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Event Contract Arbitrage

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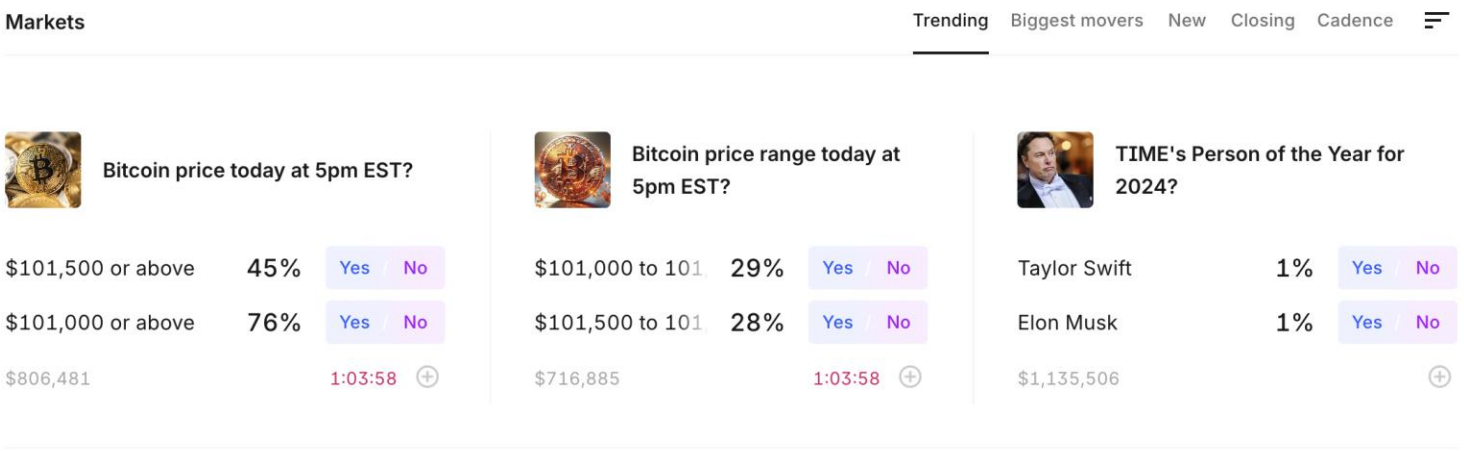
Content

I. Background
II. Strategy Overview
III. Strategy Implementation
IV. Data Collection
V. Risk-Neutral Density Construction
VI. Strategy Assumptions and Considerations
VII. Back-testing Results and Analysis
VIII. Next Steps

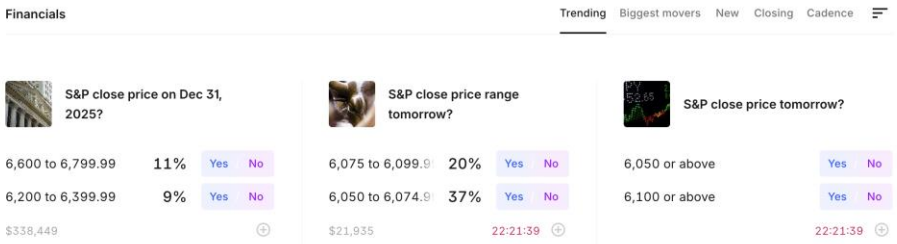
Background

- **Kalshi Exchange:** CFTC-regulated platform for trading event contracts.
- **Event Contracts:** Trade probabilities on real-world outcomes (e.g., elections, weather).
- **Binary Payoff:** Fixed payout for correct predictions.
- **Market-Based Pricing:** Contract prices reflect the crowd's prediction.
- **New Market:** Potential for price discovery and arbitrage.



Strategy Overview

- **Focus:** Statistical arbitrage on Kalshi's "S&P 500 Close Price" event contracts.
- **Event Contract Structure:** Contracts define a price range ("bucket") for the S&P 500's year-end closing price (e.g., $6,000 - $6,199.99). Payout occurs if the closing price falls within that range.
- **Arbitrage Opportunity:** The similarity between Kalshi contracts and options suggests potential for statistical arbitrage by identifying mispricing.
- **Strategy:** Exploit price discrepancies between Kalshi contracts and option market pricings to generate profit.



Strategy Implementation

- **Premise:** Assume efficient pricing in the options market and use it as a benchmark.
- **Strategy Steps:**
  - **Initialize the Pricing Mechanism:** Use option data to form a "Risk-Neutral Density" (RND).
  - **Calculate Fair Value:** Integrate the RND over the Kalshi contract's range.
  - **Exploit Discrepancies:** Compare the fair value with the market price and trade any tangible differences.

Data Collection

- **SPXW Data:** Daily end-of-day option quotes were received from Refinitiv, from the start of 2022 to 2024-11-19

- **Kalshi Data:** Daily end-of-day bid/ask data was queried from the Kalshi API, from the start of 2022 to 2024-12-07

- **Data Preparation:**

  1. SPXW contracts were filtered to match Kalshi's expirations
  2. Market-Implied Terms (Discount Factor, Forward Price, etc..) were calculated for each day using Least-Squares
  3. Illiquid Quotes were removed

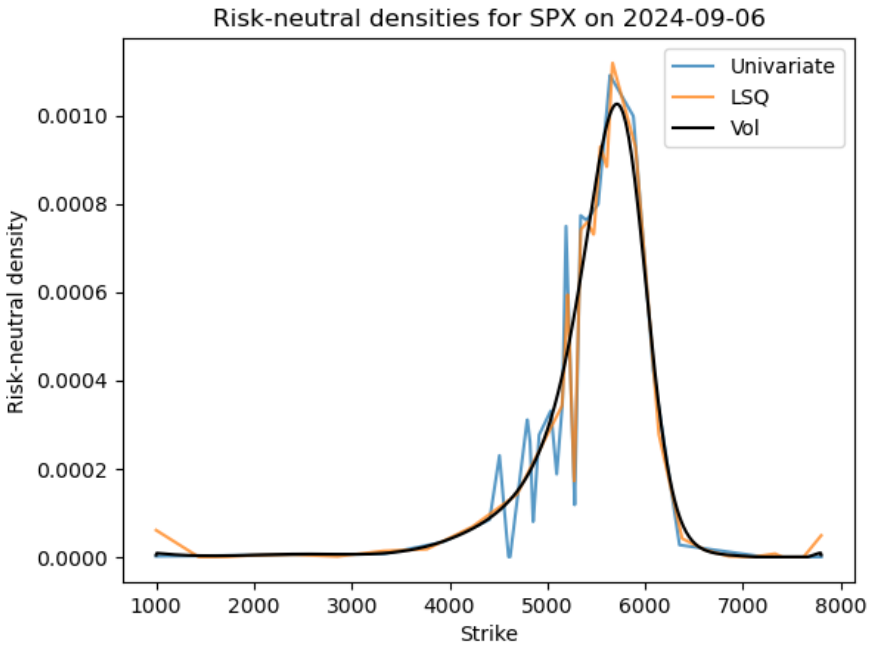
Risk Neutral Density Construction

1. The RND was constructed using the Breeden-Litzenberger formula:

$$f_{S_T}(K) = e^{rT} \frac{\partial C}{\partial K^2}(S, K)$$

Construction Steps:

1. Interpolate implied volatility surface
2. Created a dense call price surface using BS
3. Differentiate twice and normalize

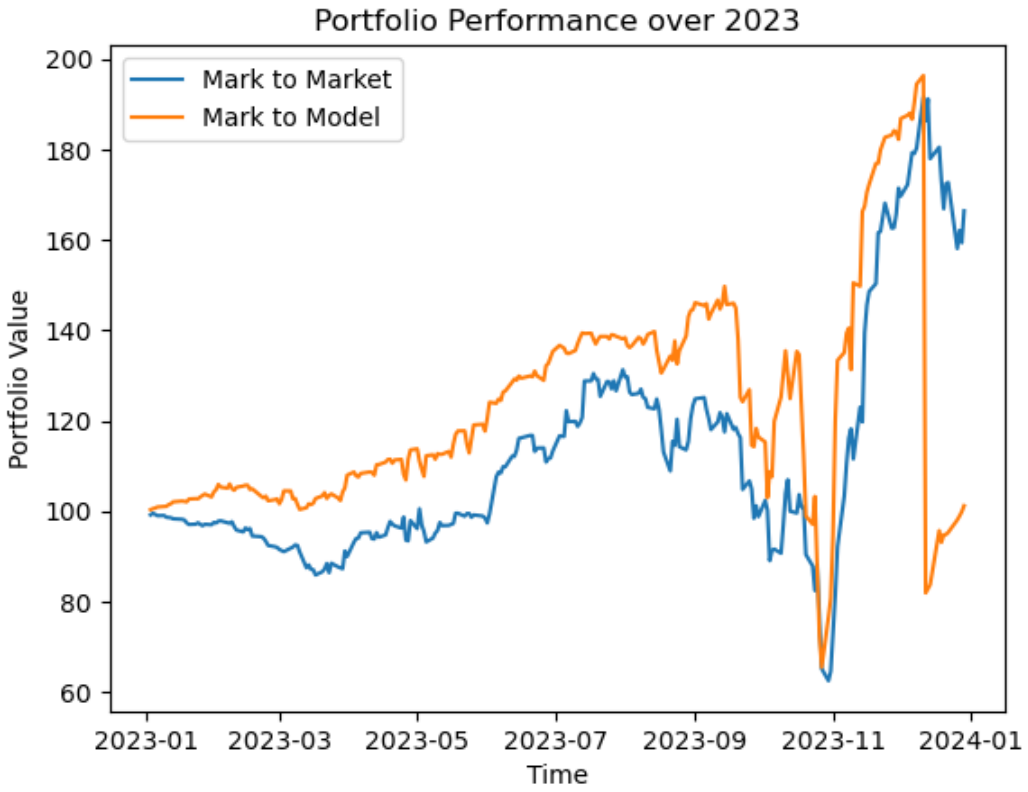


Strategy Considerations

1. **Low Liquidity on Kalshi:**
    1. Only place orders of one lot (guaranteed to fill)
    2. Mark-to-market shows last available closing price

2. **Exchange Rules:**
    1. Kalshi's market hours extend past 4pm
    2. A constant fee of 1 cent is added per contract
    3. Mark-to-market considers liquidation value with fees
    4. Did not include Kalshi's 3.95% APY, accrued monthly
        - Acts on cash **and** open contracts

Back-testing Results

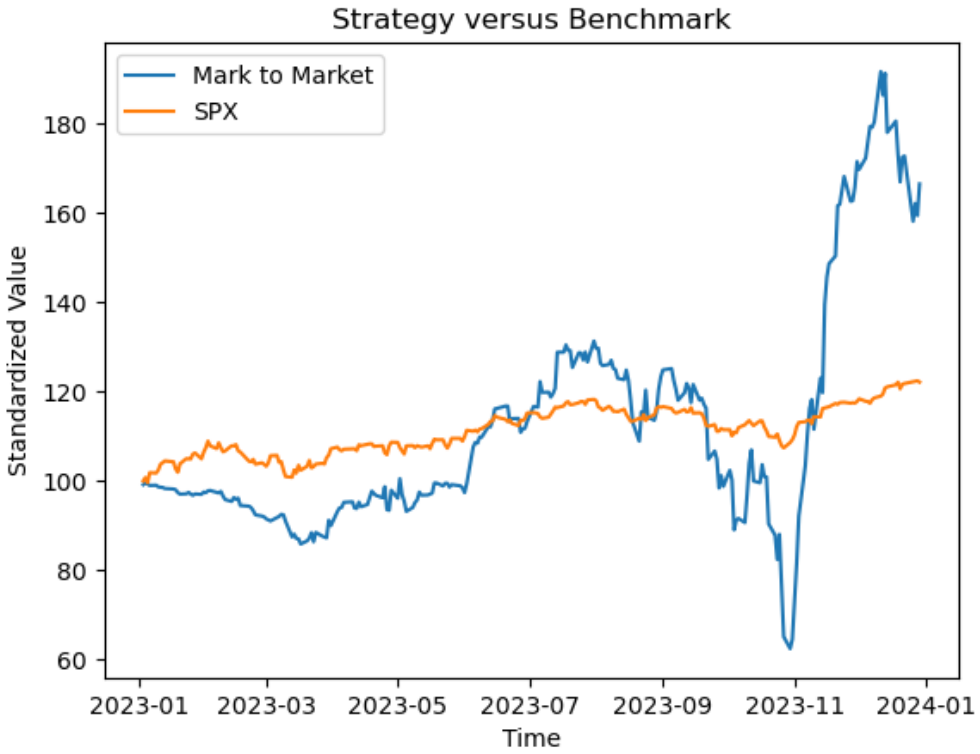


Metric	Value
Annualized Return	68.2%
Sharpe Ratio	1.143
Number of Trades	987

Note: 2023 was used, as we ran into issues with liquidity/volume in 2022 and 2024

Back-testing Analysis

Our strategy shows outperformance of the benchmark, at the cost of higher drawdowns and volatility.

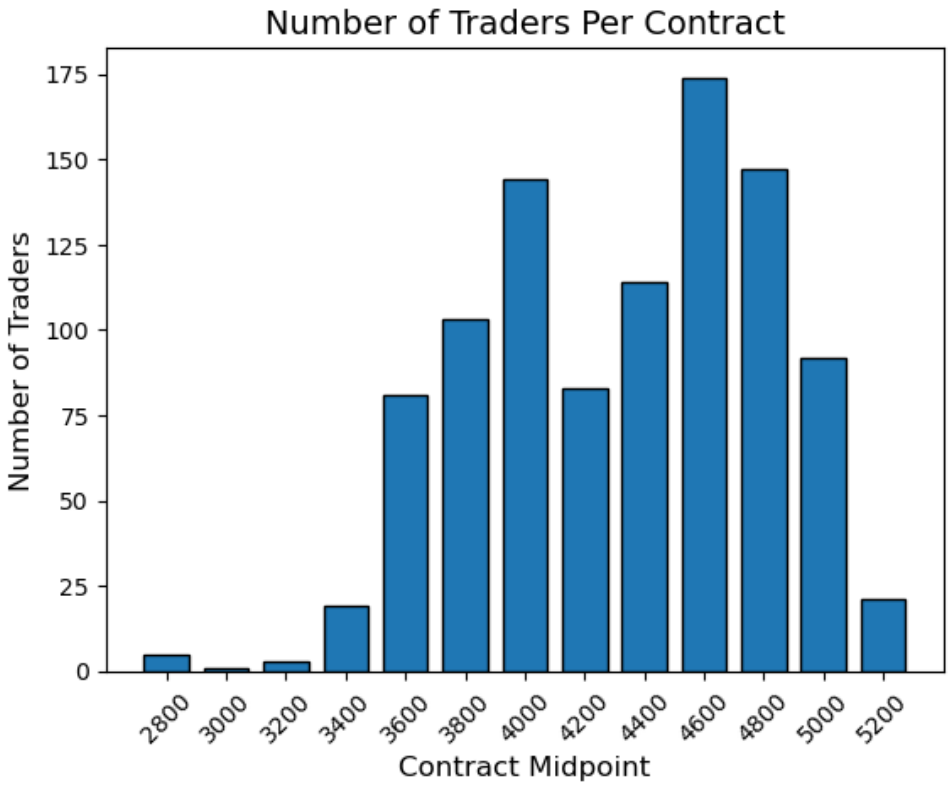


Portfolio	Sharpe	Drawdown
Strategy	1.143	-52.3%
SPX	1.458	-10.3%

Back-testing Analysis

We can also observe the trades placed per contract

1. Low number of trades in illiquid contracts
2. Most trades around ATM price level



Next Steps

1. **Refine RND:** Although the RND is created on option prices, there are many free parameters that can be optimized

2. **Test over 2022:** The lack of liquidity means our strategy struggles to mark these trades correctly and enter/exit positions effectively

3. **Match Trade Size:** Kalshi data may include bid/ask sizing, allowing us to take larger positions

4. **Implement Alternate Payoff Structures:** Kalshi offers ‘call-like’ binary contracts that are not included in our strategy (e.g. SPX price at end of year is $5800+)

5. **Integrate Kalshi's APY:** 3.95% accrued monthly on cash that is locked into contracts can provide a leveraged risk-free return that can balance our strategy's volatility.

6. **Consider Limit Orders:** Limit orders on Kalshi do not pay any transaction fees, and can mitigate execution at unwanted prices during volatile moves

7. **Explore Alternative Contracts:** Kalshi offers similar contracts for Bitcoin (for which we can use BTCO options), Crude Oil (WTI Index) and more. They also offer daily/weekly contracts instead of just yearly, which can provide more dynamic buckets with higher liquidity and volume.