Crypto Price Simulation Strategies

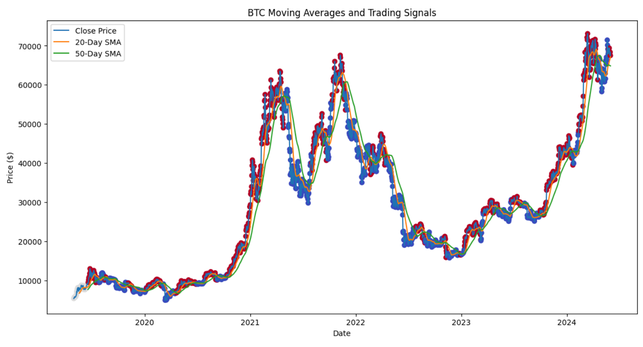
Chin-Hsien Tsai, Yanhui Li, Xiaofan Jiao, Yuhan Qian

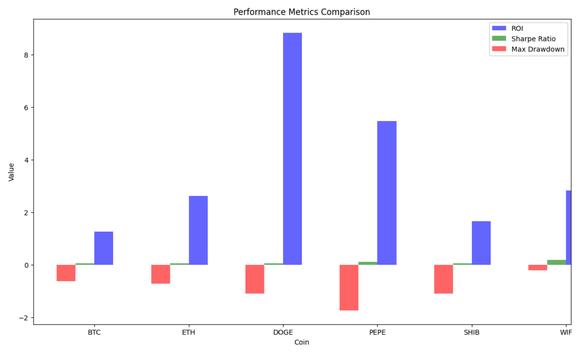
Introduction

The surge in cryptocurrency popularity inspired our project to develop a trading strategy. We use historical news data, Hidden Markov Models, and Monte Carlo simulations to create an effective and flexible approach. Our analysis covers six cryptocurrencies—BTC, ETH, DOGE, PEPE, SHIB, and WIF—using data from Yahoo Finance.

Moving Average Crossover Strategy

We implemented a Moving Average Crossover Strategy using 20-day and 50-day SMAs. Buy signals occurred when the 20-day SMA crossed above the 50-day, and sell signals when it crossed below. Starting with $100,000, we adjusted the portfolio based on these signals, plotting the portfolio value and trading signals for six cryptocurrencies to illustrate performance, profit potential, and risks.





- WIF emerged as the top performer with an ROI of 2.826, a Sharpe Ratio of 0.1912, and a Maximum Drawdown of -20.03%, indicating strong returns with favorable risk-adjusted performance and minimal risk.
- DOGE had the highest ROI of 8.841 but also the highest volatility and risk with a -109.15% Maximum Drawdown and the lowest Sharpe Ratio of 0.0505.

Incorporation of News Events

	Date	Event Description	Impact	Price Change (%)
0	2019-05-07	Binance Hack: 7,000 BTC stolen worth $40.7 mil...	negative	-0.987556
1	2019-09-23	Bakkt Launches Bitcoin Futures Contracts	positive	-20.532071
2	2020-03-12	Crypto Market Crash: Bitcoin drops 50% due to ...	negative	-31.645293
3	2020-10-21	PayPal Announces Support for Cryptocurrency Tr...	positive	12.092012
4	2021-01-08	Bitcoin Surpasses $40,000 for the First Time	positive	4.519879
5	2021-05-12	Tesla Stops Accepting Bitcoin Payments	negative	-10.879953
6	2022-03-15	Regulatory Announcement on Crypto Taxation in ...	negative	7.000421
7	2022-09-15	Ethereum Merge: Transition from Proof of Work ...	positive	-12.375387
8	2022-11-08	FTX Exchange Collapse	negative	-29.862559
9	2023-06-01	Bitcoin ETFs Approved in Several Regions	positive	1.767545
10	2023-12-10	Rise of DeFi and NFTs: Major projects gain tra...	positive	-4.980252
11	2024-01-01	First Bitcoin ETF Launched in the U.S.	positive	3.259530
12	2024-04-15	Blockchain Life 2024: Major Event in Dubai	positive	-2.281376
13	2024-05-29	Consensus 2024: Major Crypto Conference in Aus...	positive	-2.432305

Event Impact	1 Days	3 Days	5 Days	7 Days	10 Days
Positive	0.42%	1.23%	1.47%	5.12%	7.43%
Negative	-11.98%	-12.93%	-12.23%	-16.90%	-17.07%

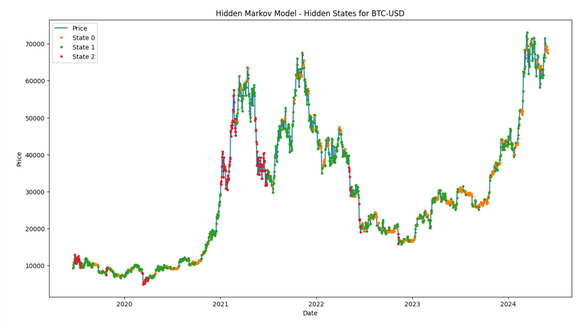
- Bitcoin (BTC):
  - Positive news: +7.43% increase after one day, sustained growth over ten days.
  - Negative news: -17.07% decline over ten days.
  - Quick and strong reaction to positive news.

Event Impact	1 Days	3 Days	5 Days	7 Days	10 Days
Positive	-1.02%	-1.35%	0.29%	6.88%	12.06%
Negative	-13.42%	-12.17%	-10.38%	-14.37%	-10.60%

- Ethereum (ETH):
  - Positive news: Initial slight decline, +12.06% gain after ten days.
  - Negative news: Immediate -10.60% drop, stabilizes after a week.
  - Delayed but strong positive effect from positive news.

Hidden Markov Models (HMM)

We applied Hidden Markov Models (HMMs) to six cryptocurrencies using log returns from closing prices. We fitted an HMM with three hidden states: Bull (increasing prices), Bear (decreasing prices), and Stagnant (fluctuating prices). Parameter estimation was done with the Expectation-Maximization (EM) algorithm, and state sequence inference used the Viterbi algorithm.

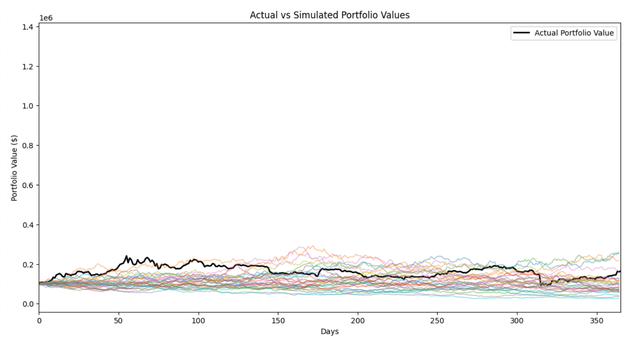


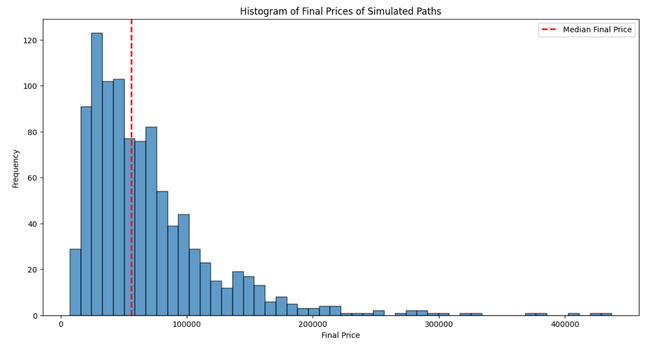
- BTC and DOGE were in a Bull Market, suggesting aggressive strategies, while ETH, PEPE, and WIF were in a Stagnant Market, favoring neutral positions. SHIB was in a Bear Market, recommending quick exits.

Using $100,000 initial capital for simulations, WIF demonstrated the best performance with a Sharpe Ratio of 0.1691, an ROI of 188.05%, and the lowest Maximum Drawdown of -28.54%. DOGE had the highest ROI of 2131.08% but was highly volatile. PEPE showed high returns with considerable risk, while BTC and ETH had moderate returns but substantial drawdowns. SHIB performed poorly with the lowest ROI and Sharpe Ratio.

Monte Carlo Intergration

Monte Carlo key steps include random variable generation, the Box-Muller transform, and price path generation. Our simulation showed that Bitcoin (BTC) and Ethereum (ETH) had stable prices with minimal risk, indicating limited growth potential. Dogecoin (DOGE) displayed potential for higher returns with moderate volatility. In contrast, PEPE and WIF exhibited poor performance and high volatility. Shiba Inu (SHIB) showed potential for growth but with notable volatility.

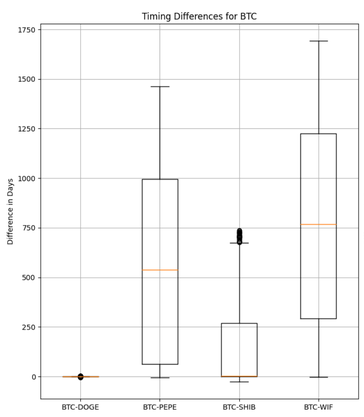


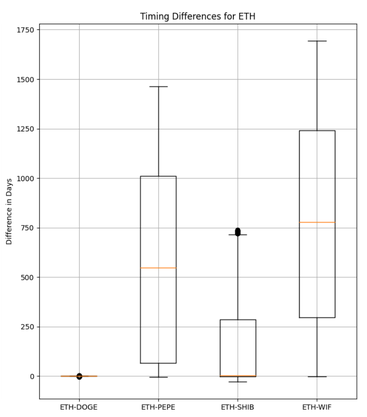


- Ethereum (ETH): Top performer with best risk-adjusted returns; solid choice for steady growth. Bitcoin (BTC): Suitable for risk-averse investors due to low risk and stable performance. Dogecoin (DOGE) and Shiba Inu (SHIB): Higher volatility, appealing to those seeking higher potential returns. PEPE and WIF: Negative expected returns and high risks; poor investment choices.
- Statistical Analysis:
  - Significant return variations among cryptocurrencies.
  - BTC underperforms compared to ETH and SHIB but outperforms PEPE and WIF.

Volumn Analysis

	Mean Difference in Days
BTC-DOGE	-0.18
BTC-PEPE	572.25
BTC-SHIB	142.55
BTC-WIF	767.06
ETH-DOGE	-0.17
ETH-PEPE	580.89
ETH-SHIB	150.55
ETH-WIF	777.09





We examined the correlation between trading volume and price reversals in major cryptocurrencies (BTC, ETH) and memecoins (DOGE, PEPE, SHIB, WIF). We identified price reversal dates and calculated the timing differences between reversals of major cryptocurrencies and memecoins. Results showed no consistent lead-lag pattern for newer memecoins (PEPE, SHIB, WIF), indicating unpredictable responses to BTC and ETH changes. However, DOGE displayed more consistent and predictable timing differences with both BTC and ETH. These findings suggest that established memecoins like DOGE are more reliable indicators of market trends than newer memecoins.

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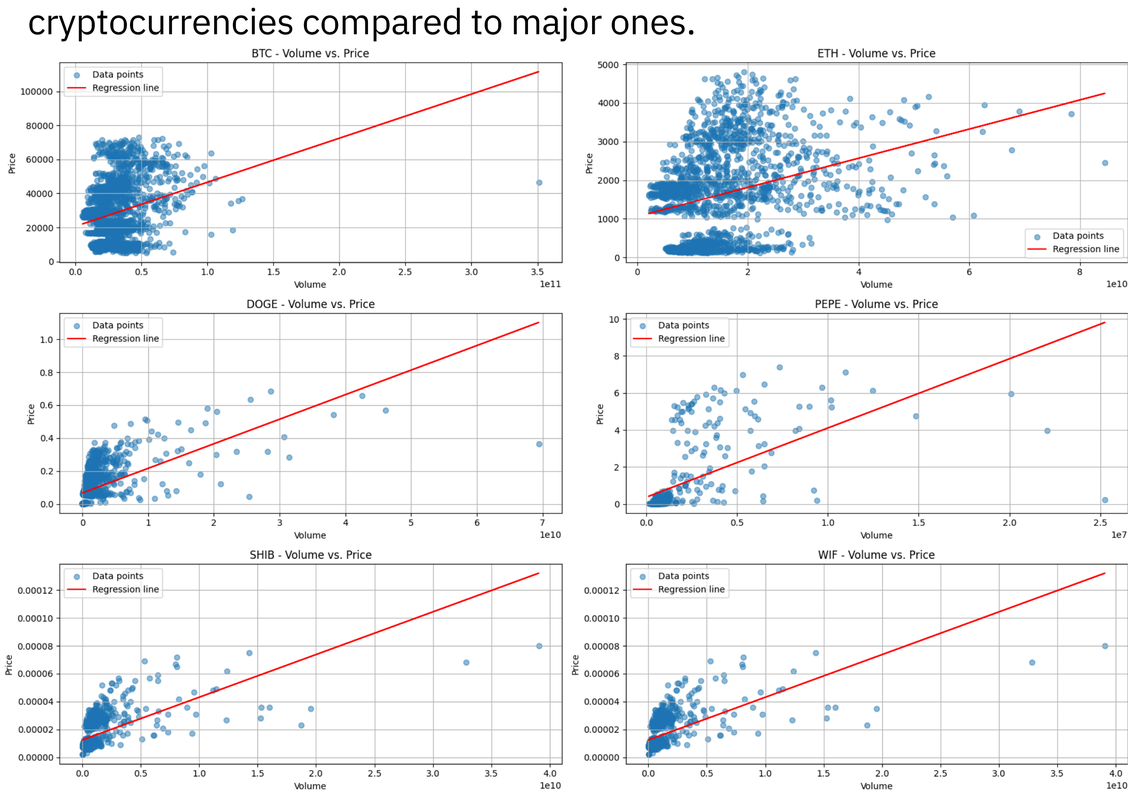
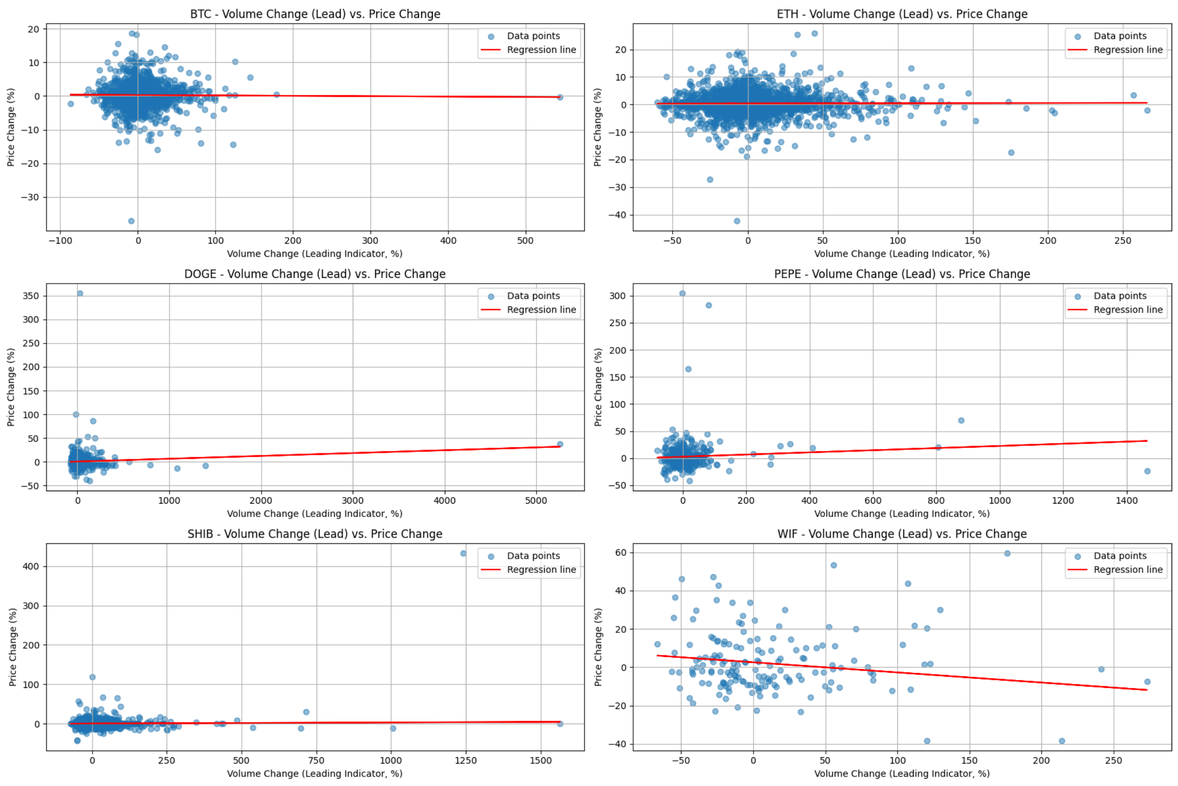
Linear Regression Analysis of Volume Predicting Price Action

- Linear Regression Analysis Results:
- Major Cryptocurrencies (BTC and ETH):
  - Low R-squared values (BTC: 0.075, ETH: 0.101)
  - Indicates weak predictive power of trading volume on price action
- Dogecoin (DOGE) and Newer Memecoins (PEPE, WIF):
  - Higher R-squared values (DOGE: 0.332, PEPE: 0.341, WIF: 0.368)
  - Suggests moderate to strong influence of trading volume on prices
- Conclusion:
- Despite some regression assumption violations, trading volume is a more significant predictor for newer and less established cryptocurrencies compared to major ones.



Linear Regression Analysis with Volume as a Leading Indicator

- Volume as Indicator: Volume does not significantly predict price changes for BTC, ETH, DOGE, WIF, SHIB, and PEPE.
- R-squared Values:
  - BTC: 0.00006
  - ETH: 0.00003
  - Indicate almost no predictive power.
- Weak Relationships:
  - DOGE and SHIB show weak correlations.
  - WIF and PEPE display no clear pattern.
- Regression Assumptions Issues:
  - Significant p-values for heteroskedasticity.
  - Violations of normality confirmed.



Conclusion

- Combined statistical modeling, technical analysis, and external factors like news headlines.
- Emphasized the need for adaptive trading strategies tailored to individual cryptocurrencies.
- Provided a strong basis for future studies and strategy development in the cryptocurrency market.

Limitation and Future Studies

- Historical data may not reflect future market conditions due to unpredictability of legislative changes and technical improvements.
- Enhance news sentiment analysis with natural language processing for immediate insights and develop hybrid models combining machine learning and technical indicators.
- Expand the dataset to include more cryptocurrencies and longer periods, and analyze various market conditions to improve risk management and trading strategy efficacy.