Judgment and Decision Making Biases in Prediction Markets

Mac Strelioff, Ryan Stokes, Michael Lee
University of California, Irvine

Abstract
Prediction markets are a popular tool for forecasting financial and geopolitical events, such as political elections. Market participants trade contracts with payouts determined by future events. Theoretically, the market price should equate to the probability of the underlying event. However, probabilistic judgments often violate laws of probability, and gambling behavior often violates assumptions of risk neutrality. Using data from an online prediction market, we provide evidence of deviations from rational pricing in terms of brief violations of the laws of probability theory and extended price misallocation consistent with utility functions described by prospect theory.

Background

Prediction Markets:
- Market
  - Which party will win the 2020 U.S. presidential election?
  - Contracts
    - Democratic
    - Republican
    - Libertarian
    - Green
  - Last Yes Price
    - (implied probability)
  - Trade prices
    - (aggregate individual beliefs)
- Contracts pay $1 to the winning side (yes or no)
- Expected value of a contract is the probability of the event
- If the contract price is lower (higher) than that probability, participants should buy (sell) units of the contract until the price matches the probability of the underlying event
- Prediction markets can be more accurate than forecasts based on economic models or polling data (e.g., Rothschild, 2009)

Research Questions
1. Do individual-level fallacies appear in prediction markets?
   - Several individual-level violations of probabilistic reasoning have been documented
   - Similar fallacies would be surprising here because prices are derived from the aggregated behavior of incentivized market participants
2. Do market prices reflect individual-level mispricing of gambles?
   - Individuals tend to overestimate the probability of low probability events and underestimate the likelihood of high probability events (Tversky & Kahneman, 1992)
   - This bias could manifest in prediction markets as an overpricing of low probability events and underpricing of high probability events

Data
- The dataset, obtained from PredictIt.org, consisted of all transactions within 1,552 resolved markets which included 5,323 contracts in total

Individual-Level Fallacies

Conjunction Fallacy:
The conjunction fallacy occurs when a set of events (e.g., feminist and bank teller) is judged to be more likely than one of its constituent events (e.g., feminist).

Disjunction Fallacy:
The disjunction fallacy occurs when an individual event (e.g., "windy weather") is judged to be more likely than a disjunct (e.g., "windy or rainy weather").

Market Disjunction Fallacy
In market prices, a disjunction fallacy occurs whenever the sum of contract prices within a market exceeds $1, which implies that the probability of the union of these events exceeds 1.

Market Calibration

Parametric:
- \( p_{ij} \): Price of contract \( i \) on day \( t \)
- \( \omega_i \): Outcome, yes=1, no=0
- \( \phi_{ij} \): Latent ‘yes’ probability, \( p(yes) \)
- \( \beta_i \): Sensitivity
- \( \delta_i \): Bias

Nonparametric:
- Markets were binned by trading price within a window of 10 cents (y-axis) each day before expiration (x-axis) to estimate the proportion of markets at each price that resolve ‘yes’ (color axis)
- A calibrated market would show horizontal colored stripes that match the color bar. Any misalignment between the heatmap and color bar represents misallocation

Implications:
- This prediction market overprices low probability events and underprices high probability events, particularly near expiration
- Near expiration markets have higher volume, and the empirical probabilities are more knowable, which mirror the lab conditions that elicit similar patterns in subjective probability misallocation

Contact
Mac Strelioff
mstrello@uci.edu
Ryan Stokes
stokes@uci.edu
Michael Lee
mdlee@uci.edu

References
3. PredictIt.org