

PREDICTABILITY IN MAJOR SPORTS LEAGUES: BETTING MARKET VS MODEL BASED PREDICTIONS

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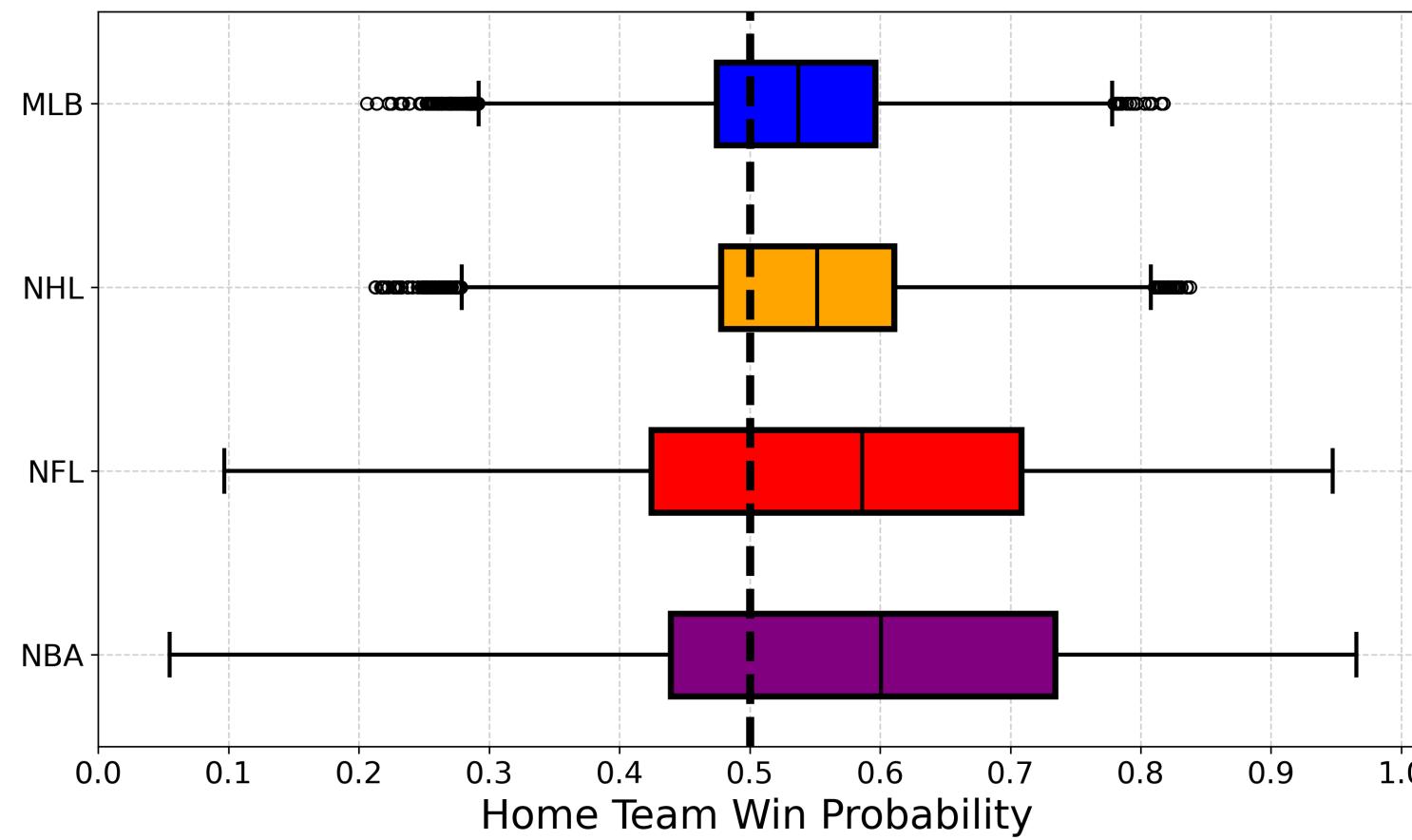
INTRODUCTION AND MOTIVATION

Professional American sports leagues are a huge deal, with championship games raking in hundreds of millions of viewers. Broadcasting rights deals for these major sports are worth tens of billions of dollars, and billions more are bet each year. In our project, we focus on questions such as the following:

- How effective is the betting market in predicting the outcomes of games compared to model based and naïve prediction methods? In particular, how accurate are moneyline based **probabilistic** predictions on game outcomes?
- How do the four major US sports leagues, MLB, NHL, NFL, and NBA, compare with each other?

DESCRIPTION OF DATA

- **Summary of Data:** Regular and postseason games from MLB, NHL, NFL, and NBA, 2009–2021. (38,546 MLB, 20,223 NHL, 4,258 NFL, 18,960 NBA games)
- **Probabilistic Win Predictions:** Betting market predictions based on moneyline scores archived at OddsPortal [3]. Elo predictions (NFL only) based on the FiveThirtyEight ELO Model [2].
- **Descriptive Statistics:** Betting market based win probabilities:



EVALUATING PROBABILISTIC PREDICTIONS

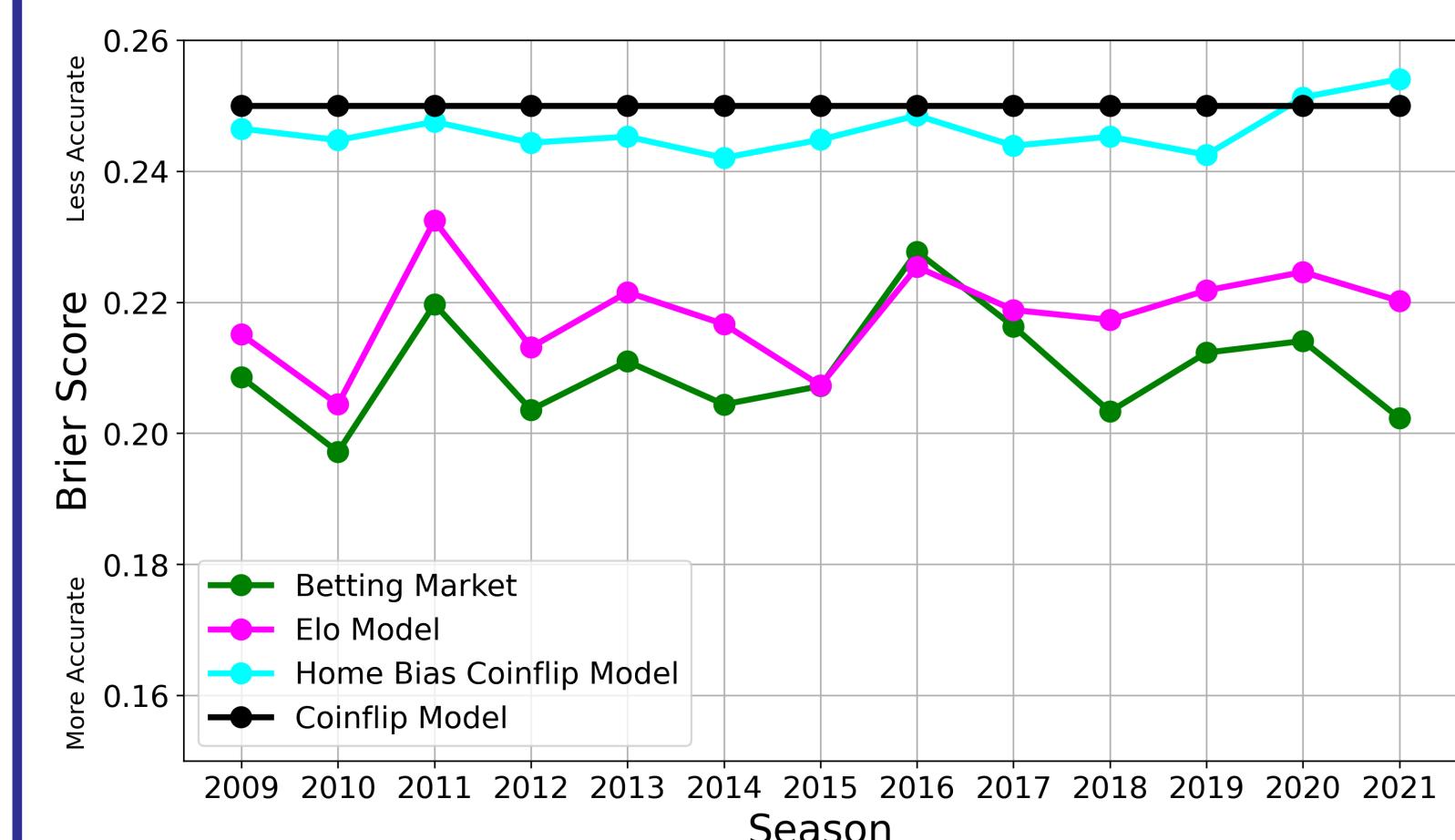
- **Brier Score [1]:** Numerical quantity representing the average square deviation between predicted and actual probability, defined as

$$BS = \frac{1}{N} \sum_{i=1}^N (p_i - o_i)^2,$$

where p_i represents the probabilistic prediction and o_i represents the actual outcome (0 for loss, 1 for win). The lower the Brier score, the more accurate the probabilistic prediction.

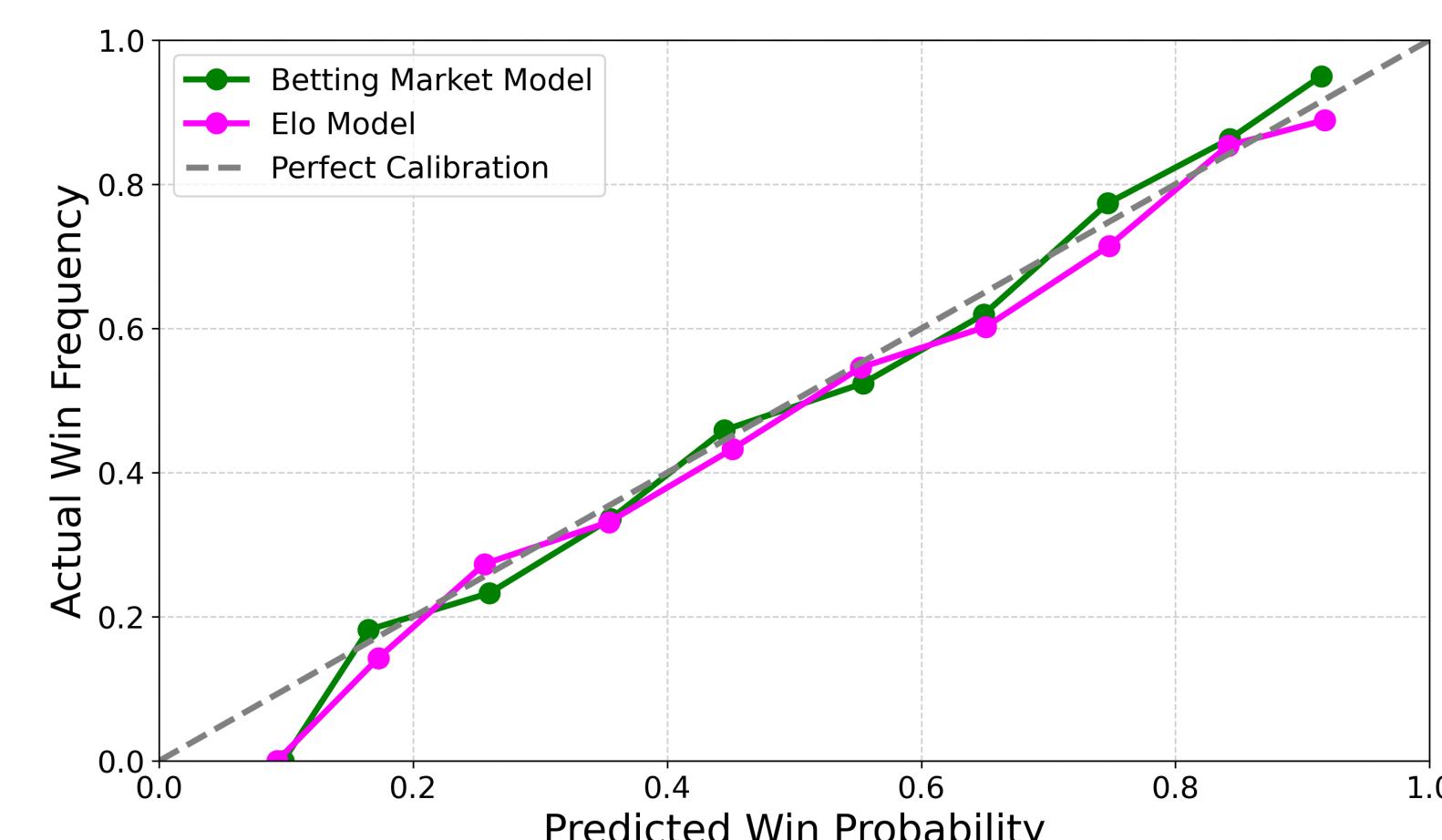
- **Calibration Plot:** Plots the actual proportion of games won against the predicted win probability.

BETTING MARKET VS MODEL-BASED PREDICTIONS (NFL 2009-2021)



Brier scores for different probabilistic prediction models. A lower score corresponds to a more accurate prediction.

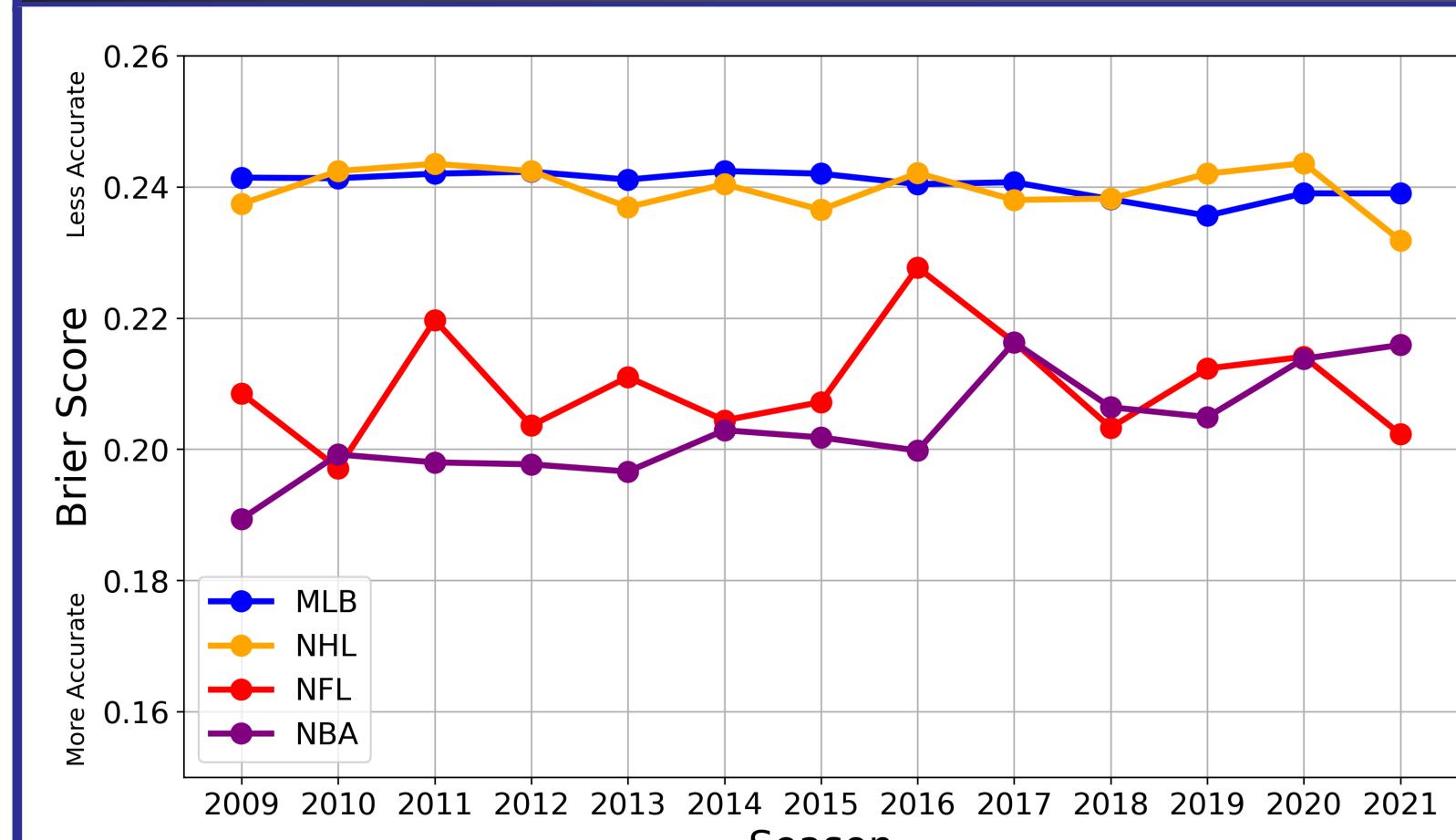
- **Betting Market:** Predictions based on moneylines.
- **Elo Model:** Predictions based on FiveThirtyEight's NFL Elo model.
- **Home Bias Coinflip Model:** Home team is predicted to win with probability equal to the historical home team win rate.
- **Coinflip Model:** Each team is predicted to win with probability 50%.



Actual proportion of games won vs predicted win probability based on betting market and Elo using bins of width 0.1.

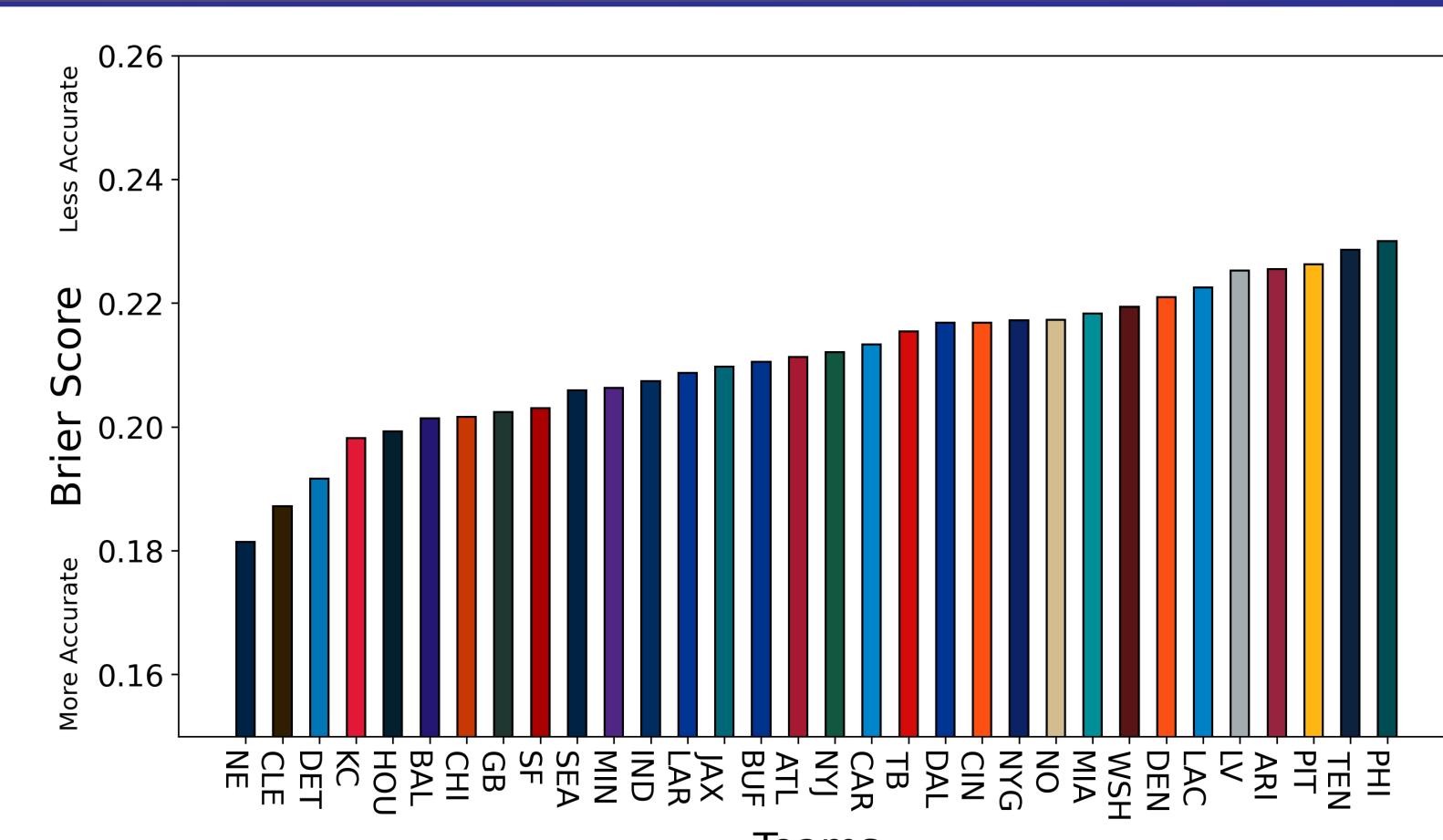
- The dotted line represents a perfect calibration of the probabilistic predictions in which the actual proportion of games won is equal to the predicted win probability.
- The graph shows that both betting market and Elo-based probabilistic predictions are very close to perfect calibration.

PREDICTABILITY BY LEAGUE, SEASON, AND TEAM



Brier scores for betting market predictions by league and season.

- MLB and NHL have the highest Brier scores, meaning they are the least predictable leagues. NFL and NBA have the lowest Brier scores.
- NFL has the most variation from season to season. This is likely due to the NFL playing the fewest number of games per season.



Brier scores for betting market based probabilistic predictions, grouped by teams across the 2009-2024 seasons.

- New England and Cleveland on the left have the lowest Brier scores and hence are the most predictable.
- Philadelphia and Tennessee on the right have the highest Brier scores and hence are the least predictable.

KEY TAKEAWAYS

- Betting market based probabilistic predictions are consistently the most accurate among the methods we considered, as measured by Brier scores, indicating the betting market is very efficient. (Other accuracy measures like logloss and AUC support this conclusion.)
- Predictions based on the FiveThirtyEight Elo model do almost as well. This is consistent with earlier findings by H. Stern [4] for **binary predictions** comparing the betting market with least squares models.
- Both the betting market and the FiveThirtyEight Elo model are significantly more accurate than the naive predictions based on home team advantage.
- Both the betting market and the FiveThirtyEight Elo model are very well calibrated, meaning the predicted win probabilities match the actual win probabilities very closely.
- MLB and NHL are significantly less predictable than NFL and NBA.

RELATED WORK

- **Stern (1997) [4]:** Analyzed accuracies of binary predictions in professional and collegiate sports based on betting market, least squares models, and a naive model based on home team advantage.
- **Wilkens (2021) [5]:** Analyzed betting market and machine learning based predictions across approximately 39,000 professional men's and women's tennis matches from 2010 to 2019.

REFERENCES

- [1] Brier, G. W. (1950). Verification of forecasts expressed in terms of probability. *Monthly weather review*, 78(1), 1-3.
- [2] FiveThirtyEight (Nate Silver, Jay Boice, Neil Paine). How our NFL predictions work. <https://fivethirtyeight.com/methodology/how-our-nfl-predictions-work/>.
- [3] OddsPortal. <https://www.oddsportal.com/search/results/>.
- [4] Stern, H. S. (1997). How accurately can sports outcomes be predicted?. *Chance* 10, 19-23.
- [5] Wilkens, S. (2021). Sports prediction and betting models in the machine learning age: The case of tennis. *Journal of Sports Analytics*, 7(2), 99-117.