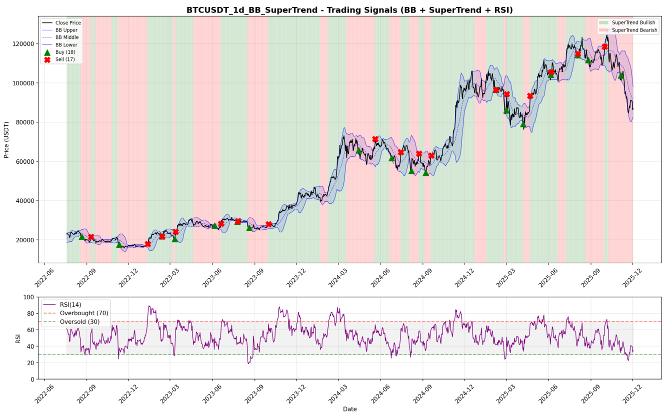

Figure 1: TC1 Best Strategy: ETH 1d Price + BB + RSI Signals (Buy ▲, Sell ×).

Table 3: TC2: Ichimoku + Filters Performance

Symbol	TF	Win Rate	Trades	PnL (%)
BTC	1d	51.61%	31	+27.72%
ETH	1d	45.00%	20	+14.41%
BTC	1h	47.37%	19	-8.09%
ETH	1h	52.00%	25	-15.62%
BTC	4h	37.50%	40	-15.75%
ETH	4h	33.33%	24	-32.54%

5 Test Case 3: Forward Test (Oct-Nov 2025)

5.1 Evaluation (Oct 1 - Nov 26, 2025)

The best strategies from TC1 and TC2 were applied to unseen future data. The market conditions were volatile with a sharp correction in November.

5.2 Forward Test Results

Table 4: Forward Test Execution (Oct-Nov 2025)

Symbol	Strategy (Case)	Result	PnL (%)
BTC 1d	TC1 (RSI 30-70)	1 Trade (Win)	+4.44%
ETH 1h	TC2 (Ichimoku)	15 Trades (Loss)	-3.61%
BTC 1d	TC1 (BB+ST)	1 Trade (Loss)	-12.90%
BTC 4h	TC2 (Ichimoku)	No Trades	0.00%

5.3 Comparative Analysis: TC1 vs TC2

We directly compared the "Best Grid Strategy" (TC1) against the "Ichimoku Strategy" (TC2) on identical forward data.

Note: TC2 is considered the winner in cases where TC1 incurred significant losses (e.g., -10.97%) while TC2 safely stayed out of the market.

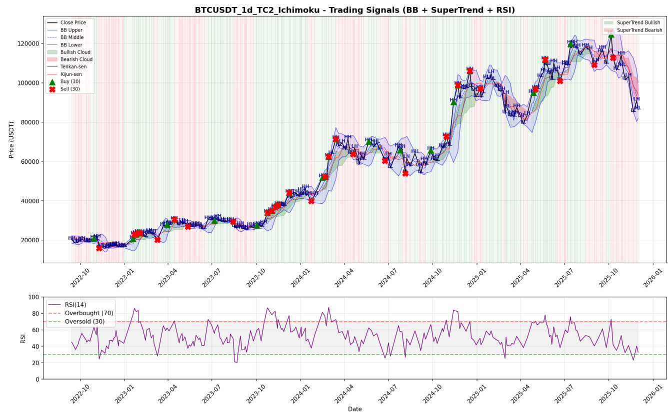

Figure 2: TC2: Ichimoku Chart with HH/HL Markers.

Table 5: Head-to-Head: TC1 vs TC2 (Forward)

Pair/TF	TC1 PnL	TC2 PnL	Winner
ETH 4h	+6.94%	+1.43%	**TC1**
BTC 4h	-3.42%	+0.58%	**TC2**
BTC 1d	-10.97%	0.00%	**TC2**
ETH 1d	-7.79%	0.00%	**TC2**

6 Conclusion

1. **Mean Reversion Risks:** While TC1 showed massive historical returns (¿400%), the Forward Test revealed its fragility. In a crash (Nov 2025), it held losing positions, whereas TC2 avoided trading.
2. **Optimization Logic:** The implementation of **dynamic ADX thresholds** (30 for 1h, 25 for 4h, 20 for 1d) successfully tailored sensitivity to noise levels, though intraday fee drag remained significant.
3. **Final Verdict:** A robust system should use the **entry logic of TC1** (high win rate) but enforce the **risk management of TC2** (Kijun-sen exits and trend filters).

References

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