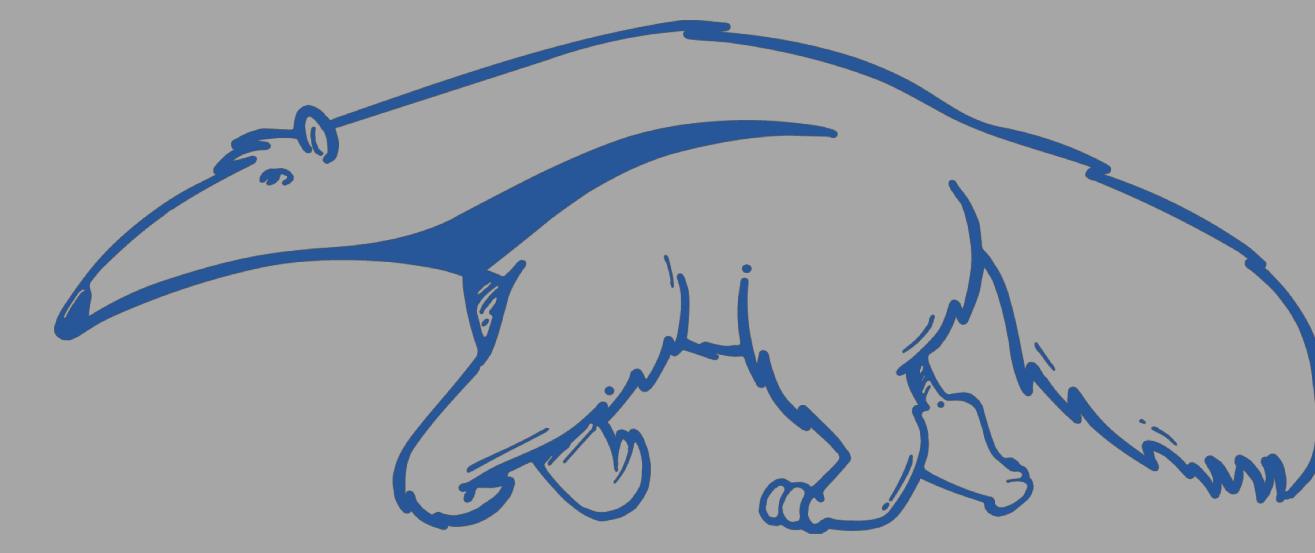


Judgment and Decision Making Biases in Prediction Markets



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



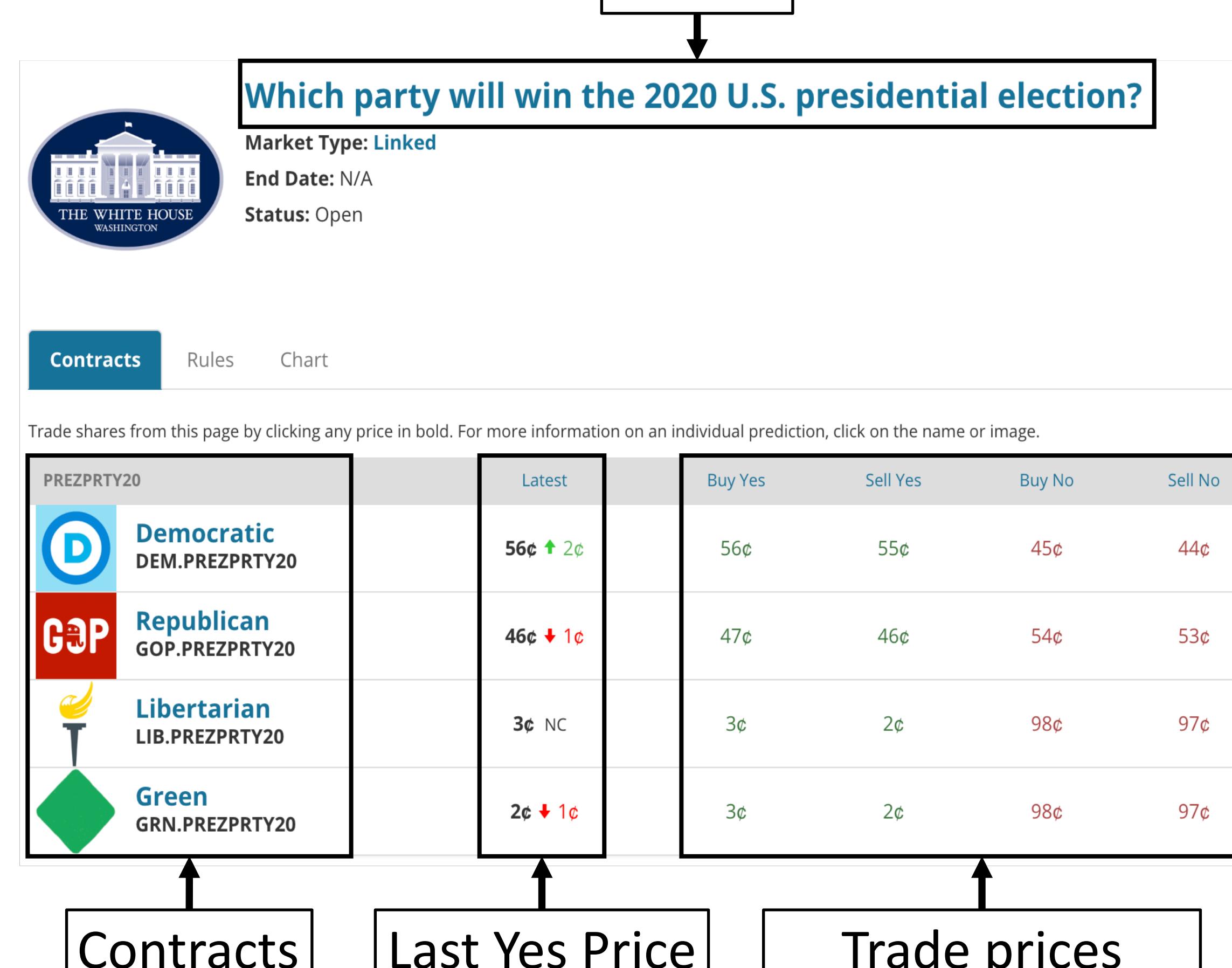
Abstract

Prediction markets are a popular tool for forecasting financial and geopolitical events, such as political elections. Market participants trade contracts with payoffs 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 miscalibration consistent with utility functions described by prospect theory.

Background

Prediction Markets:

Market



- 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 market prices?

- 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

Dataset:

- 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:

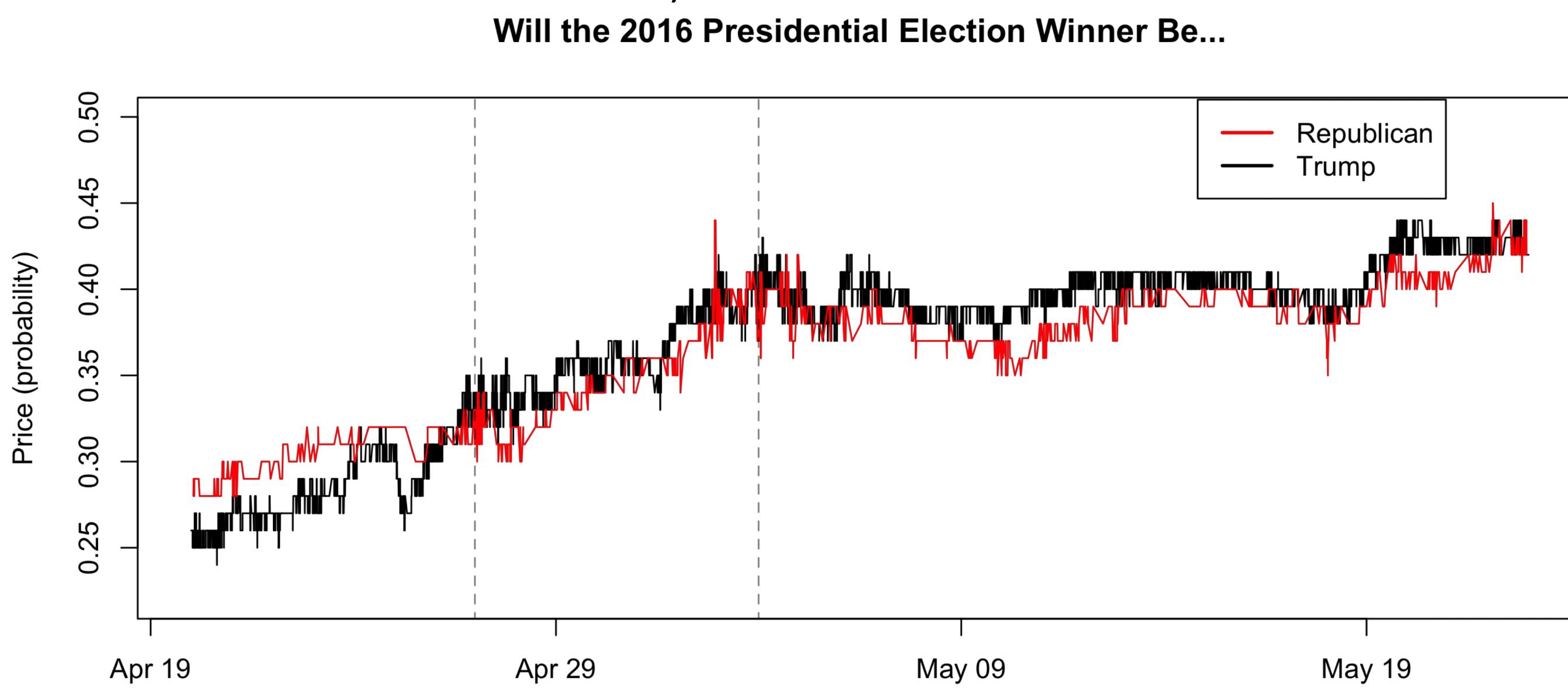
The conjunction fallacy occurs when a set of events (e.g., feminist and bank teller) is judged to be more likely than one of its constituent events (e.g., feminist).

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").

Contract Conjunction Fallacy

In market prices, a conjunction fallacy occurs whenever the contract price for an individual event (e.g., "Donald Trump will win the 2016 Presidential Election") is greater than that of a contract that is a conjunction of that individual contract with other events (e.g., "A Republican will win the 2016 election").

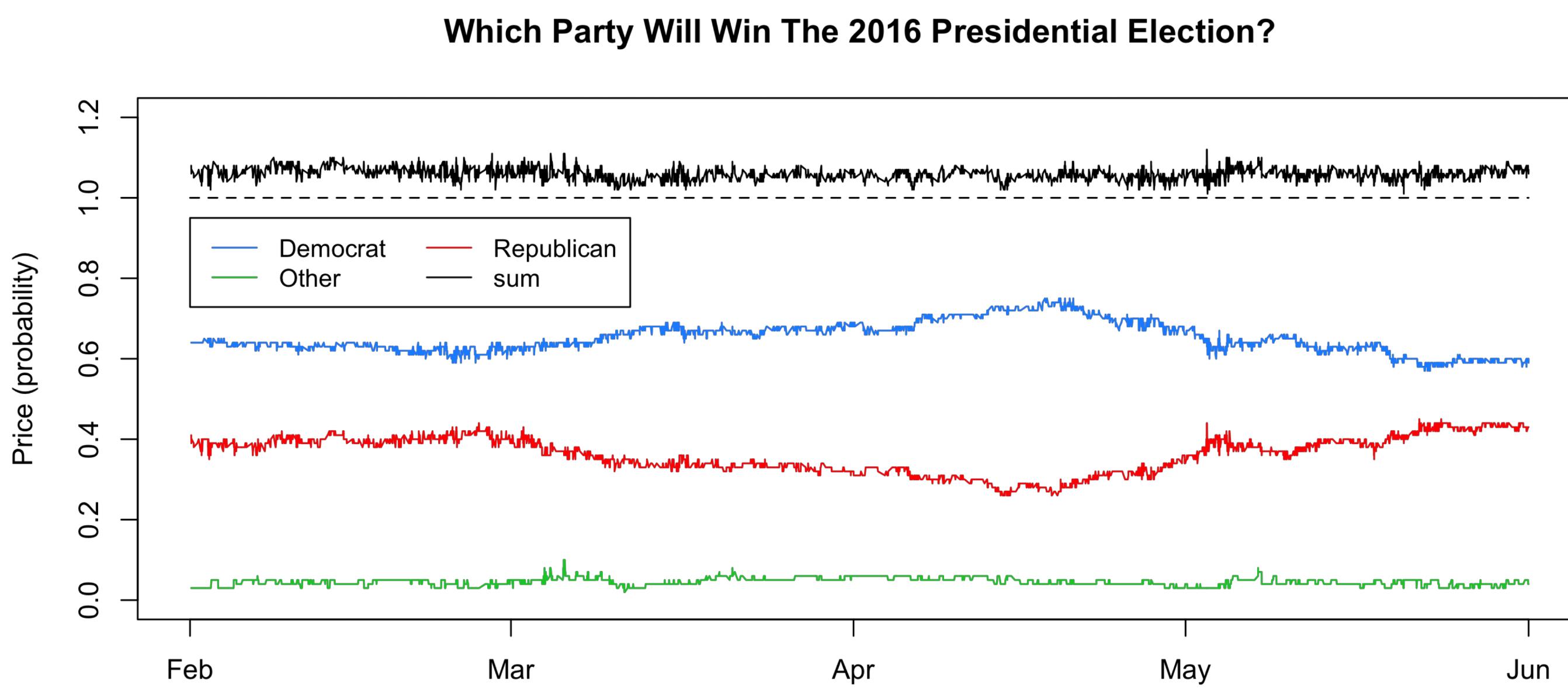


Implications:

- Carlson & Yates (1989) attribute the conjunction fallacy to a misinterpretation of the marginal event (A) as the conjunct (A&~B), this wouldn't apply in the prediction market case because marginal events (contracts) are clearly defined as not being conjuncts of this kind (e.g., Hillary clearly is also a democrat)
- These mispricings may be based on an availability heuristic that is eventually corrected by market forces. For example, when an event happens that increases the probability of Trump winning the election, the more specific "Trump" is more accessible than the conceptual class of which he is a member, "Republican"

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.



- These mispricings are rarely large enough to ensure a guaranteed profit after accounting for contract price spreads and platform fees
- Fees may bias probability estimates and undermine the validity of implied probabilities

Implications:

- Market disjunction fallacy might arise from a bias toward affirmative 'yes' shares over counterfactual 'no' shares on the complementary event. This might reflect a general bias in availability of the affirmation of an event relative to the negation of its complement

Market Calibration

Parametric:

$p_{i,t}$: Price of contract i on day t

ω_i : Outcome, yes:1, no:0

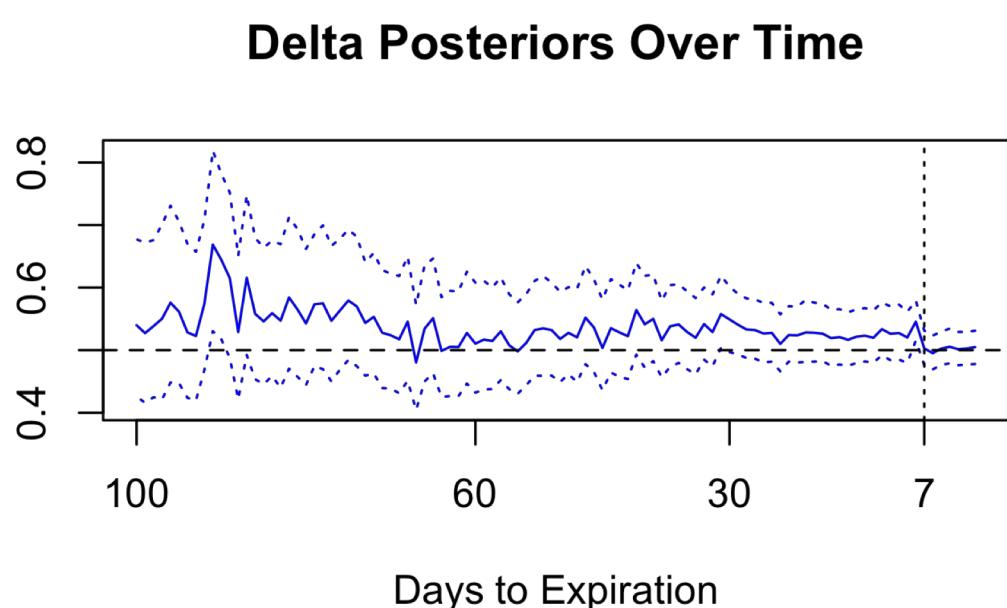
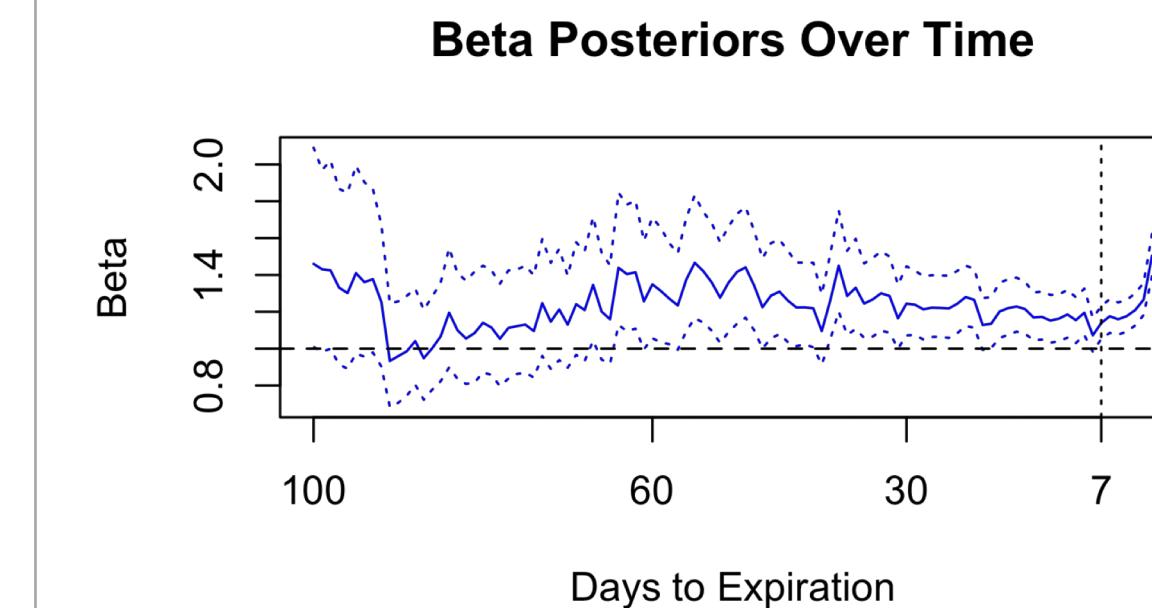
$\phi_{i,t}$: Latent 'yes' probability, $p(yes)$

β_t : Sensitivity

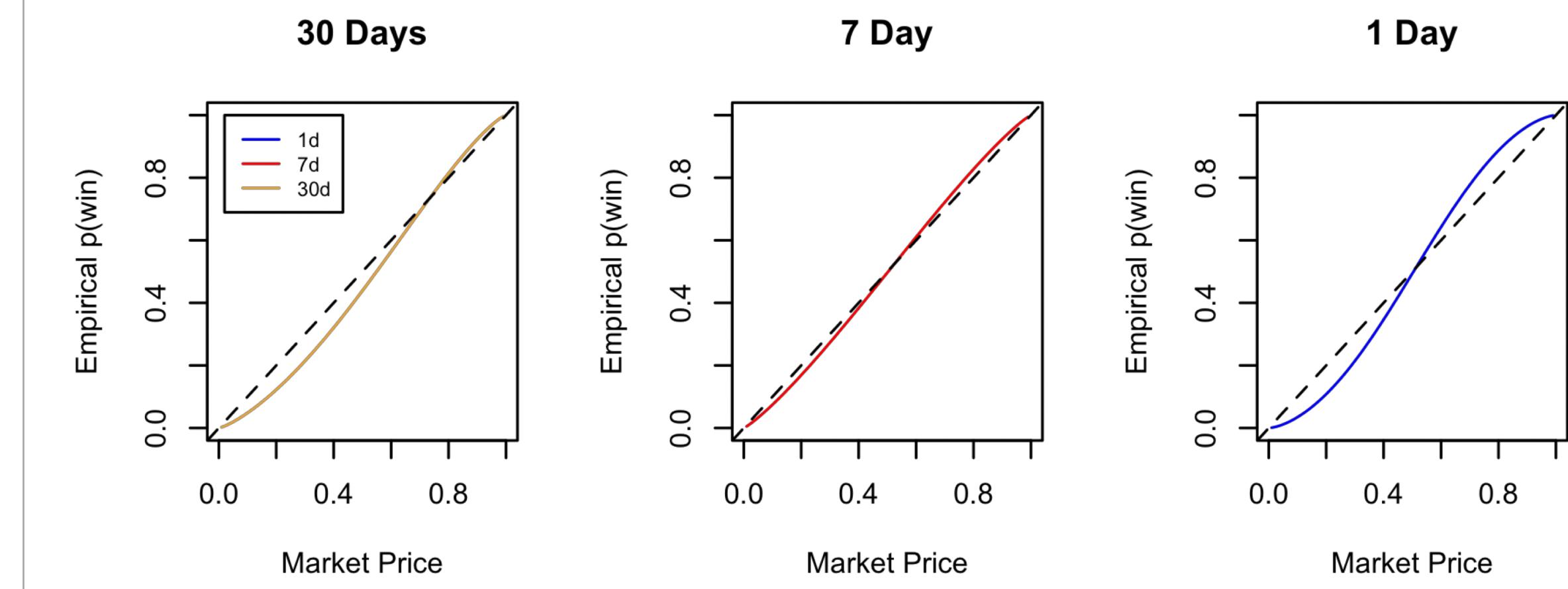
δ_t : Bias

$\omega_i \sim Bernoulli(\phi_i)$

$$\phi_{i,t} = \frac{1}{1 + e^{-\beta_t(\log \frac{p_{i,t}}{1-p_{i,t}} - \log \frac{\delta_t}{1-\delta_t})}}$$



- Sensitivity increases as expiration approaches
- Slight positive bias corrects with more volume close to expiration



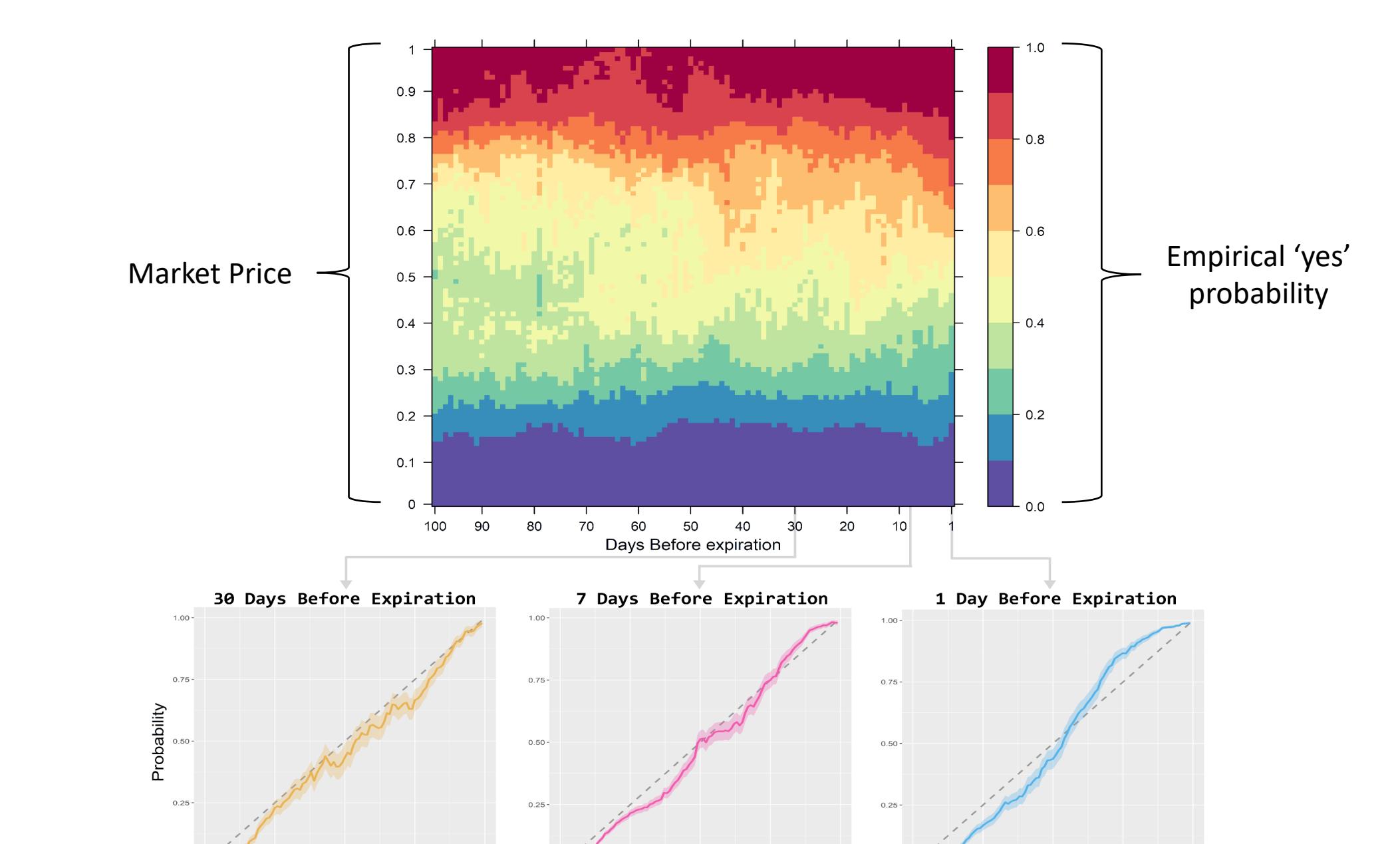
- Typical mispricing patterns emerge near expiration

Limitations:

- Non-independent markets and contract prices
- Structural relationships between contracts within markets

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 miscalibration



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 miscalibration

Contact

Mac Strelloff
mstrello@uci.edu

Ryan Stokes
stokesr@uci.edu

Michael Lee
mdlee@uci.edu

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