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Kalshi Event Contracts

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Interest & Relevance

Event Contract Markets

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Event Contract Markets Dynamics & Predictions

- Recent legalization of event betting and election betting in the US lead to various betting websites:
  - E.g., Kalshi, Polymarket, Deriv, IQ Option
  - 2024 Election cycle introduces immediate implied probability of various elections that are displayed on the various exchanges
- Event Contracts function similarly to other derivatives products:
  - *"YES and NO contracts always come in pairs. If you would like to invest in a market, Kalshi will match you with another user on the platform looking for the opposite contract on the same market. One of you will receive a YES contract, the other will receive a NO contract, and in return, the two of you will pay a total of $1." (What Are Event Contracts, Kalshi)*
- What other features and quirks can the team explore with regards to market efficiency, pricing, etc.?

Could Political Betting Swing the US Election?

Prediction markets have been around for hundreds of years, but their ability to change reality is increasing.

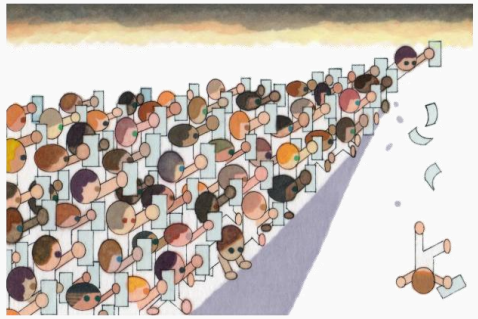

Illustration: Saehan Parc for Bloomberg

Political Betting Markets See Vindication in Trump Victory

Prediction markets, which surged to prominence during the presidential campaign, started reflecting a likely Trump win several weeks ago, even as opinion polls showed a tight race.

Share full article

The average odds from five political betting markets showed Donald Trump with better-than-a-coin-flip odds heading into Election Day. Isadora Kosofsky for The New York Times

Exclusive: Prediction market Kalshi launches crypto deposits as Trump maintains big lead on betting sites

BY LEO SCHWARTZ
October 28, 2024 at 12:49 PM EDT

BUSINESS

Kalshi's daring bet on election betting is paying off — to the tune of $100 million

By Lydia Moynihan
Published Oct. 31, 2024, 6:00 a.m. ET

45 Comments

Previous Semester's Work

Contract Markets & Starting Point this Semester

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Overview of event contract lifecycle

Kalshi used as the exchange to trade as it has a friendly/usable API & with heightened volume compared to other platforms within the event contract market

1. Market Listing & Ideation

"Kalshi members are able to suggest new markets… Before a new market is approved for trading, it undergoes review through the Kalshi team and the Commodity Futures Trading Commission (CFTC)… [then] the market is searchable on Kalshi"

2. Market Open

Trading begins, ability to buy and sell positions across various contracts with binary outcomes: e.g., the "Highest temperature in Chicago today" gives, 'yes' & 'no' contracts across various discrete temperature ranges

3. Market Closure

"Trading ends for the market… trading continues until the market's predetermined close date… the 'Student debt forgiveness' market with a latest possible closure datetime of 12-31-2024 at 10:00 am and a latest possible resolution time 5 hours later; if student loans are forgiven on 09-14-2023, the market closes the next day at 10:00 am and resolves 5 hours after that."

4. Market Resolution or determination

"Winners are determined based on predefined contract criteria… data [received] from the source agency [used] to verify the outcome of the market, as defined in the market contract"

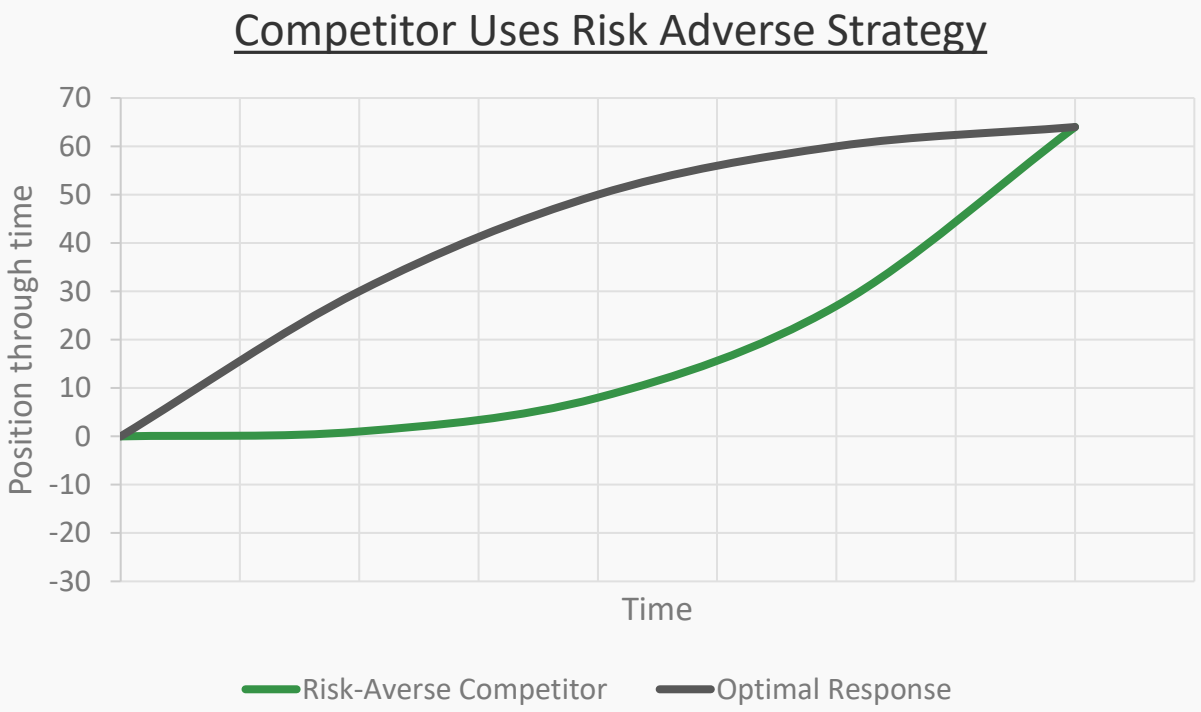
5. Market Settlement

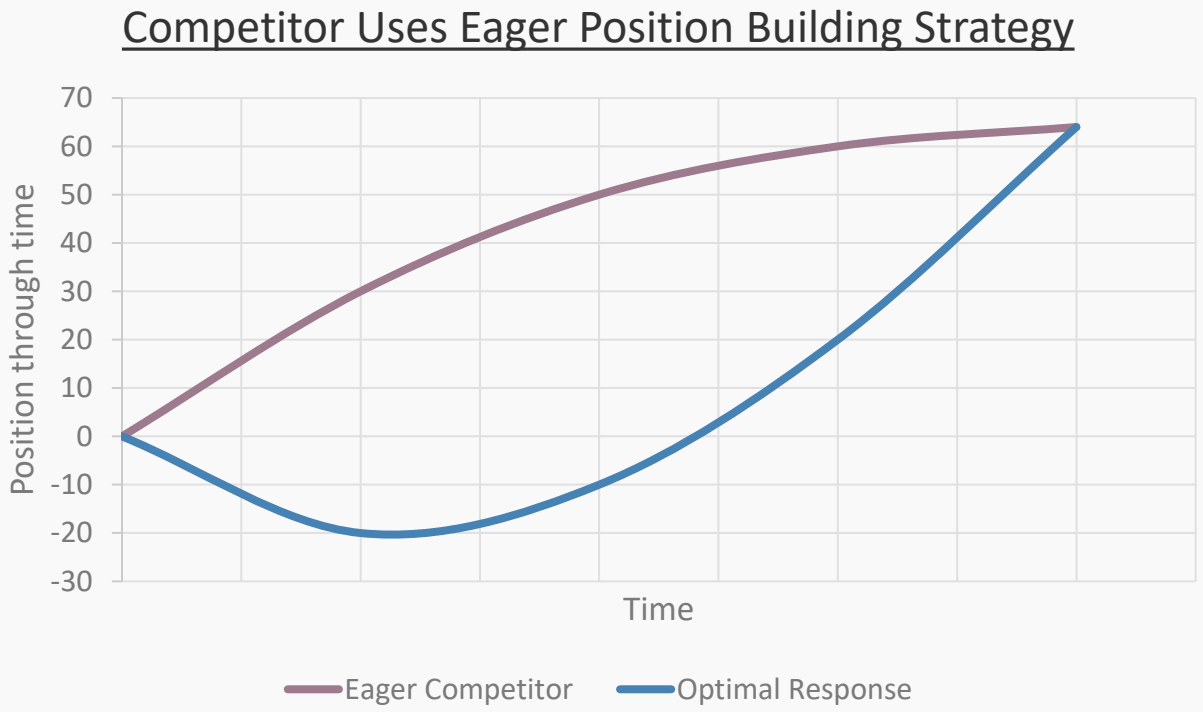
"Few hours after the market result is determined, based on the predetermined source, market settlement occurs; members receive $1 for each correct contract they are holding at expiration…typically happens three hours after market resolution but can sometimes be longer

What is the Market Life Cycle, Kalshi

Position Building Strategies in Competition

"Optimal position-building strategies in competition" (Chriss, 2024)





$$2\ddot{a} + \lambda\ddot{b} + \kappa\dot{a} + \lambda\kappa\dot{b} - \kappa\dot{a} \xRightarrow[Euler-LaGrange]{} \ddot{a} = -\frac{\lambda}{2}(\ddot{b} + \kappa\dot{b})$$

Implementation Process & Roadmap

We know that information releases closer to expiration have an increased price impact, thus a market-making strategy can leverage individuals who enter the market with an aggressive buying strategy

Completed: EOY - 2024

1 Understanding & Data Gathering

- Developed understanding and downfalls of various platforms, e.g. transaction costs, API usage requirements, etc.
  - Kalshi chosen as default platform
- Aggregated historic data collection method and convert to candlestick data

2 Investment Ideation & Selection

- Selected and blended three white-papers to develop market making strategy to apply on Kalshi
- Identified implementation hurdles and began preliminary development of white-paper strategy development

Implementation: 1H - 2025

3 Creation & Strategy Refinement

- Implementation Items:
  - Refine volume indicator to approximate peak volume window
  - Define Market implied probability from listing to expiration
  - Create adverse selection model
- Refinement and studies

4 Paper Trading

- Create method to record and implement paper trading
- Select potential benchmark to monitor performance of market making strategy
- Record results and determine scalability of strategy

Research Topic Pivot To Weather Event Contracts

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Political Event Contract Difficulties

- Pros:
  - Socially relevant
  - Sampling methods and applications
- Cons:
  - Non-established
  - Very limited data
  - Data available is subject to sampling methods and bias concerns
  - Data have long release cycles
  - Strategy application remained unclear (front-running is very possible in illiquid markets)

Weather Contracts

- Pros:
  - Frequent (daily+) and semi-structured discrete data
  - Applicable and well-defined models
  - Weather markets (incl. event markets) are established
  - Free & paid services
- Cons
  - Interesting, but somewhat mundane
  - Free services may have unforeseen issues/quirks
  - Historical forecast data limited but possible to get

Literature Review

Diving into the papers that inspired the project

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Binning & Weather Forecasting

Reliable Probabilistic Quantitative Precipitation Forecasts from a Short-Range Ensemble Forecasting System, (Stensrud & Yussouf, 2007) & A Temperature Binning Approach For Multi-Sector Climate Impact Analysis, (Sarofim et al, 2021)

Range	Historical Correction Value
0.00 – 0.10	##%
0.10 – 0.20	##%
0.20 – 0.30	##%
0.30 – 0.40	##%
0.40 – 0.50	##%
…	…
0.90 – 1.00	##%

- The use of binning from a reputable data helps reduce the impact of minor observation variations, smoothing the data, decreases outliers, improves analysis, and scales with the quality of data.
- Binning has a clear application to weather forecasting

Implementation Strategy

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Understanding Weather Reporting

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Percentage of Precipitation (PoP) = (% of Area Affected) * (Forecaster Certainty)

General Strategy Process

Kalshi Contract: "Will it rain in NYC today"

Data Gathering
- Kalshi Data
- National Weather Service Data

Model Assembly
- Not pursued: Creation of weather model based on humidity, cloud cover, wind, pressure

Historic Data Adjustment
- Binning

Trading
- Signal deployment, execution strategy & paper trading

Back-Testing
- Model Accuracy: Brier Score
- Position Building: return & risk associated with strategy

Data Gathering

- Kalshi
  - Despite having an API, Kalshi API & API documentation have existing gaps
    - Documentation at times appeared to be misleading and unclear
    - Data is present but difficult to parse, scrapping these data is not an option to go around this
  - Hurdles around closed contracts and current data storage
    - Different processes around gathering closed event/contract data versus accessing open event/contract data (ex. ask/bid prices by minute)

- NWS: Weather Stations & Weather Event Reporting
  - Weather Stations Quirks:
    - NWS data is disbursed through radio messages:
      - *".TUESDAY...Partly sunny in the morning, then mostly cloudy with a chance of rain in the afternoon. Highs in the upper 50s.Southeast winds 10 to 15 mph. Chance of rain 30 percent. .TUESDAY NIGHT...Rain. Lows in the upper 40s. East winds around10 mph with gusts up to 20 mph. Chance of rain 90 percent. .WEDNESDAY...Rain. Highs in the mid 50s. East winds 10 to 15 mph with gusts up to 25 mph. Chance of rain 90 percent."*
    - Broken up by region (KOKX is New York City):
      - Made up of weather reporting stations that list out specific reports throughout the day
      - One zone hub that produces forecasts for the region
      - Follows ICAO Station Identifiers
  - Data Quirks:
    - Real Life Decisions:
      - Stations can go offline, move, change reporting names, report on behalf of other stations…

Historical Correction

After the historical data is put together binning process begins; the historical correction is put onto the paper trade period to correct the values

- Due to the data structure of the weather reports and forecast reports, there are some time correction that needs to be done when processing the data
- Process:
  1. Aggregate weather reports & forecast reports
  2. Scrape for the date & time-period forecast
  3. Account for anomalies
  4. Combine weather forecast & weather station report
  5. Bin forecast for the historic period
  6. Apply binning to the trading period

Range	Historical Correction
0.00 – 0.10	##%
0.10 – 0.20	##%
0.20 – 0.30	##%
0.30 – 0.40	##%
0.40 – 0.50	##%
…	…
0.90 – 1.00	##%

Market Execution

Project focus on long yes or no contracts, although clear application to sell contracts through Kalshi's market maker program

- Pull down the Kalshi yes ask and no ask for the NYC rain contract, the team checked against the historic correction probability and the probability compliment
  - –To account for the lower liquidity in the NYC rain contract market if the difference between the ask price and the historic correction probability is meaningful then we either buy a yes or no contract
- The NYC rain contract has relatively low daily volume ($10,000 - $100), despite the life of the contract has $1,157,576 through the contract life-time[1]
- Due to low volumes in this contract, there are high opportunities to find alpha (even through opportunistic trades) even during the final day, consideration to the order book needed
  - –If market deems that there is high certainty in an outcome thus low order book depth & trades not possible
- Our team realizes that there are further opportunities for execution allocation and placement though at this point, model development and function is a priority – further refinement to occur at a later point in time

1. As of 5/8/2025, the contract has existed since Sept 8,2021

Results

Back Test Results, Model Success, and Future Considerations

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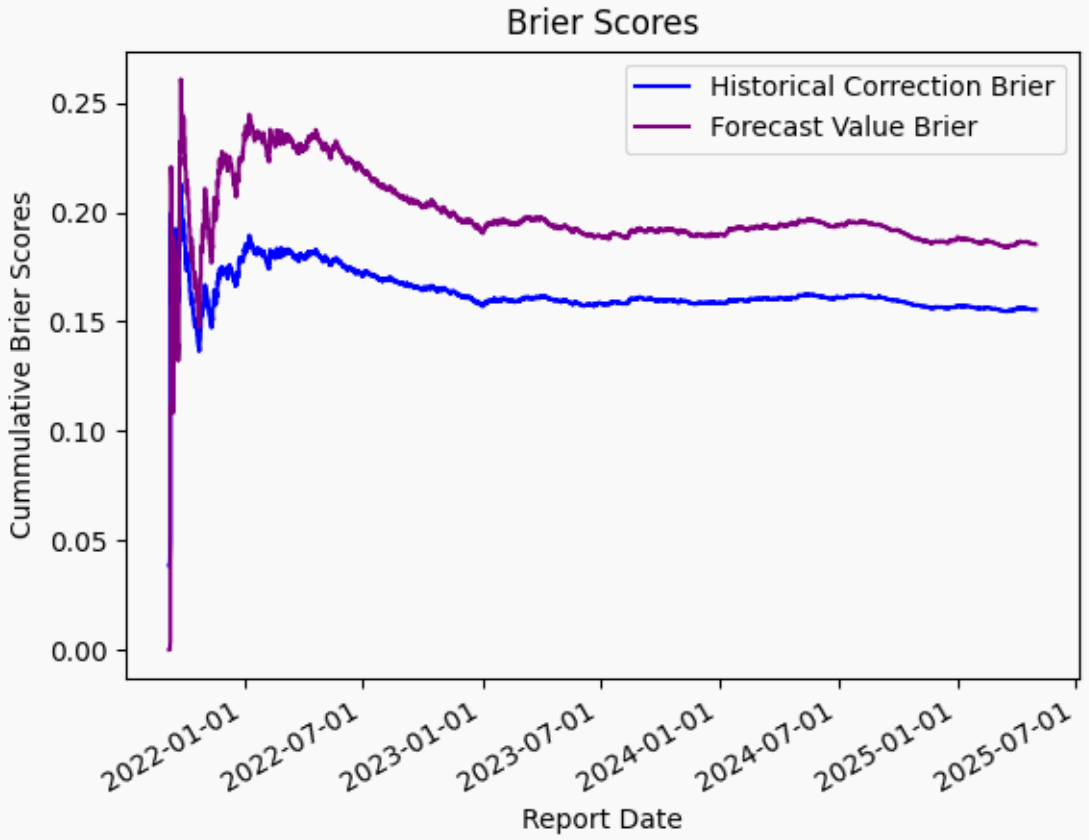
Model Strength – Cumulative

Brier Score[1] $= \frac{1}{N}\sum_{t=1}^{N}(f_t - o_t)^2$: f_t *is probability of that forecast,* o_t *is the actual binary outcome*



1. There are other possibilities to slice the data by individual bin, and by period

Return & Risk Results

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Known Issues, Project Optimization & Hurdles Through Process

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The project allowed for insight into the intersection between meteorology and finance – much learned about weather reporting despite headaches involved

- Ideally this strategy would be optimized:
  - –Data:
    - ○Structured forecast data (tomorrow.io)
    - ○Application to other markets
    - ○Scrape directly from NWS website, not third party
  - –Model & Historic Data Correction
    - ○Have some form of weather model to inform likelihood of weather and feed into historical correction
    - ○Rolling window for binning
    - ○Bayesian Inference
  - –Trading & Execution
    - ○Account for lower volume, threshold testing
    - ○Portfolio building process
  - –Back-testing
    - ○Order-size considerations (implementation of confidence of outcomes)
    - ○Risk profile
    - ○Accounting for slippage (given possible contract size considerations)
    - ○Market entry (Limit vs market)

Q&A

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