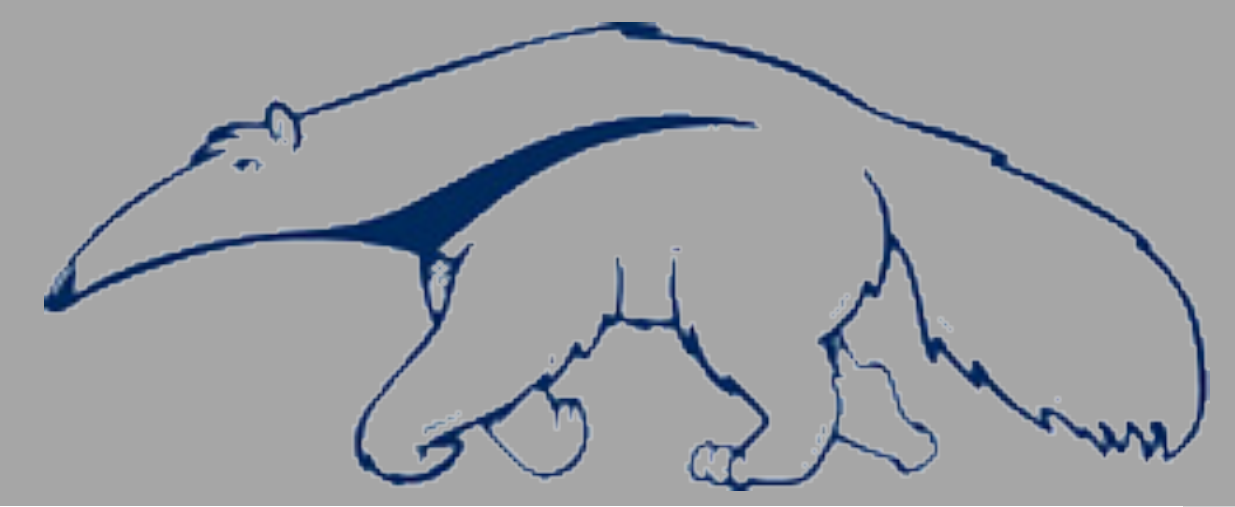


The Irrationality of Political Prediction Market Prices

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Background

Prediction markets are a relatively new tool for forecasting the outcomes of paramount events such as political elections or movements in financial markets. Participants in prediction markets buy or sell contracts with payoffs that depend on the occurrence of a future event. The price of these contracts is determined by the market of buyers and sellers. Rational decision theory asserts that, if market participants are rational agents, then the price of a contract should reflect the probability of the underlying event. Indeed, prior research has found that forecasts based on prediction markets can outperform forecasts based on economic models or polling data (e.g. Rothschild, 2009). However, individual probabilistic reasoning often violates assumptions of rationality. Specifically, individuals tend to overestimate the likelihood of low probability events and underestimate the likelihood of high probability events (Tversky & Kahneman, 1992). Such a bias would manifest in prediction markets as a systematic overpricing of low probability events and underpricing of high probability events. Here we investigate such mispricing in the market, as well as other sources of mispricing, across time relative to market expiration, and discuss implications for the accuracy of forecasts based on prediction market data.

Data

Explanation of the Dataset:

- The dataset, obtained from PredictIt.org, consisted of all transactions within 1,552 resolved markets. These included 5,323 binary events (e.g. “Will Greece pass a referendum on proposed bailout terms by July 6th, 2015?”).
- We categorized these markets as follows:
 - Election markets, e.g. “Who will win the US presidential election?”
 - Polling markets, e.g. “Will Trump’s approval rating be above 35% on July 31st?”
 - Event markets, e.g. “Will North Korea have a successful nuclear missile test by July 31st?”
 - Others, e.g. “How many totally false statements will Trump make in August?”

Non-Parametric Findings:

- Markets were compared with one another relative to their date of expiration
- For each day before expiration, markets were binned by their trading price using a moving window of 10 cents.
 - For example, markets trading at 20 cents included all markets between 15 and 25 cents. At 21 cents all markets between 16 and 26 were used.
- Each binned price was then compared to the proportion of markets in that bin which resolved as yes (Figure 1)

Market Calibration

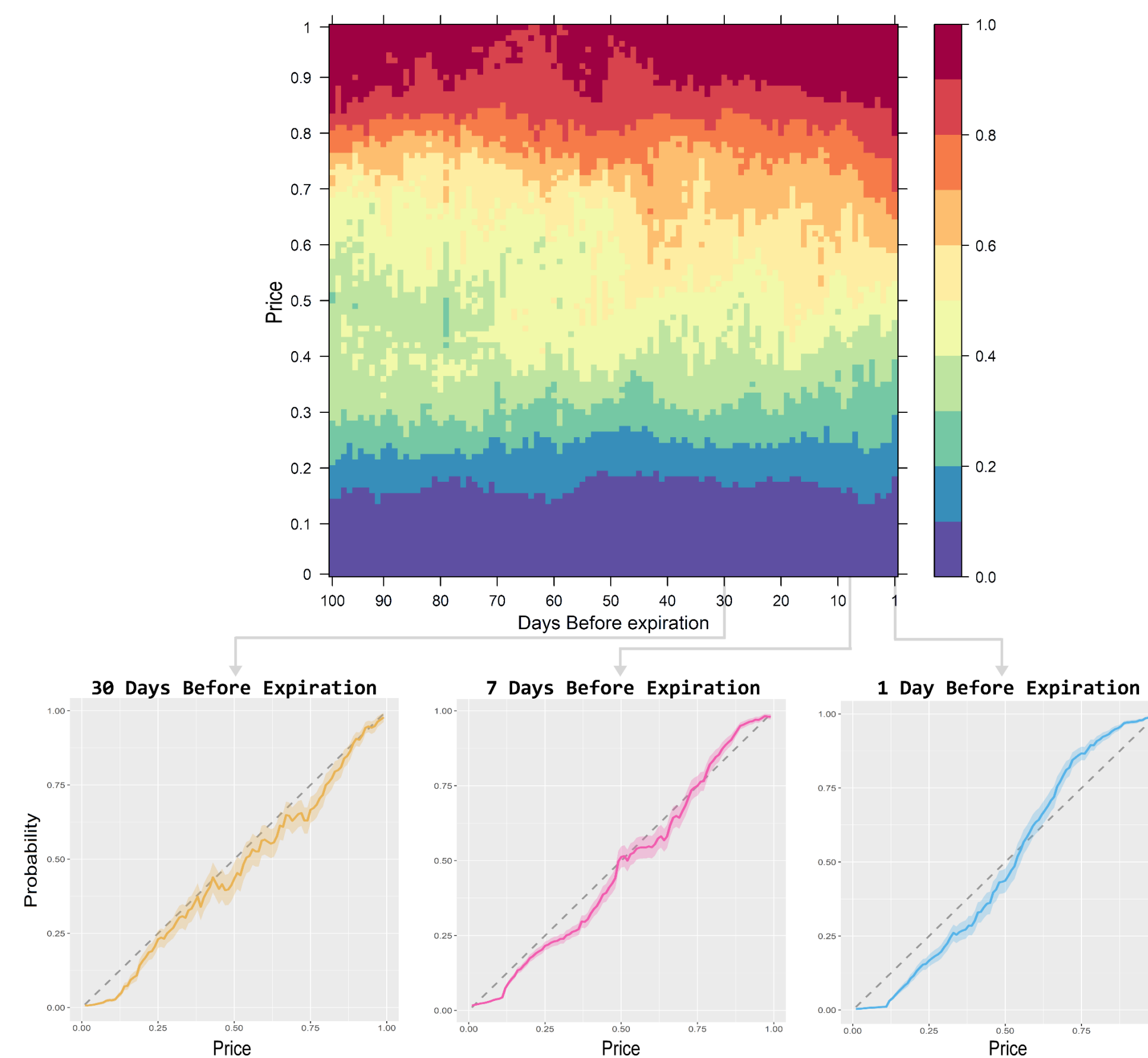


Figure 1. Market calibration by days before expiration. Color on main plot represents the proportion of markets resolving yes.

Parametric Models

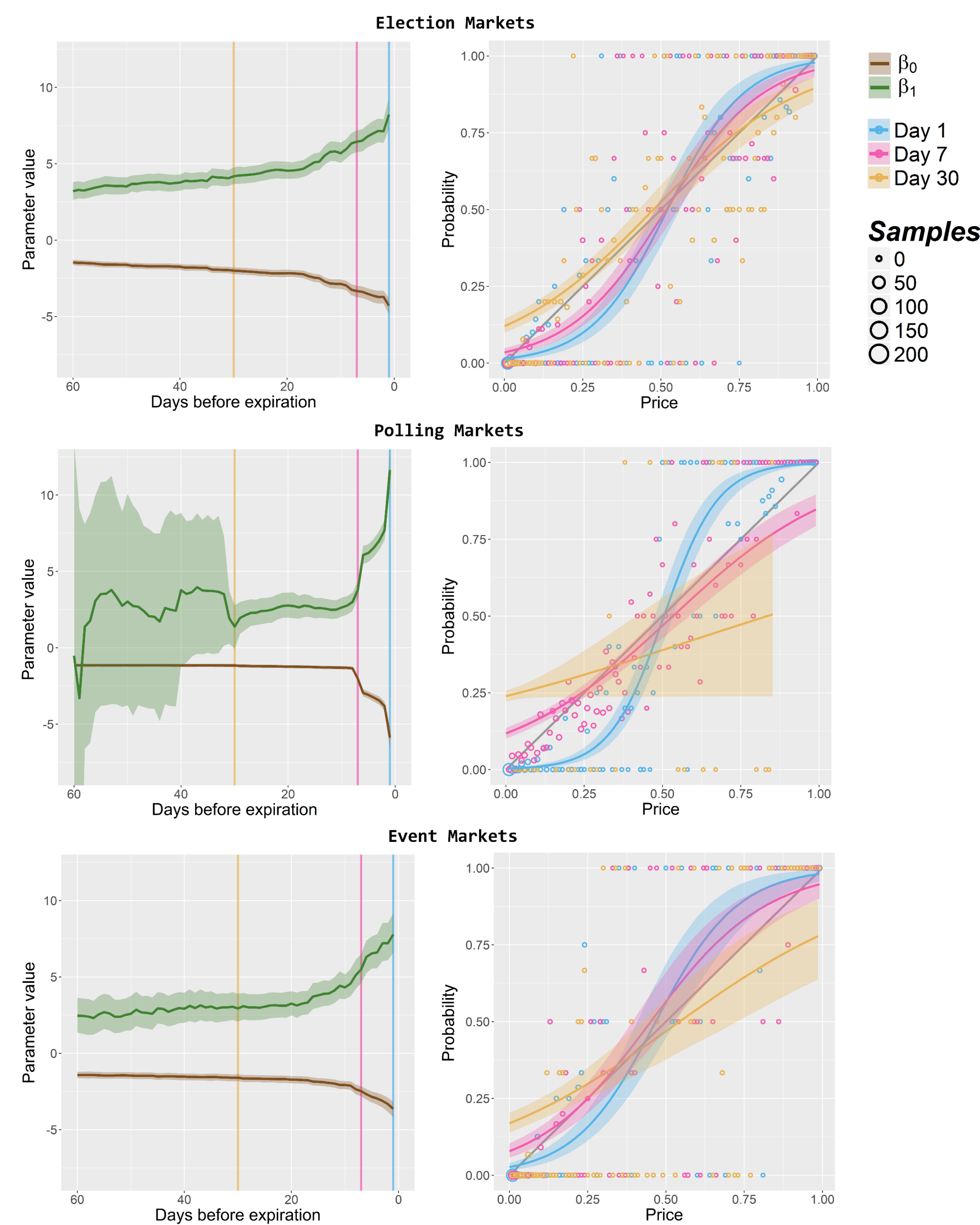


Figure 2. Parametric fits for the election, polling, and event market categories

Fee Adjusted Price

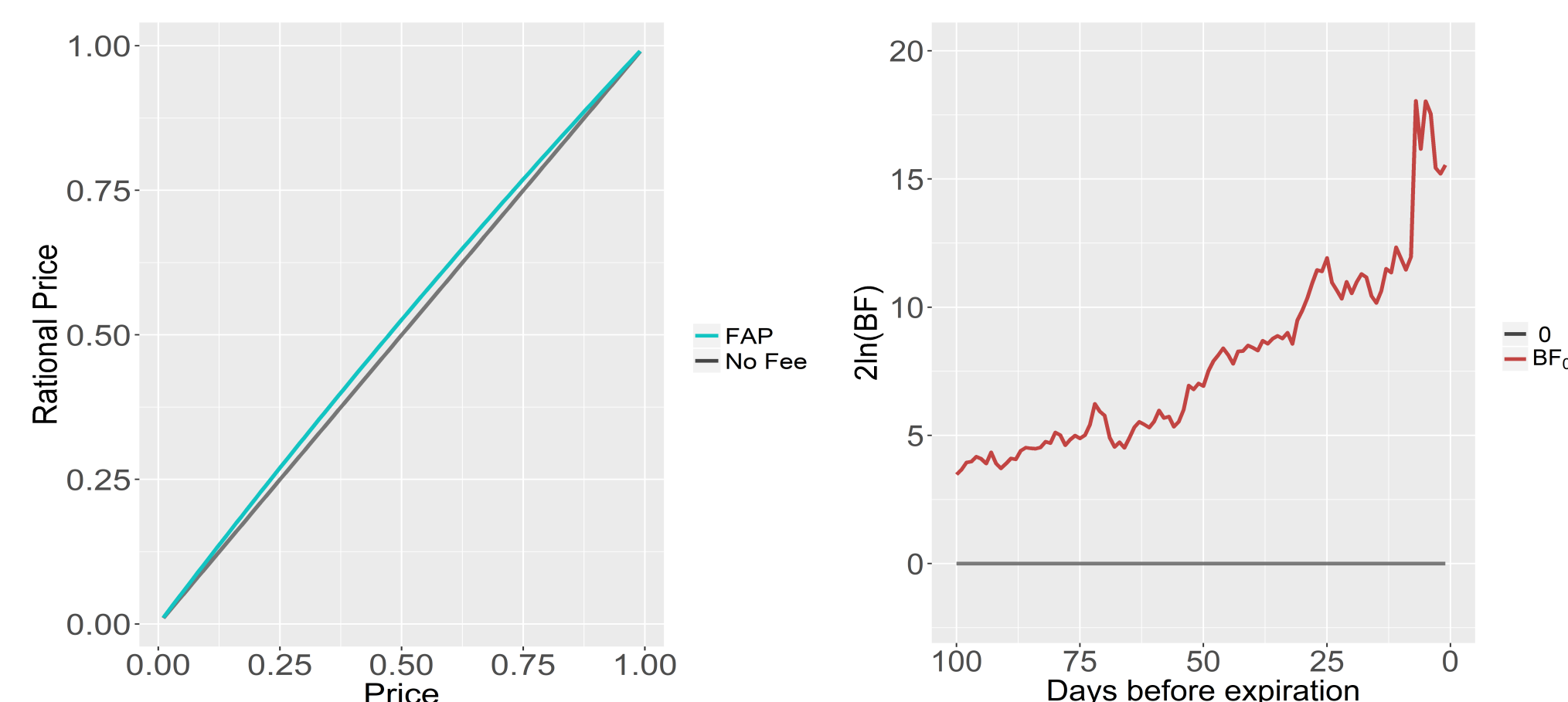


Figure 3. Fee adjusted price (FAP) and Bayes Factor for H_0 : Market price and H_1 : FAP

Methods

Parametric Methods:

- We used Bayesian logistic regression models to investigate changes in market calibration.
- Posterior distributions of the parameters were approximated with MCMC simulations, implemented with JAGS in MATLAB.
- Separate models were estimated at each of 0 through 100 days before the market concluded using the full dataset, as well as each subcategory. Specifically, for market m at time t , our model was;

$$\log\left(\frac{P_m(\text{True})}{1-P_m(\text{True})}\right) = \beta_{0t} + \beta_{1t} \text{Price}_{m,t} \quad \begin{matrix} \beta_{0t} \sim N(0,100) \\ \beta_{1t} \sim N(0,100) \end{matrix}$$

- Plots in the left column of Figure 2 show the posterior means and 95% CI for the coefficients across time for particular submarkets. Plots in the right column of Figure 2 show the posterior mean and 95% CI for estimated probabilities one day, one week, and thirty days before market expiration.

Fee Adjusted Price:

- PredictIt.org charges a fee of 10% of profits. To account for this, we derived a fee adjusted price (FAP), from expected utility theory, as:
$$FAP = \left(\frac{\text{Price}}{0.9 + 0.1\text{Price}}\right)$$
- If market participants rationally account for fees, the FAP would be a better estimate of the true probabilities than the actual market price.

Results

Hypothesis Test Results:

- Markets approaching expiration tended to become less calibrated (See Fig. 1).
- Market calibration varies across time (See Fig. 2).
- Individuals fail to account for fees in markets close to expiration (See Fig. 3).

Discussion

Limitations:

- Correlated markets
- Correlated prices

Future Directions:

- Explore the applicability of models for subjective probability weighting for prediction of market outcomes
- Categorize markets based on patterns in price trajectories

Conclusions

We find that market price generally overestimates the likelihood of low probability events and underestimates the likelihood of high probability events, consistent with established biases in individual probabilistic decision making. But this trend is only apparent near expiration, and we find the opposite pattern as we move further from expiration. Additionally, we find strong evidence of a neglect for fees near expiration, but only weak evidence of such neglect far before expiration.

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