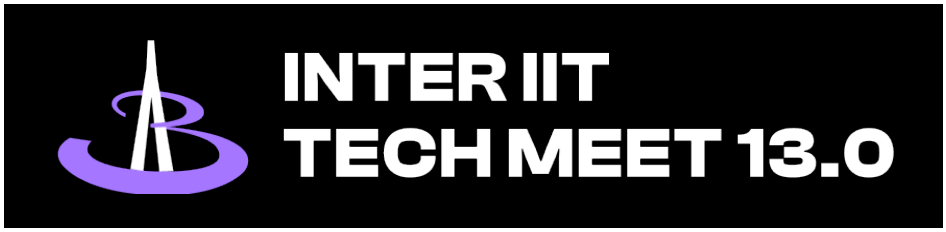
INTER-IIT TECH MEET 13.0

HP2 (Quantitative Finance)



CURATING ALPHAS ON BTC AND USDT CRYPTO MARKET

End-Term Evaluation Report

Team ID : 44

1 Progress Update

1.1 Current Status

The trading strategies applied to BTCUSDT and ETHUSDT pairs were tested over the period from 2019 to 2023, with separate training and testing phases. In the training phase, parameters were fine-tuned to maximize returns and minimize risk, showing stable profitability in backtesting.

Initially, we focused on basic indicators such as Moving Averages (MA), Relative Strength Index (RSI), and Moving Average Convergence Divergence (MACD) during the mid-term. However, as the evaluation progressed, we shifted to more comprehensive strategies incorporating Average Directional Index (ADX), and Price-Volume Trend (PVT), aiming for consistent long-term returns.

Our analysis revealed that while the MACD+RSI strategy, used earlier, provided strong performance metrics, it struggled to generate consistent profits and frequently incurred substantial losses. In contrast, the EMA+ADX and PVT+ADX strategy offered a more balanced approach, delivering steady performance and reasonable profits over time. Additionally, we developed a candlestick pattern-based strategy that combined Heikin Ashi candles with Kalman filters. This strategy achieved exceptional results prior to 2020 and continued to produce solid profits in the following years.

We also explored alternative strategies like pairs trading, Bitcoin network analysis, and correlations with the S&P 500 and SPDR S&P 500 ETF Trust. However, these did not provide significant improvements in performance compared to previously mentioned strategies.

In conclusion, the selected trading strategies, particularly those based on EMA+ADX, PVT+ADX and MACD+RSI, demonstrated reliable performance across the BTCUSDT and ETHUSDT markets, with appropriate risk management and optimization across the testing period.

1.2 Challenges Encountered

We encountered several challenges while developing a strategy aimed at maximizing alphas in the BTC and USDT crypto markets. Some of the key difficulties we faced include:

- **Low Number of Trade Executions:** The strategy executed a relatively small number of trades, which can limit its overall profitability and risk diversification. A low number of trades may also result in missed opportunities, especially during volatile market conditions. This factor could be due to conservative entry or exit rules, or market conditions that did not align with the strategy's signals.
- **Difference in Performance of the Same Strategy Across Both Markets:** The same strategy showed different performance results across both markets, leading to a variance in profitability. In one market, the strategy might have been more successful due to favorable trends or lower volatility, while in the other, it could have underperformed due to market conditions that did not align with its assumptions. This discrepancy highlights the importance of considering market-specific factors and adjusting strategies accordingly.

1.3 Solutions Implemented

To address the challenges above, several solutions were implemented to improve strategy performance and robustness:

- **Low Number of Trade Executions:** To increase the number of trades, we relaxed the previously set conditions to accommodate more entry opportunities. This adjustment also resulted in improved performance metrics across the markets.
- **Difference in Performance of the Same Strategy Across Both Markets:** We customized the parameters of the same strategy for each market to better align with their unique characteristics and demands, resulting in more optimized performance.

2 Strategy Overview

2.1 Core Concept and Objectives of the Trading Strategy

We have tested various strategies using combinations of indicators across both BTC and ETH, including several indicator pairings such as:

1. **Exponential Moving Averages with Average Directional Index (EMA + ADX)**: The purpose of this strategy is to combine EMA crossovers to identify trend direction and ADX to measure trend strength. By using the ADX to filter out weak trends (ADX < 15), it ensures trades are only taken during strong trends. This approach minimizes false signals and improves trade accuracy.
2. **Price Volume Trend + Average Directional Index (PVT + ADX)**: This strategy combines the PVT to confirm volume-backed price moves and the EMA200 to filter out short-term fluctuations. The ADX ensures trades are made during strong trends (ADX > 15) and avoids weak or consolidating periods (ADX < 15). This alignment of volume, price direction, and trend strength enhances the likelihood of successful trades.
3. **Heikin Ashi Candles + Kalman Filters**

Note: For the EMA + ADX and PVT + ADX strategies, we have provided two substrategies each, tailored to different time frames.

2.2 Key Features and Indicators: Functions and Correlations

The primary indicators applied in the strategy development include:

- **EMA (Exponential Moving Average)**
  Indicates: Trend
  Use: Similar to SMA but gives more weight to recent prices for quicker trend response.
  Formula:
  $$\text{EMA} = \text{Price}_{\text{current}} \times k + \text{EMA}_{\text{previous}} \times (1 - k)$$
  where $k = \frac{2}{N+1}$.
- **ADX (Average Directional Index)**
  Indicates: Trend Strength
  Use: Measures the strength of a trend, with values above 25 indicating a strong trend.
  Formula:
  $$\text{ADX} = \frac{\text{Smoothed}(|\text{+DI} - \text{-DI}|)}{\text{Average True Range}}$$
  where +DI and -DI are the Directional Indicators.
- **PVT (Price-Volume Trend)**
  Indicates: Trend Confirmation
  Use: Combines price and volume to determine the direction of a trend.
  Formula:
  $$\text{PVT}_t = \text{PVT}_{t-1} + \frac{\text{Close}_t - \text{Close}_{t-1}}{\text{Close}_{t-1}} \times \text{Volume}_t$$
- **Heikin Ashi Candles**
  Indicates: Smoothed Price Action
  Use: A type of candlestick chart that filters out market noise to reveal smoother trends.
  Formula:
  $$\text{HA Close} = \frac{\text{Open} + \text{High} + \text{Low} + \text{Close}}{4}$$
  $$\text{HA Open} = \frac{\text{HA Open}_{\text{previous}} + \text{HA Close}_{\text{previous}}}{2}$$
  $$\text{HA High} = \max(\text{High}, \text{HA Open}, \text{HA Close})$$
  $$\text{HA Low} = \min(\text{Low}, \text{HA Open}, \text{HA Close})$$
- **Kalman Filter**
  Indicates: Signal Smoothing
  Use: A recursive filter used to smooth noisy time-series data.
  Formula: The Kalman filter involves a prediction and correction step, but the equations are more complex, typically involving a state vector and error covariance matrices. A simplified form would look like:
  $$x_k = x_{k-1} + K_k \times (z_k - H_k x_{k-1})$$
  where x_k is the estimate, K_k is the Kalman gain, and z_k is the observed value.

3 Performance Metrics

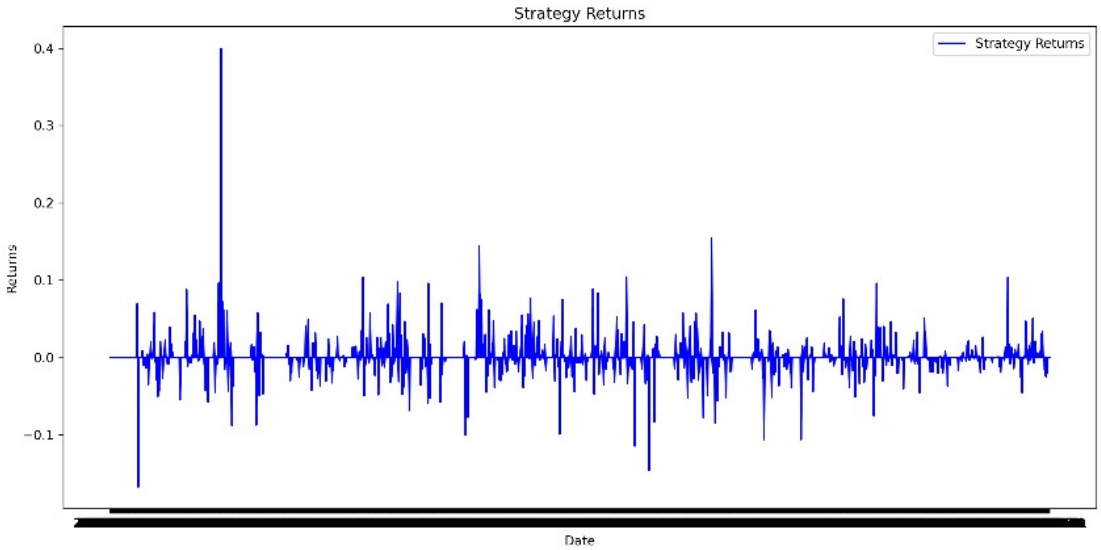
3.1 Comparison of Performance Metrics Across Different Strategies

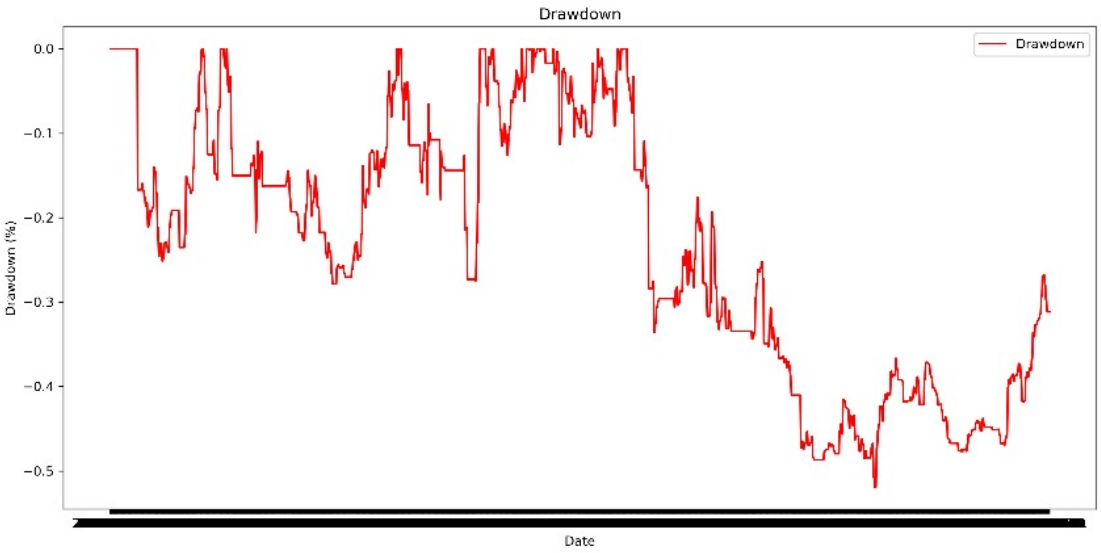
Strategy	Time Period	Market	Profit%	Sharpe	Max Drawdown%	Annualized Returns (Final Balance)
EMA + ADX	1 day	BTC	454.85	5.39	37	5548.587
		ETH	1154.54	7.06	42	12545.46
PVT + ADX	4 hr	BTC	112.08	-1.99	17.39	2120.81
		ETH	2200.32	3.95	15.94	23003.25
PVT + ADX	1 day	BTC	350.28	7.80	24.4	4502.87
		ETH	783.89	6.62	11.16	8838.92
EMA + ADX	4 hr	BTC	489.07	3.32	37.80	5090.78
		ETH	438.38	3.13	45.15	5384.85
HA + Kalman	30 mins	BTC	66	1.40	51.42	1664.38

3.2 Exponential Moving Averages with Average Directional Index (EMA + ADX) - 1 Day

3.2.1 BTCUSDT

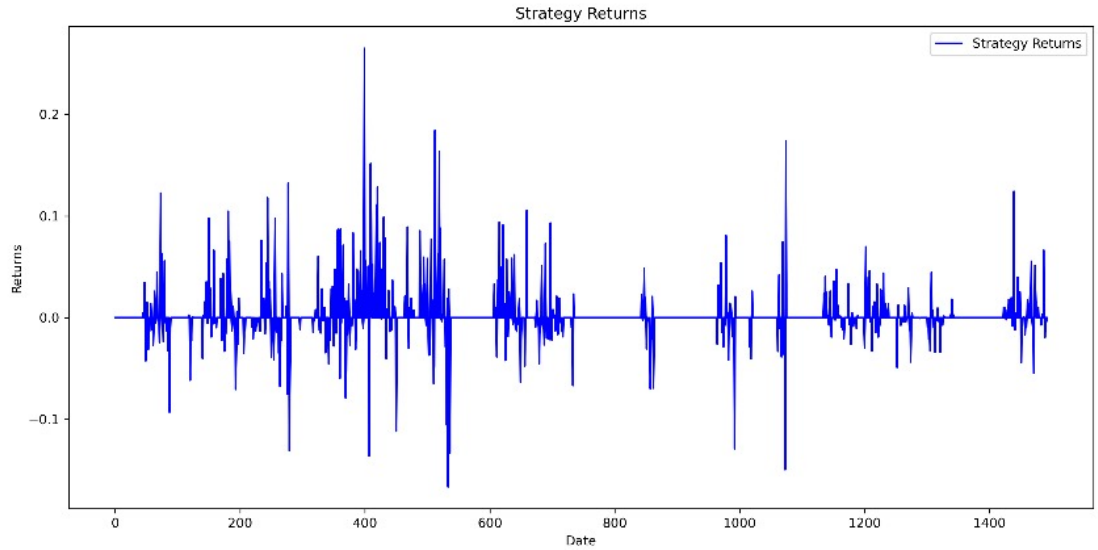
This strategy uses ADX with 25 threshold along with EMA-9, EMA-11 and EMA-45.

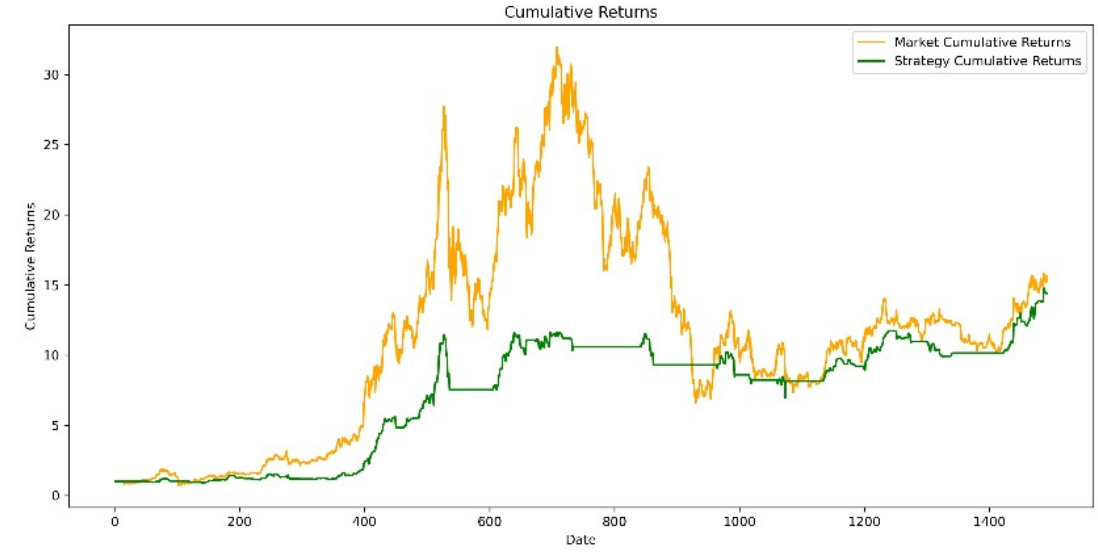


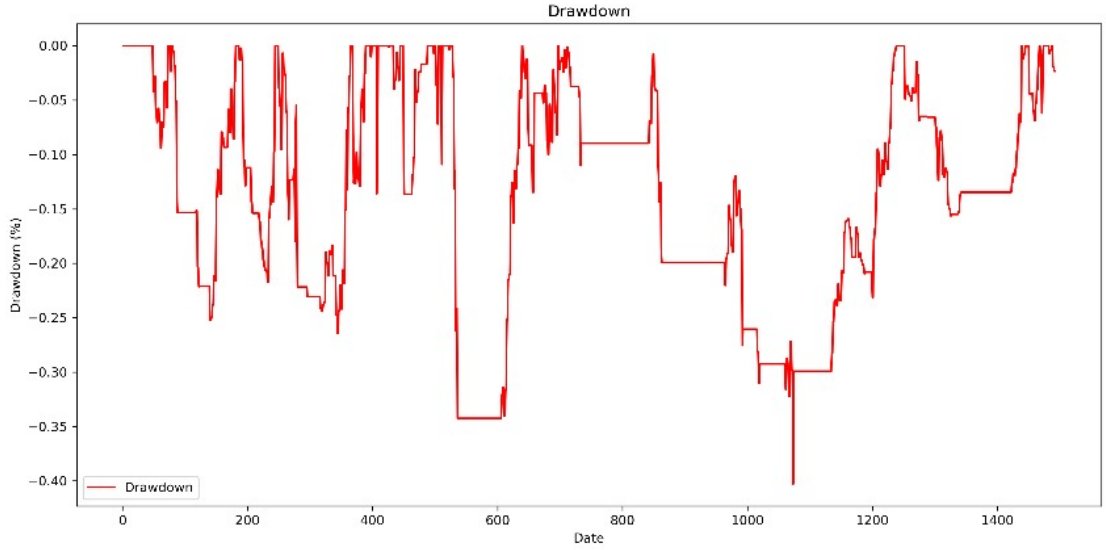


3.2.2 ETHUSDT

This strategy uses ADX with 15 threshold along with EMA-9, EMA-11 and EMA-45.



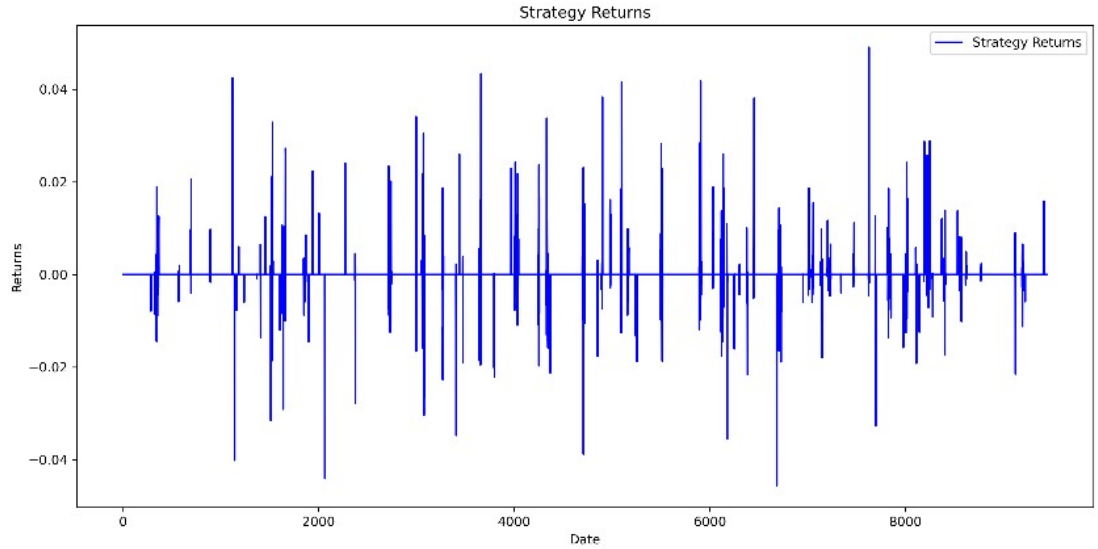


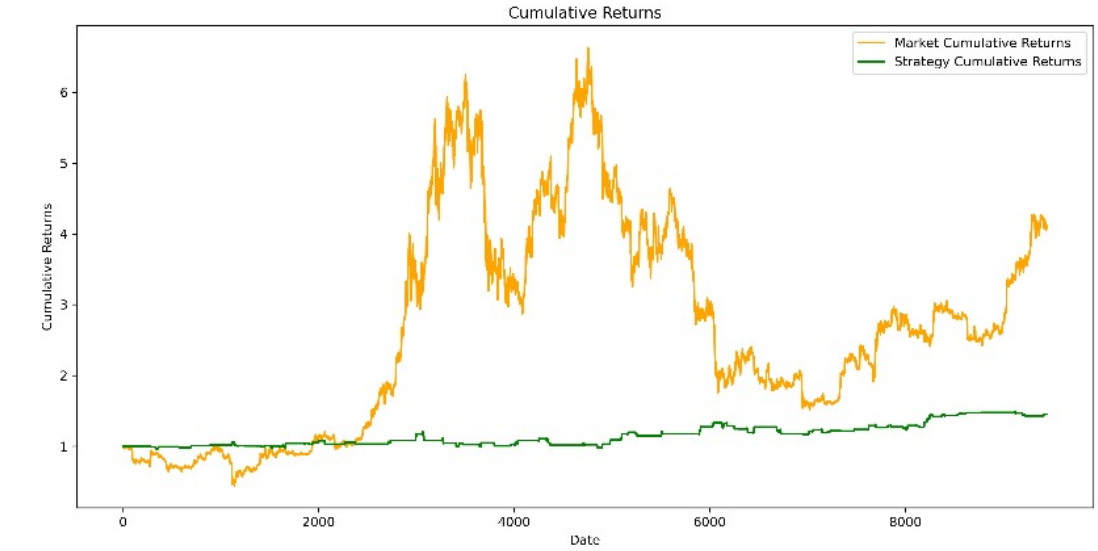


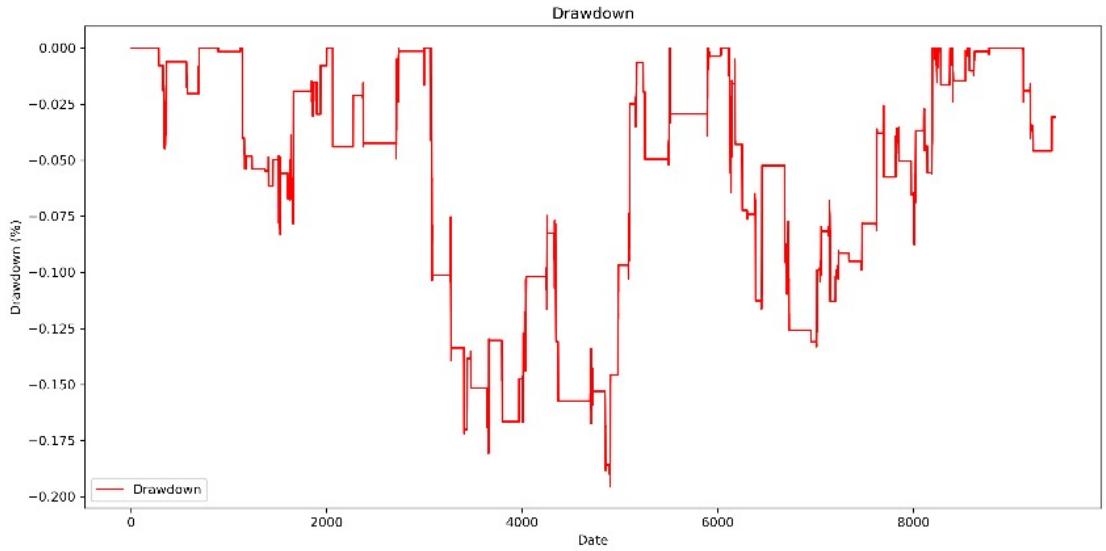
3.3 Price Volume Trend with Average Directional Index (PVT + ADX) - 4 Hr

This uses ADX threshold of 15 and smoothening using 200-EMA length for both the markets. The time frame used is 4 Hour Data.

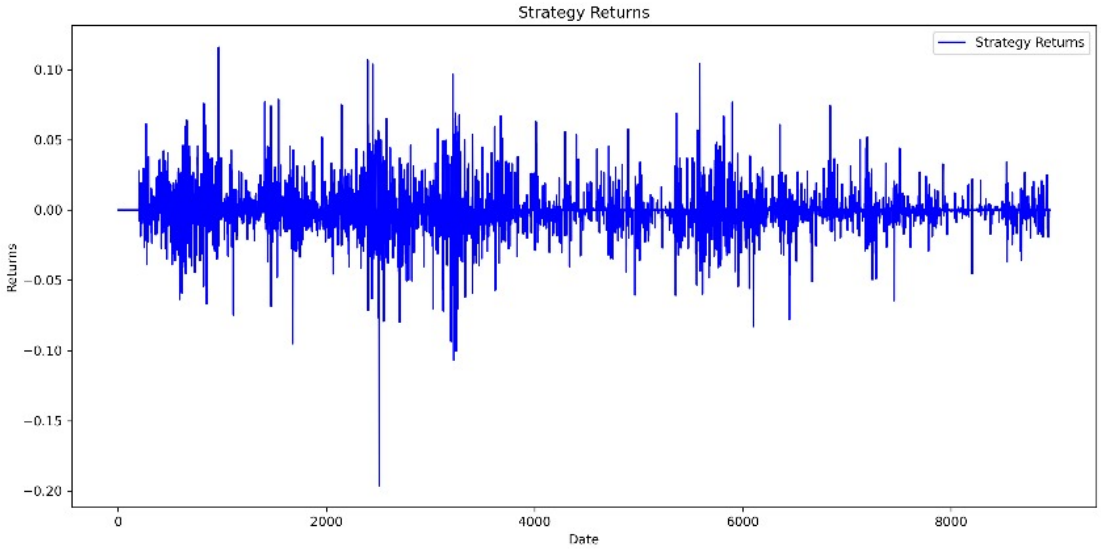
3.3.1 BTCUSDT

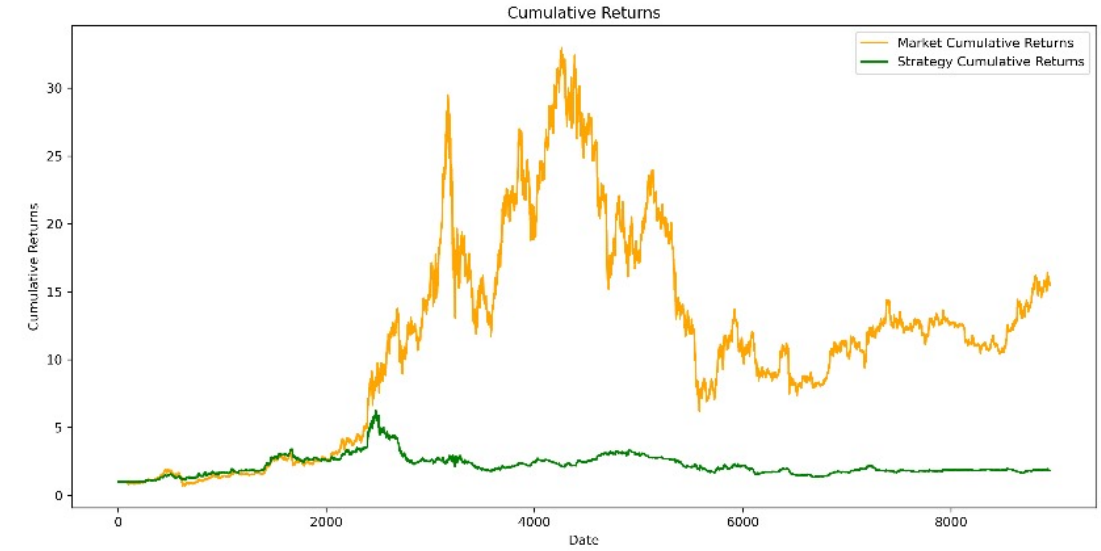

Strategy Returns
Strategy Returns
Returns
0.04
0.02
0.00
−0.02
−0.04
0
2000
4000
6000
8000
Date

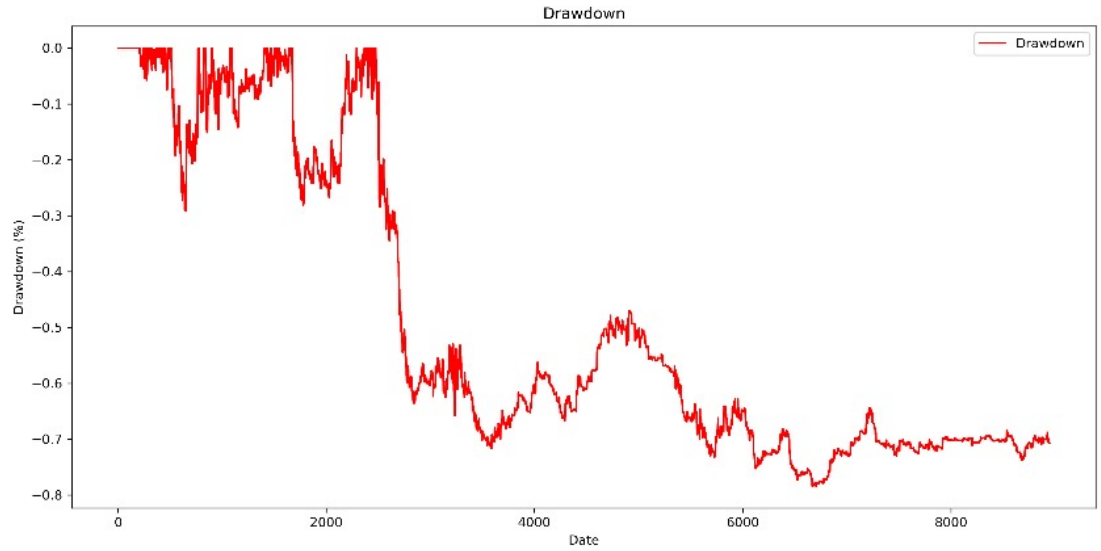

Cumulative Returns
Market Cumulative Returns
Strategy Cumulative Returns
Cumulative Returns
6
5
4
3
2
1
0
2000
4000
6000
8000
Date


Drawdown
Drawdown (%)
0.000
−0.025
−0.050
−0.075
−0.100
−0.125
−0.150
−0.175
−0.200
Drawdown
0
2000
4000
6000
8000
Date

3.3.2 ETHUSDT



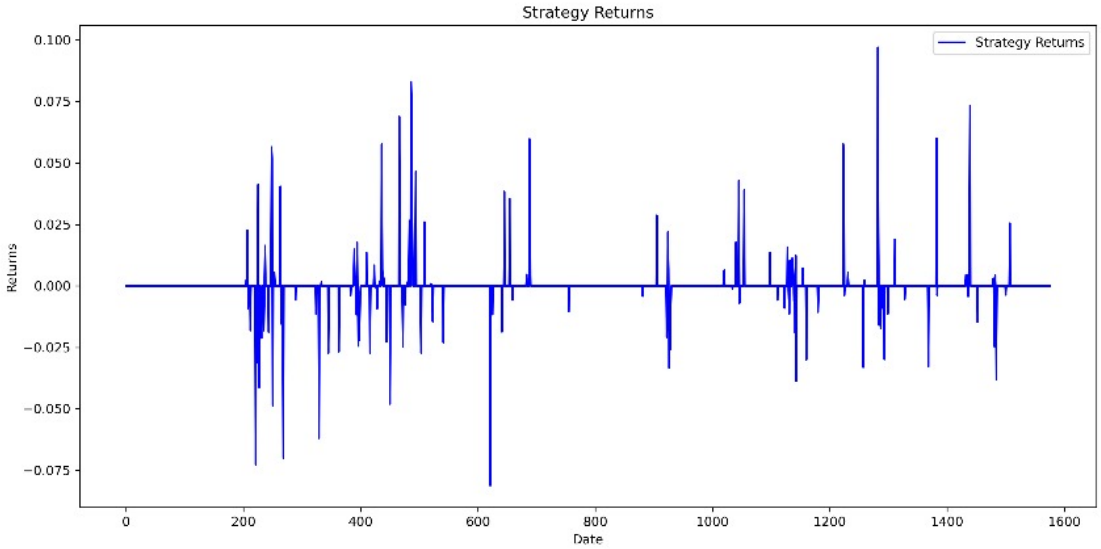


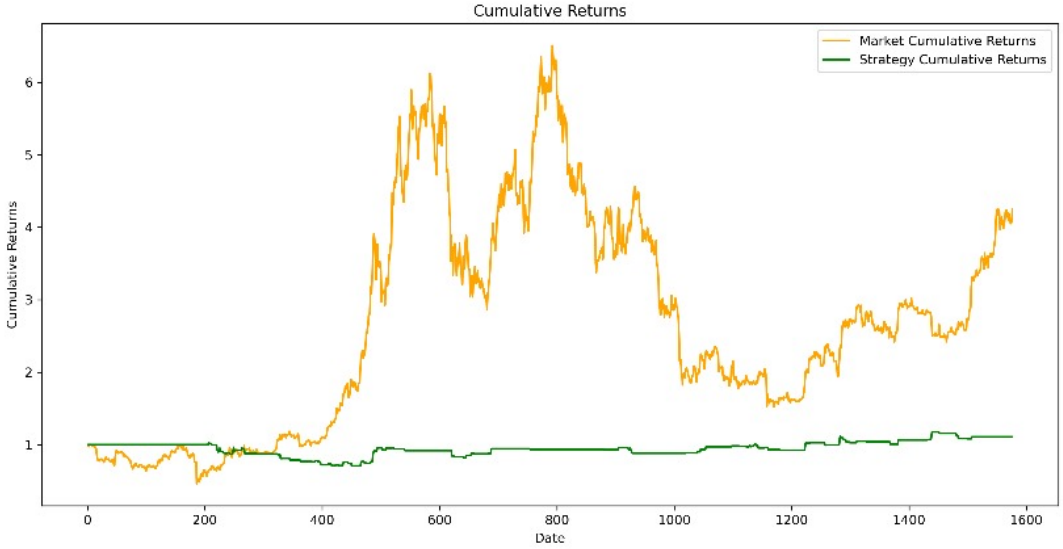


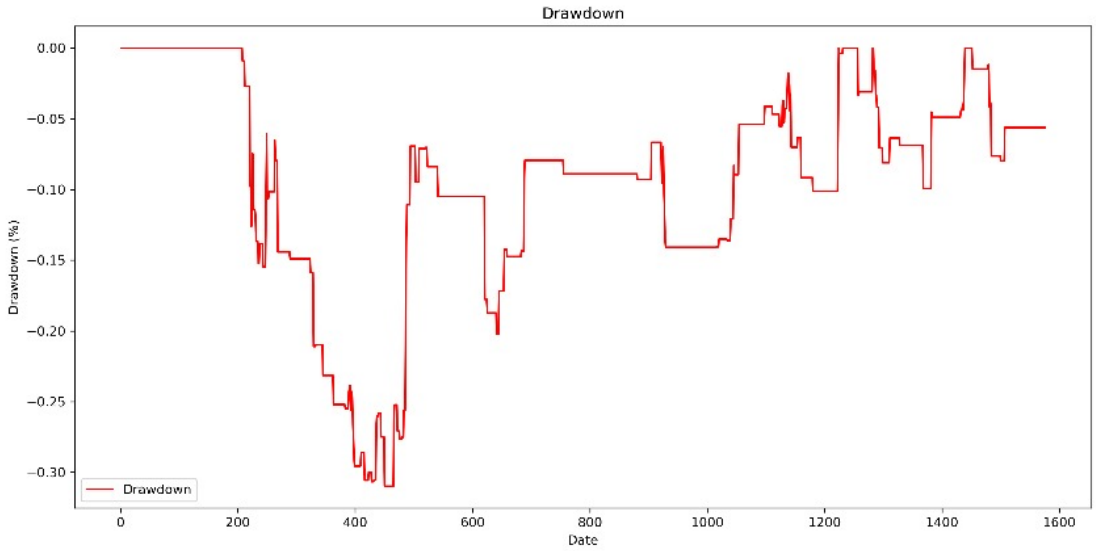
3.4 Price Volume Trend with Average Directional Index (PVT + ADX) - 1 Day

This uses ADX threshold of 15 and smoothening using 200-EMA length for both the markets. The only difference is time frame used is 1 day data.
This also doesn't step into the territory of intra-day trading.

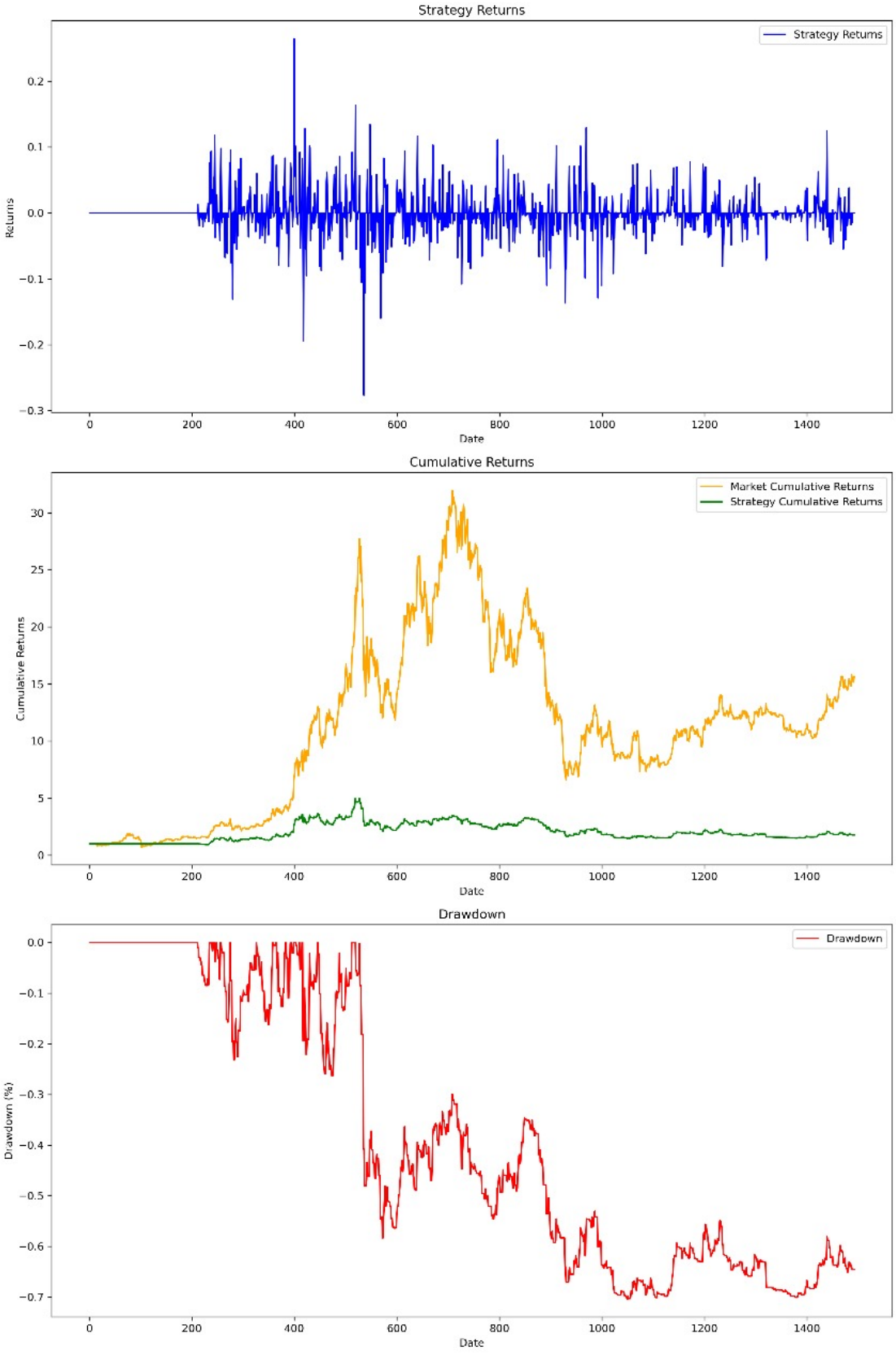
3.4.1 BTCUSDT


Strategy Returns
Strategy Returns
Returns
Date


Cumulative Returns
Market Cumulative Returns
Strategy Cumulative Returns
Cumulative Returns
Date


Drawdown
Drawdown
Drawdown (%)
Date

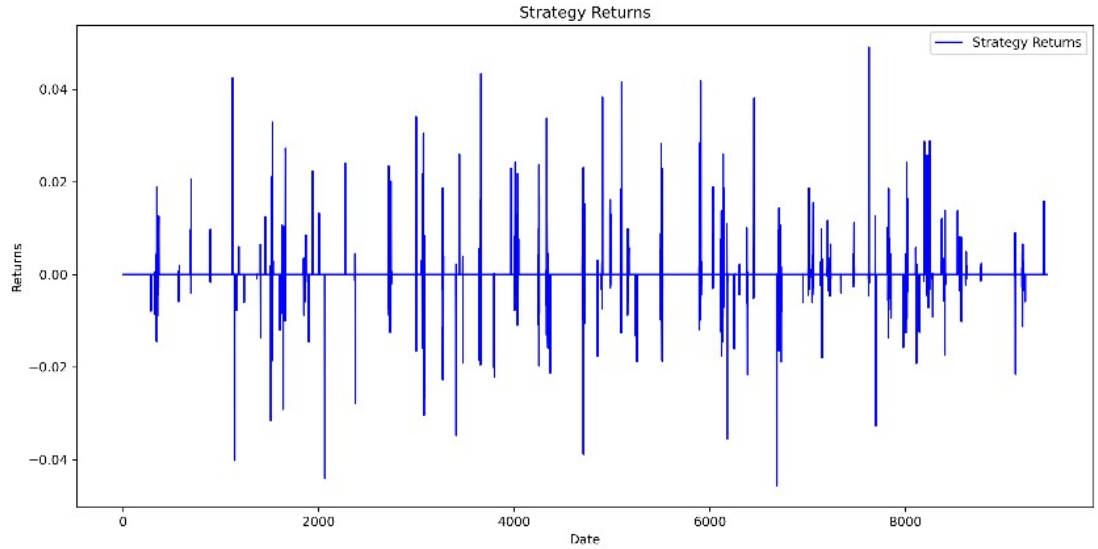
3.4.2 ETHUSDT



3.5 Exponential Moving Averages with Average Directional Index (EMA + ADX) - 4 Hours

This strategy uses ADX threshold of 15 along with EMA-9, EMA-11 and EMA-45 to decide entry and exit conditions.

3.5.1 BTCUSDT


Strategy Returns
Strategy Returns
Returns
0.04
0.02
0.00
−0.02
−0.04
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2000
4000
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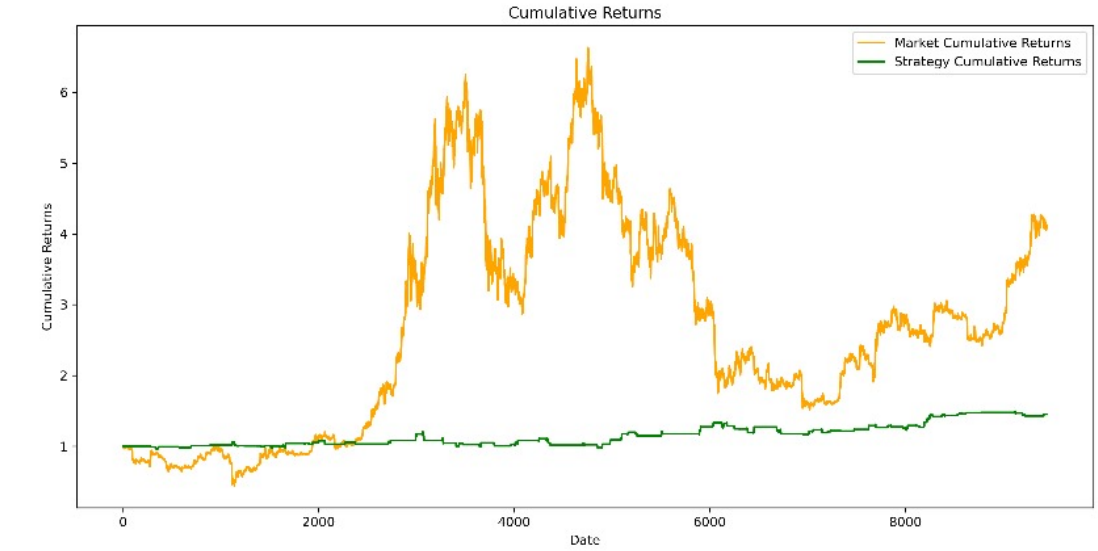
Date


Cumulative Returns
Market Cumulative Returns
Strategy Cumulative Returns
Cumulative Returns
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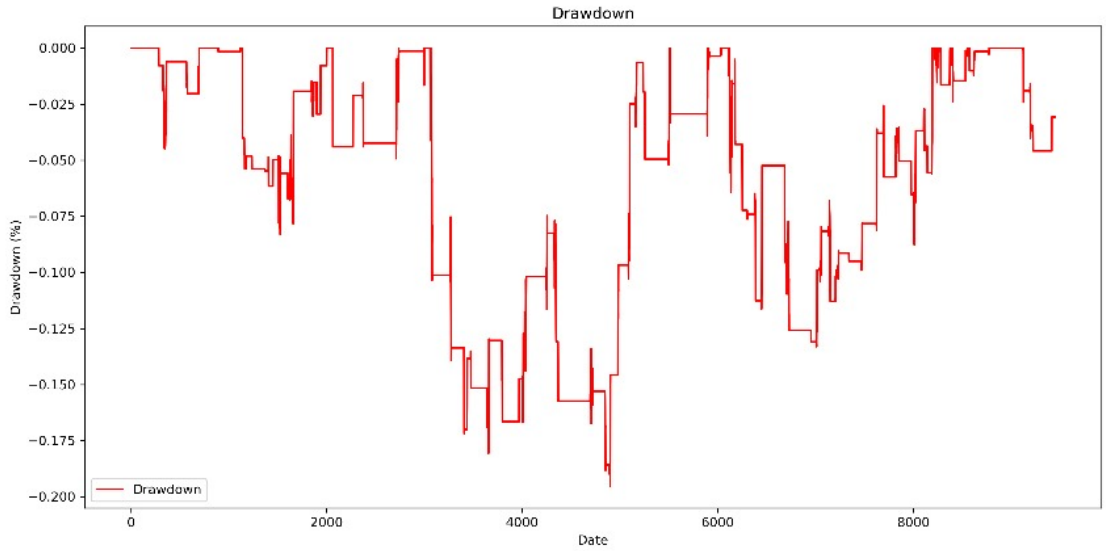
Date


Drawdown
Drawdown (%)
0.000
−0.025
−0.050
−0.075
−0.100
−0.125
−0.150
−0.175
−0.200
Drawdown
0
2000
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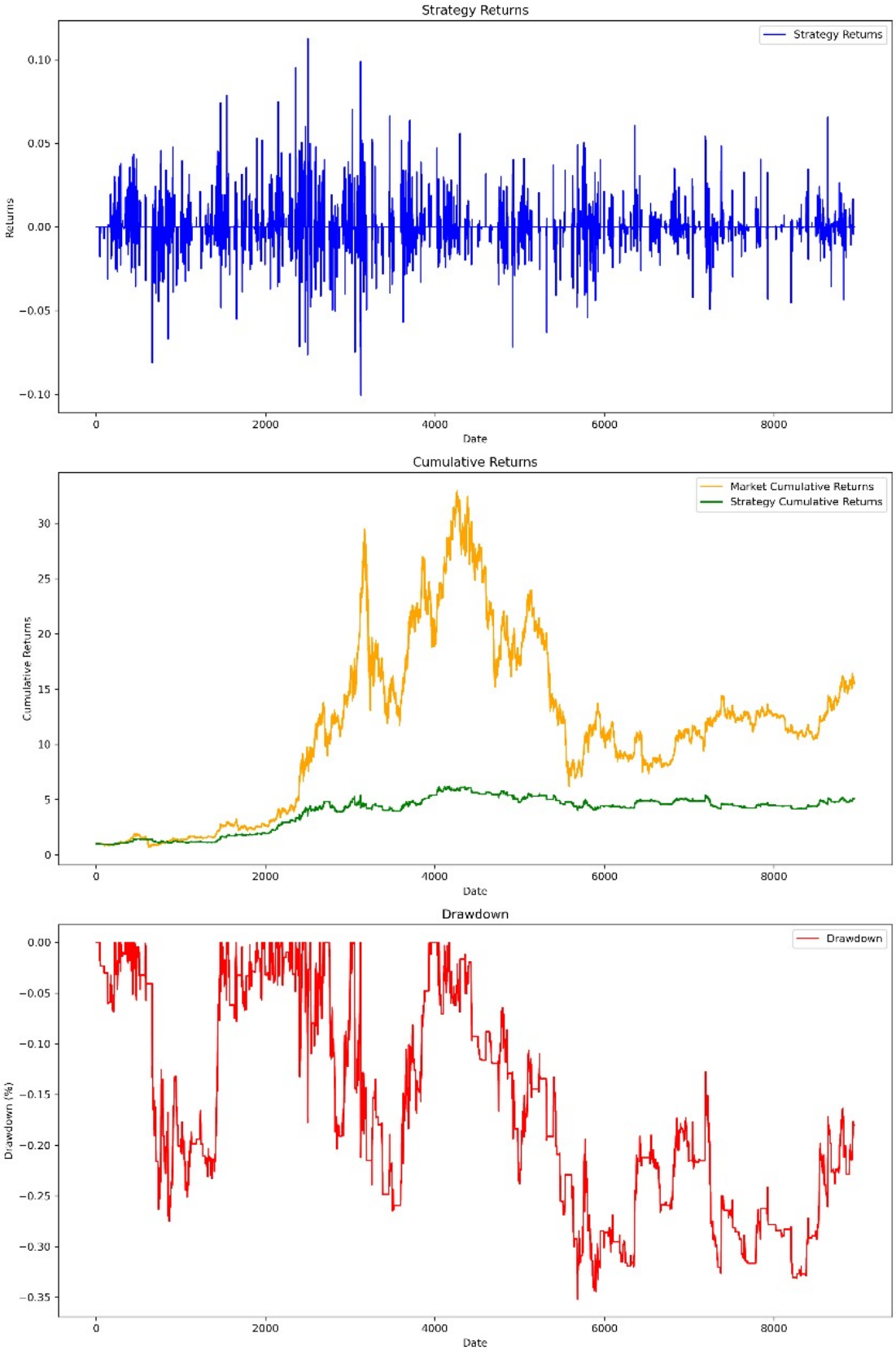
Date

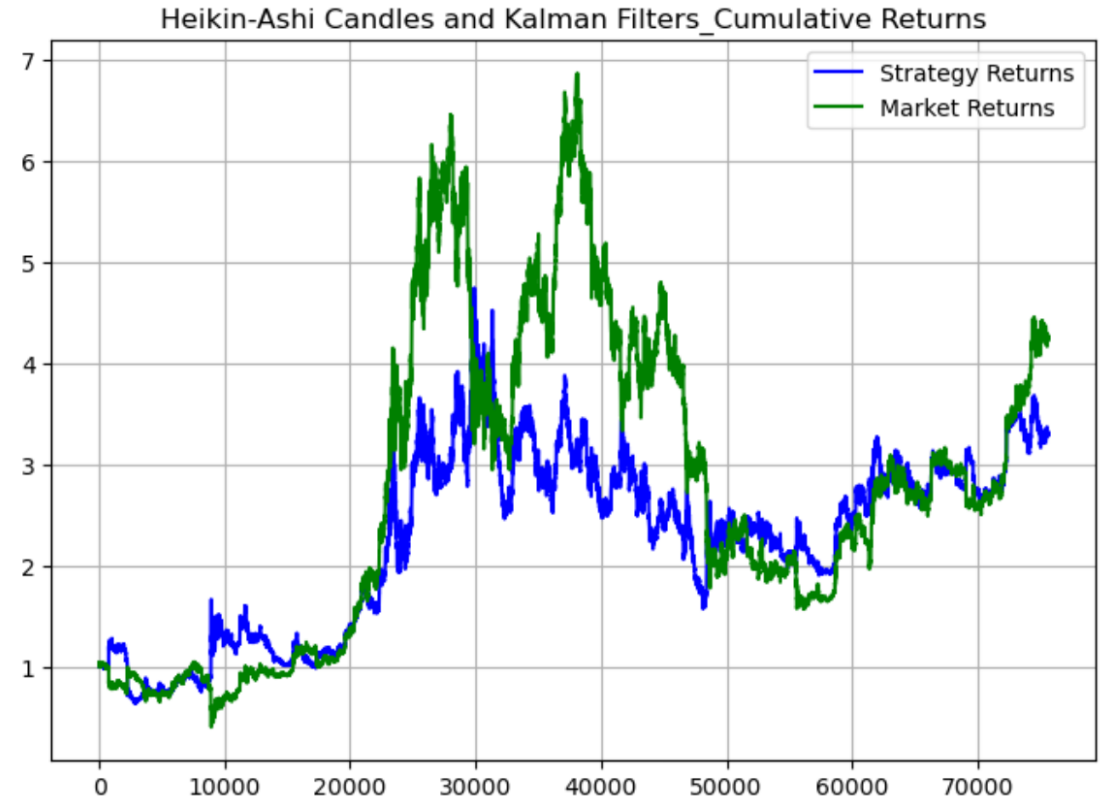
3.5.2 ETHUSDT

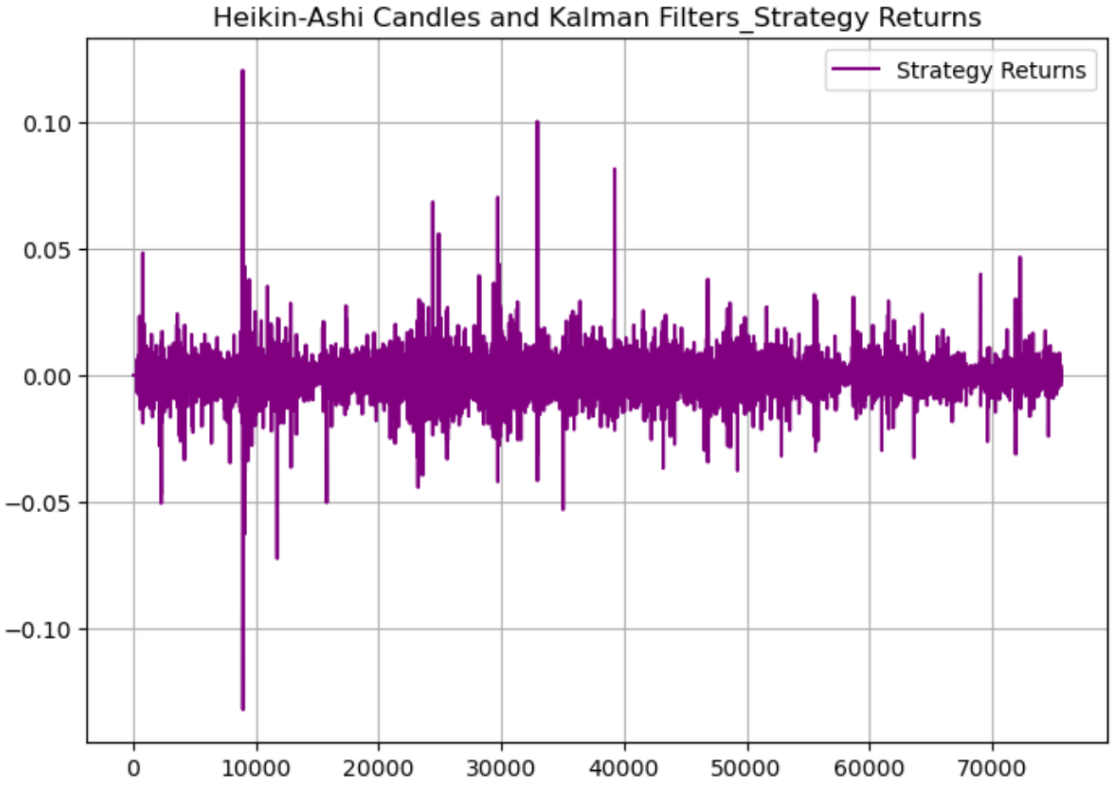


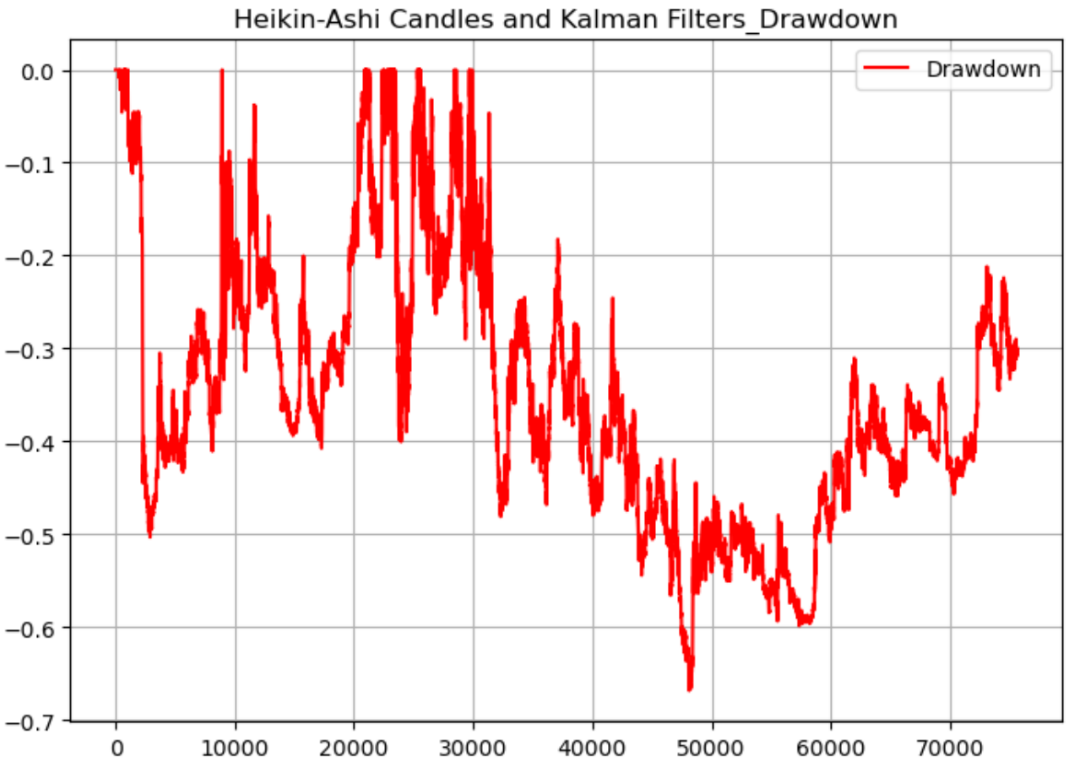
3.6 Heikin Ashi Candles + Kalman Filters

This strategy smoothens the volatility of the price and then we use 60-SMA for fast line and 300-SMA for slow line in the filtered data.

3.6.1 BTCUSDT


Heikin-Ashi Candles and Kalman Filters_Cumulative Returns
Strategy Returns
Market Returns
7
6
5
4
3
2
1
0
10000
20000
30000
40000
50000
60000
70000


Heikin-Ashi Candles and Kalman Filters_Strategy Returns
Strategy Returns
0.10
0.05
0.00
−0.05
−0.10
0
10000
20000
30000
40000
50000
60000
70000


Heikin-Ashi Candles and Kalman Filters_Drawdown
Drawdown
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
0
10000
20000
30000
40000
50000
60000
70000

4 Unique Approaches and Innovations

4.1 Unique Aspects of the Strategy and Associated Market Inefficiencies

4.1.1 Unique Aspect of the Strategy

- **Adjusted ADX Threshold:** The ADX threshold was lowered from the usual 25 to 15 to better differentiate between uptrends and downtrends, specifically catering to markets like `ETH`, which experience higher volatility.
- **Customized Moving Average Periods:** Different time periods for moving averages were chosen to smooth out data more effectively, ensuring that the strategy adapts to both short-term (intraday) and long-term market conditions.
- **Tailored for Market Variations:** The adjustments in parameters ensure the strategy can cater to different market types, providing a flexible approach that handles varying volatility and trend behaviors across multiple timeframes.
- **Heikin-Ashi Candles for Smoothing:** Heikin-Ashi candles were used to smooth candlestick patterns by providing average values for each candle. Essentially, Heikin-Ashi candles filter out the noise caused by high volatility, making it easier to identify the underlying trend.

4.1.2 Market Inefficiencies

The COVID-19 pandemic caused significant market volatility, and while markets eventually declined, our strategy struggled to capture these new trends. The rapid and unexpected changes in market behavior made it challenging for the strategy to adapt effectively.

4.2 Comparison with Traditional Trading Methods and Application of Novel Mathematical Models

4.2.1 Novelty Compared to Traditional Methods

1. **Trend Identification and Confirmation**
   Traditional methods like **Simple Moving Averages (SMA)** and **Support/Resistance** levels can be slow and unreliable, especially in volatile markets. The **EMA + ADX** strategy improves trend identification by using **Exponential Moving Averages (EMA)** for quicker response and **ADX** to confirm trend strength, ensuring trades only occur during strong trends.
2. **Volume Analysis**
   Traditional volume analysis, such as **On-Balance Volume (OBV)**, often lacks sophistication and can miss subtle trend signals. The **PVT + ADX** combination provides a more dynamic approach by confirming price moves with volume and ensuring trades happen only in strong, volume-backed trends.
3. **Noise Reduction and Smoothing**
   Traditional candlestick patterns can be distorted by market noise. **Heikin Ashi Candles** smooth out price action, while the **Kalman Filter** further reduces noise and adjusts predictions, providing clearer, more reliable signals compared to standard candlestick analysis.
4. **Adaptability to Volatility**
   Traditional methods use fixed parameters (e.g., SMA periods), which struggle in volatile markets. The advanced strategies adjust **moving average periods** and **ADX thresholds** to better capture trends in volatile markets like **BTC** and **ETH**, making them more adaptable to changing conditions.
5. **Complexity and Signal Smoothing**
   Traditional indicators like **RSI** and **SMA** are simple but can lack precision. The **Kalman Filter** and **Heikin Ashi Candles** offer advanced smoothing techniques, reducing noise and improving accuracy, making them more effective in volatile markets.