



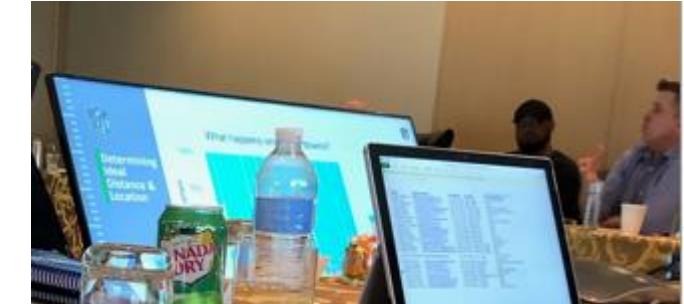
FOOTBALL OPERATIONS



LESSONS FROM BEHIND THE SHIELD

Michael Lopez, JSM 2020

BACKGROUND



STATISTICS IN 2003



Nomar or Derek? Analyzing and Applying Mathematics to America's Pastime

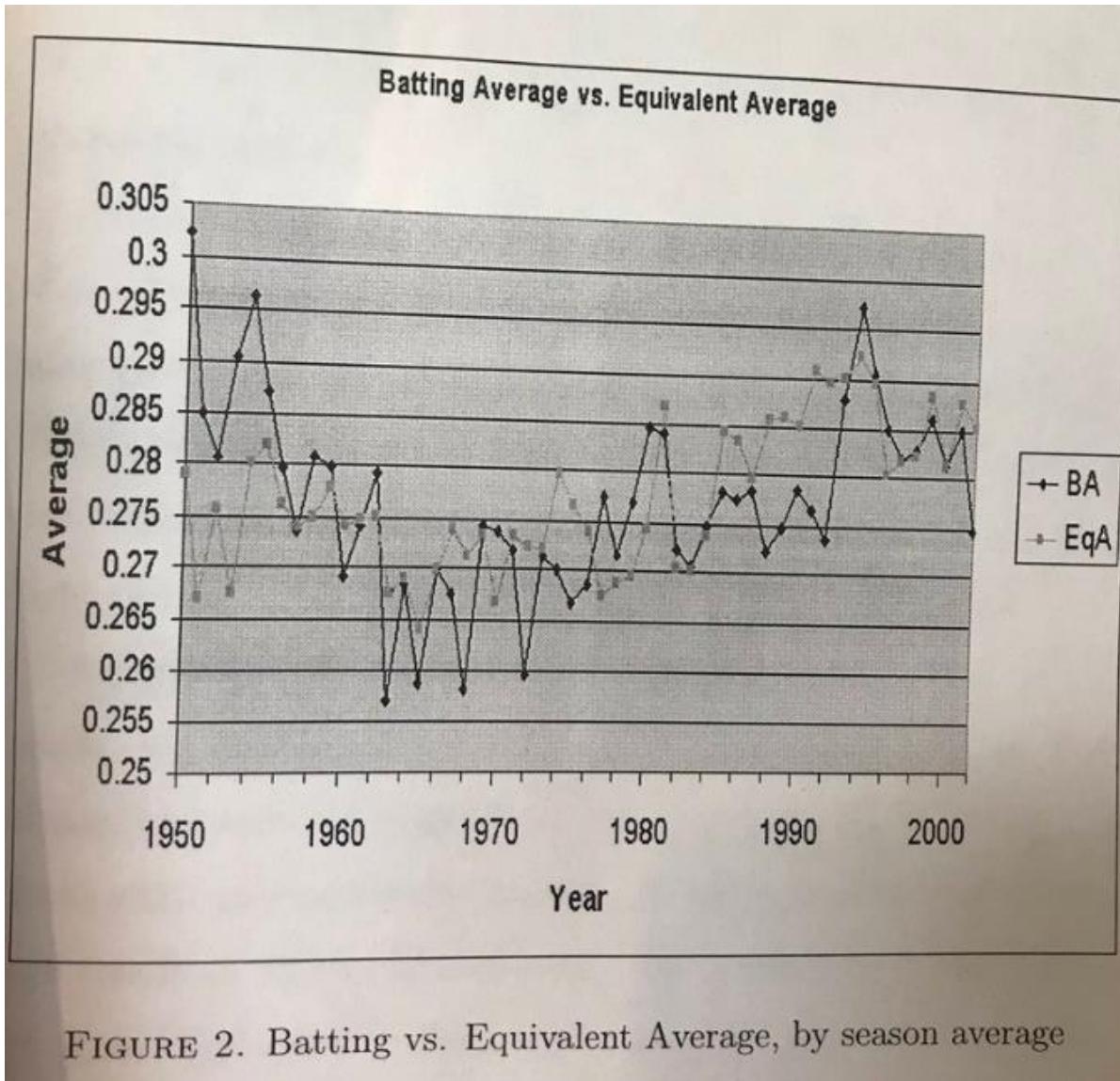
A Thesis

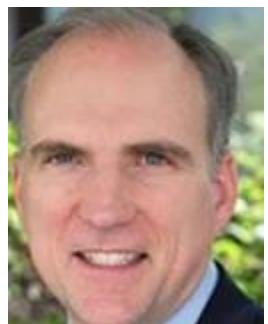
Presented to the Department of Mathematics
Bates College

in partial fulfillment of the requirements for the
Degree of Bachelor of Arts

by Michael J. Lopez
Lewiston, Maine
December 12, 2003

STATISTICS IN 2003





Do Firms Maximize? Evidence from Professional Football

David Romer

University of California, Berkeley and National Bureau of Economic Research

https://eml.berkeley.edu/~dromer/papers/JPE_April06.pdf

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*If we all listened to the professor, we may be all looking for professor jobs –
Bill Cowher*





STATISTICS IN 2020 (TEAMS)

	Charlie Adkins	Coordinator, Football Analytics & Research
	Meredith Manley	Football Analytics Assistant
	Kevin Jordan	Football Analytics Assistant
	John Taormina	Manager of Football Analytics
	Emily Badis	Salary Cap and Contract Analyst
	Danny Leskin	Football Analyst
	David McDonald	Director of Research & Development
	Scott Cohen	Director of Football Research
	Corey Krawiec	Manager, Player Evaluations & Analytics
	Sarah Mallepalle	Player Personnel Analyst
	Derrick Yam	Quantitative Analyst
	Daniel Stern	Football Analyst
	Sean Clement	Football Analyst
	Dennis Lock	Director of Football Research and Strategy
	Luis Guilamo	Director of Analytics & Application Development
	Shuler Cotton	Data Analyst
	Taylor Rajack	Director of Football Analytics
	Brad Goldsberry	Director of Football Analytics/Research
	Sam Francis	Football Data Analyst
	Paul DePodesta	Chief Strategy Officer
	Kwesi Adofo-Mensah	Vice President of Football Operations
	Ken Kovash	Vice President, Player Personnel Process & Development
	Andrew Healy	Vice President, Research & Strategy
	Dave Giuliani	Director, Research & Strategy
	Nate Sterken	Lead Data Scientist
	Sam Schmall	Football Research Analyst
	Tom Robinson	Director of Football Research
	Adam Vonder Haar	Football Research Analyst
	Alok Pattani	Football Research Consultant
	Tony Lazzaro	Senior Director, Football Technology and Research
	Scott Flaska	Senior Manager, Football Analytics
	Emily Kuehler	Data Scientist

	Cao Brightenti	Football Analytics Assistant
	Michael Pelfrey	Football Analytics Assistant
	Mike Halbach	Director of Football Technology
	Jack Prominski	Football Analytics Manager
	Weller Ross	Assistant Director of Football Information Systems for Analytics
	Curtis Goodwin	Sports Performance Data Scientist
	Kevin Clark	Football Data and Applications Engineer
	John Park	Manager of Football Research & Strategy
	George Li	Senior Football Strategy Analyst/Game Management
	Tony Khan	Senior Vice President of Football Administration and Technology
	Arri Landsman-Roos	Vice President of Decision Science
	Momin Ghaffar	Manager of Strategic Research & Development
	Victor Li	Advanced Analytics Developer
	Sam Burgess	Data Analyst
	Brandt Tilis	Director of Football Administration
	Michael Frazier	Statistical Analysis Coordinator
	David Christoff	Director of Football Analytics
	Brendan Kirbach	Player Personnel - Analytics
	Taimoor Chattoor	Data Scientist, Player Analytics
	Walter King	Football R&D
	Aditya Krishnan	Director of Football Research & Analytics
	Ryan Garlisch	Manager, Software Development
	Jake Temme	Manager, Data and Analytics
	Sarah Bailey	Manager, Data and Analytics
	Eugene Shen	Director, Personnel Analytics
	Max Mulitz	Manager, Coaching Analytics
	Harrison Freid	Football Research Assistant
	Scott Kuhn	Director, Analytics/Pro Scout
	Rex Johnson	Football Analyst
	Richard Miller	Director of Research
	Ernie Adams	Football Research Director
	Matt Lindsay	Director of Data Science and Software

	Ryan Herman	Football Research & Strategy
	Ty Siam	Director of Football Data & Innovation
	Jon Berger	Senior Director of Football Information
	Courtney Kennedy	Football Data Analyst
	Brian Shields	Senior Manager, Football Scouting Research Analytics
	Jason Feldman	Coordinator, Football Analytics
	Zach Stuart	Coordinator, Football Analytics
	Alec Halaby	Vice President of Football Operations and Strategy
	James Gilman	Senior Quantitative Analyst
	Chase Perlen	Senior Quantitative Analyst
	Jon Liu	Football Operations Analyst
	Tosin Kazeem	Football Analyst
	Jay Whitmire	Football Analyst
	Brian Hampton	Vice President of Football Administration
	Demetrius Washington	Manager, Football R&D
	Patrick Ward	Director of Research and Development
	Brian Eayrs	Research Analyst
	N/A	
	N/A	
	Connor Barringer	Football Strategy Analyst/Scouting Assistant

@SethWalder, ESPN

STATISTICS IN 2020 (LEAGUE OFFICE)



League-wide data



FOOTBALL OPERATIONS DATA & ANALYTICS



- 1) Ensure competitiveness
- 2) Rules adherence & monitoring: officiating, replay, competition committee
- 3) Drive innovation (Ex: Big Data Bowl, Combine, game-day technology)
- 4) Serve Football Ops initiatives



Example 1...

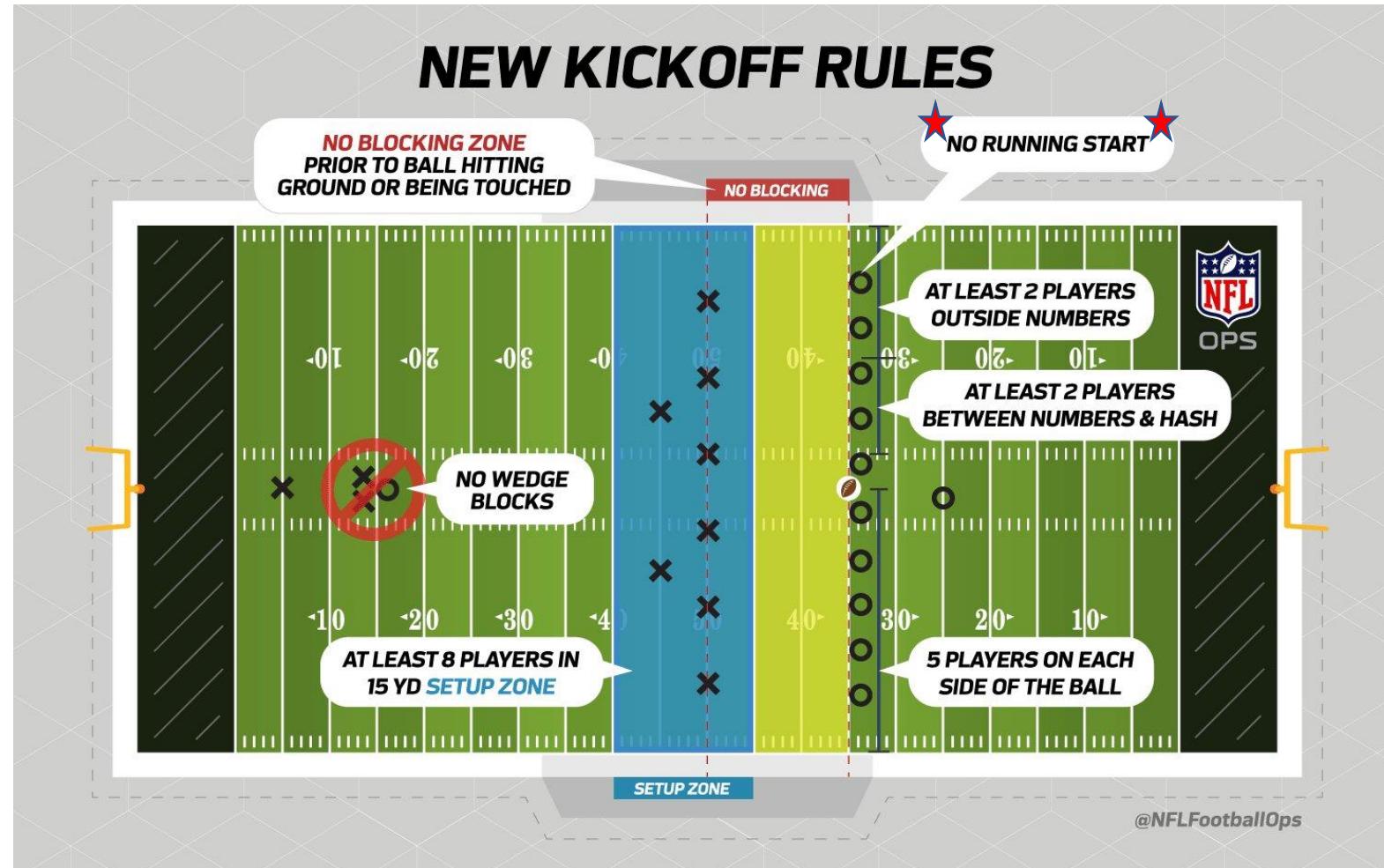
Example: Onside kick

Did a post-2017 kickoff rule change result in lower onside kick recovery rates?



Example: Onside kick

Did a post-2017 kickoff rule change result in lower onside kick recovery rates?





Example: Onside kick

Did a post-2017 kickoff rule change result in lower onside kick recovery rates?

Option 1: Change in recovery rate → Statistically significant

SEASON	NO. OF ONSIDE KICKS	NO. RECOVERED BY KICKING TEAM	PCT.
2017	60	13	21.7
2018	53	4	7.5

<https://www.washingtonpost.com/sports/2019/01/16/onside-kicks-have-become-almost-impossible-convert-will-nfl-make-change/?arc404=true>



Example: Onside kick

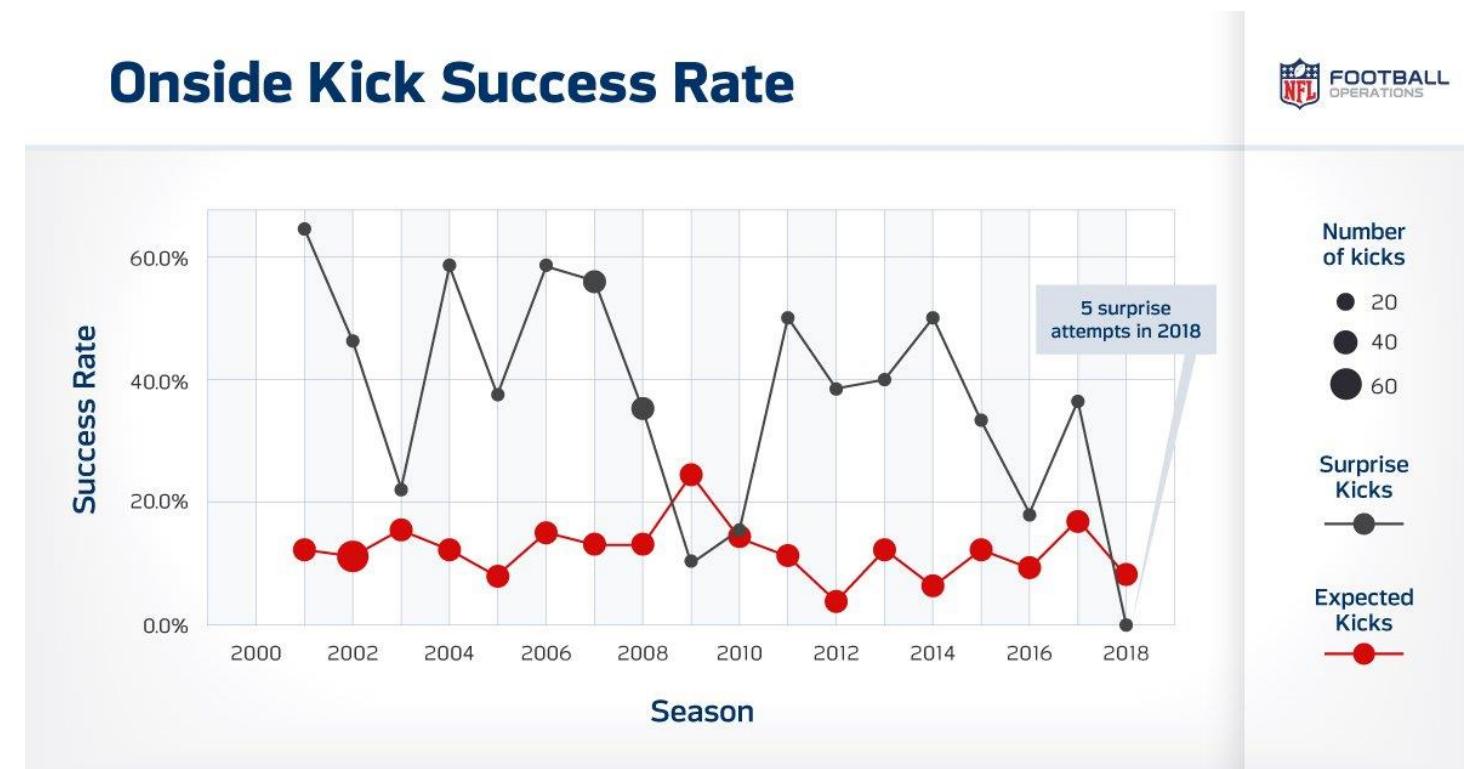
~~Did a post-2017 kickoff rule change result in lower onside kick recovery rates?~~

Did a post-2017 kickoff rule change result in lower **expected** onside kick recovery rates?

Example: Onside kick

Did a post-2017 kickoff rule change result in lower **expected** onside kick recovery rates?

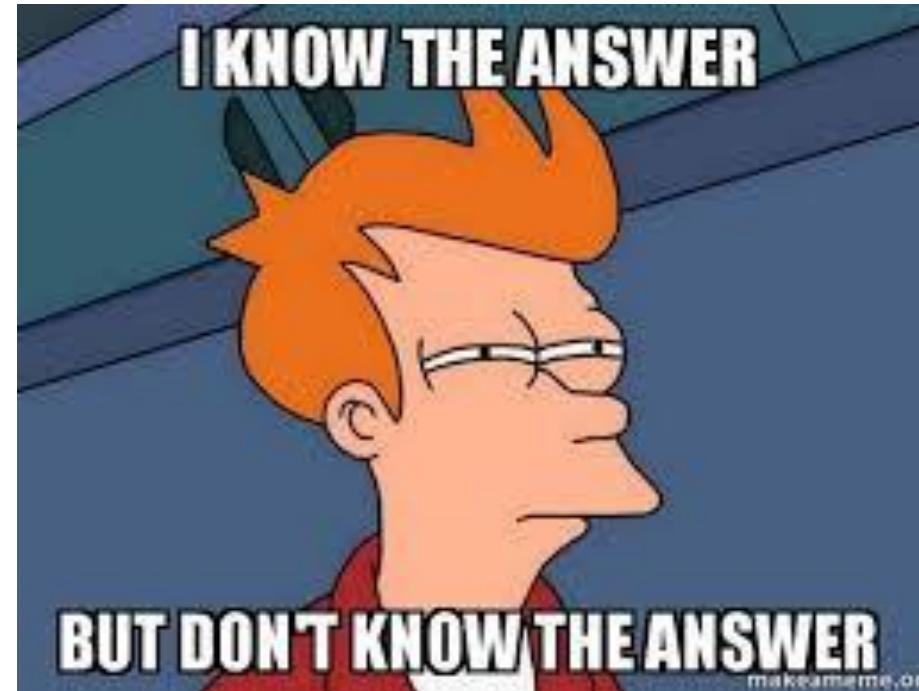
Option 2: Change in recovery rate (**red line**) → **Not** statistically significant



Example: Onside kick

Did a post-2017 kickoff rule change result in lower **expected** onside kick recovery rates?

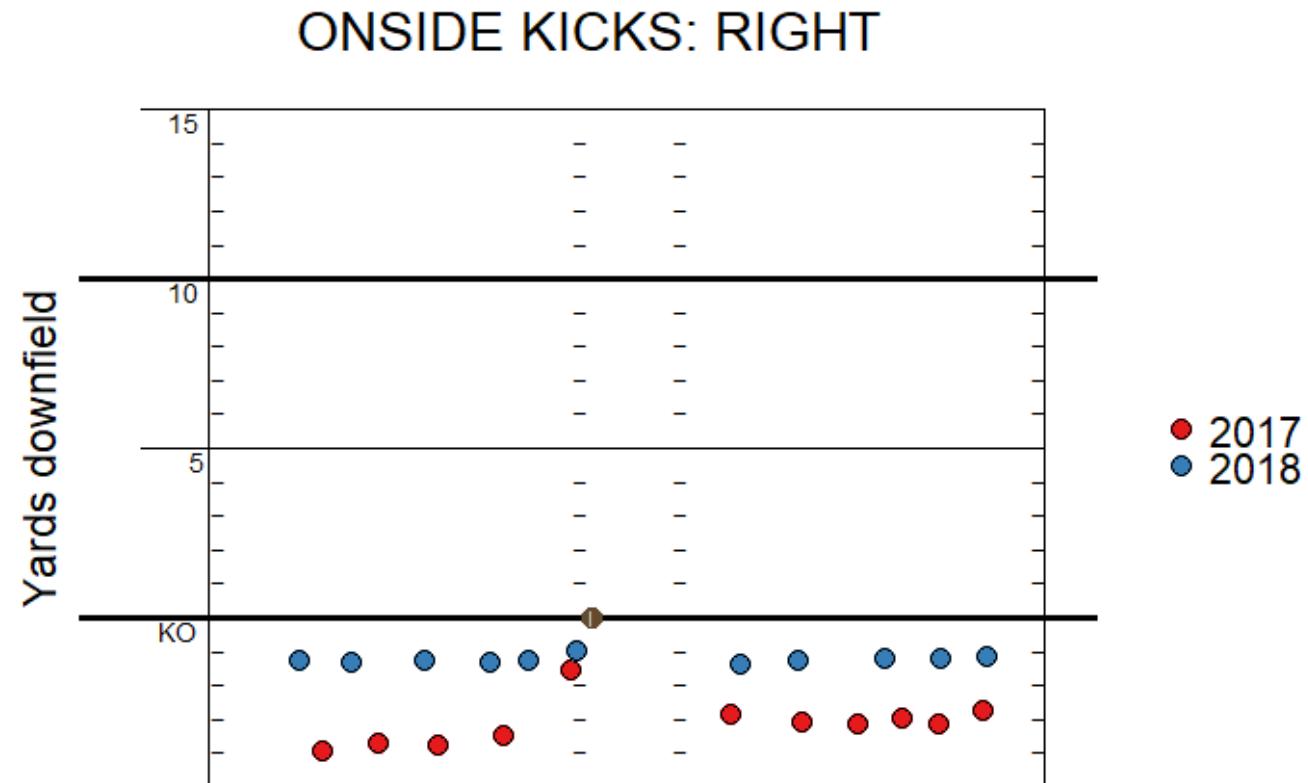
Aside: What if we're uncertain of an answer?



Example: Onside kick

Did a post-2017 kickoff rule change result in lower **expected** onside kick recovery rates?

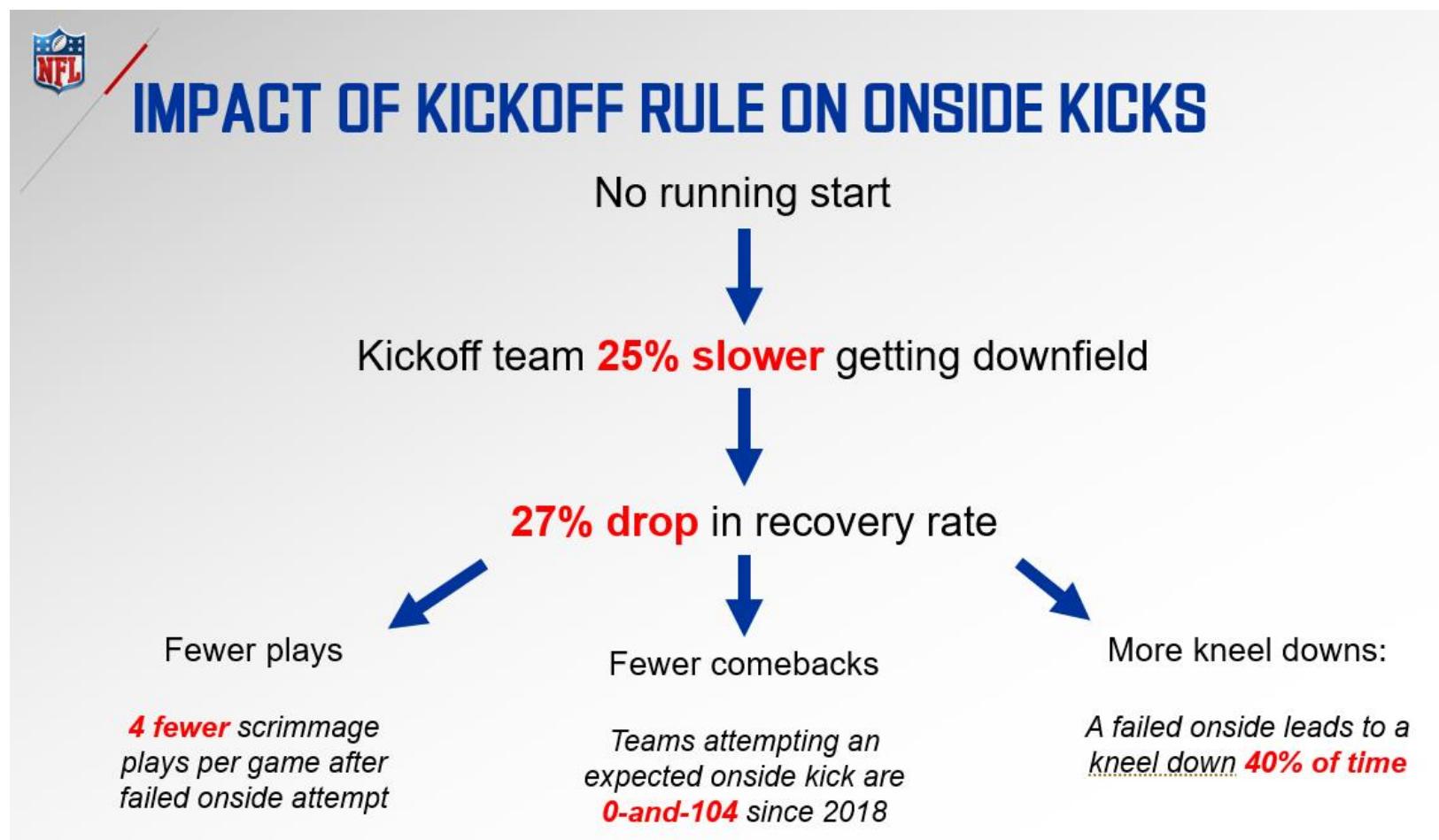
Option 3: Better data & estimand



Example: Onside kick



Our answer (post-2019)



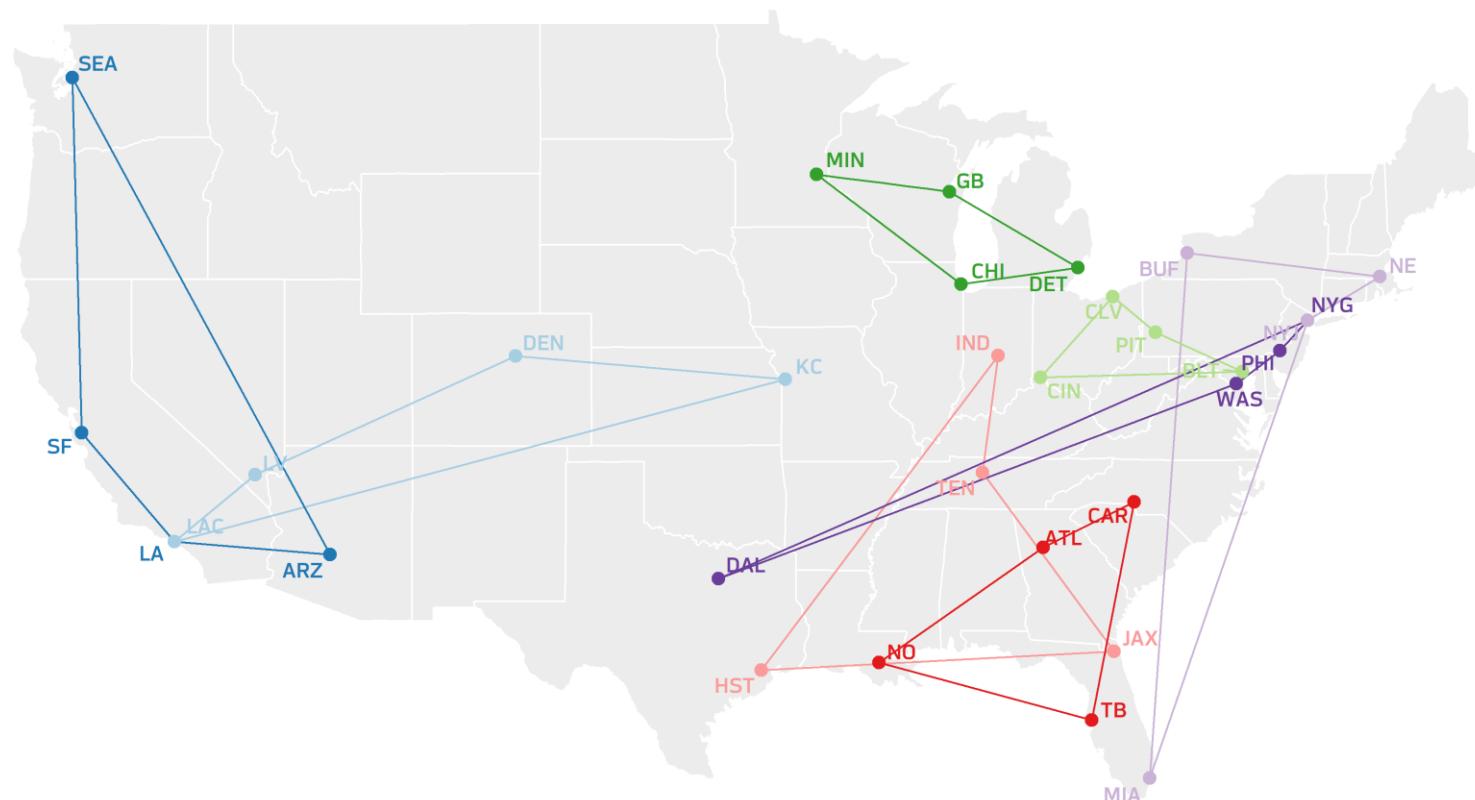


Example 2...

Example: Game factors

What is the impact of bye, rest, and travel advantages within an NFL schedule?

Current Divisions



Example: Game factors

What is the impact of bye, rest, and travel advantages within an NFL schedule?

Team strength



Playing at home



Rest



Body clock



Travel



Example: Game factors

What is the impact of bye, rest, and travel advantages within an NFL schedule?

Team strength



Playing at home



Rest



Body clock



Travel



HOW OFTEN DOES THE BEST TEAM WIN?
A UNIFIED APPROACH TO UNDERSTANDING RANDOMNESS
IN NORTH AMERICAN SPORT

BY MICHAEL J. LOPEZ

Skidmore College
AND

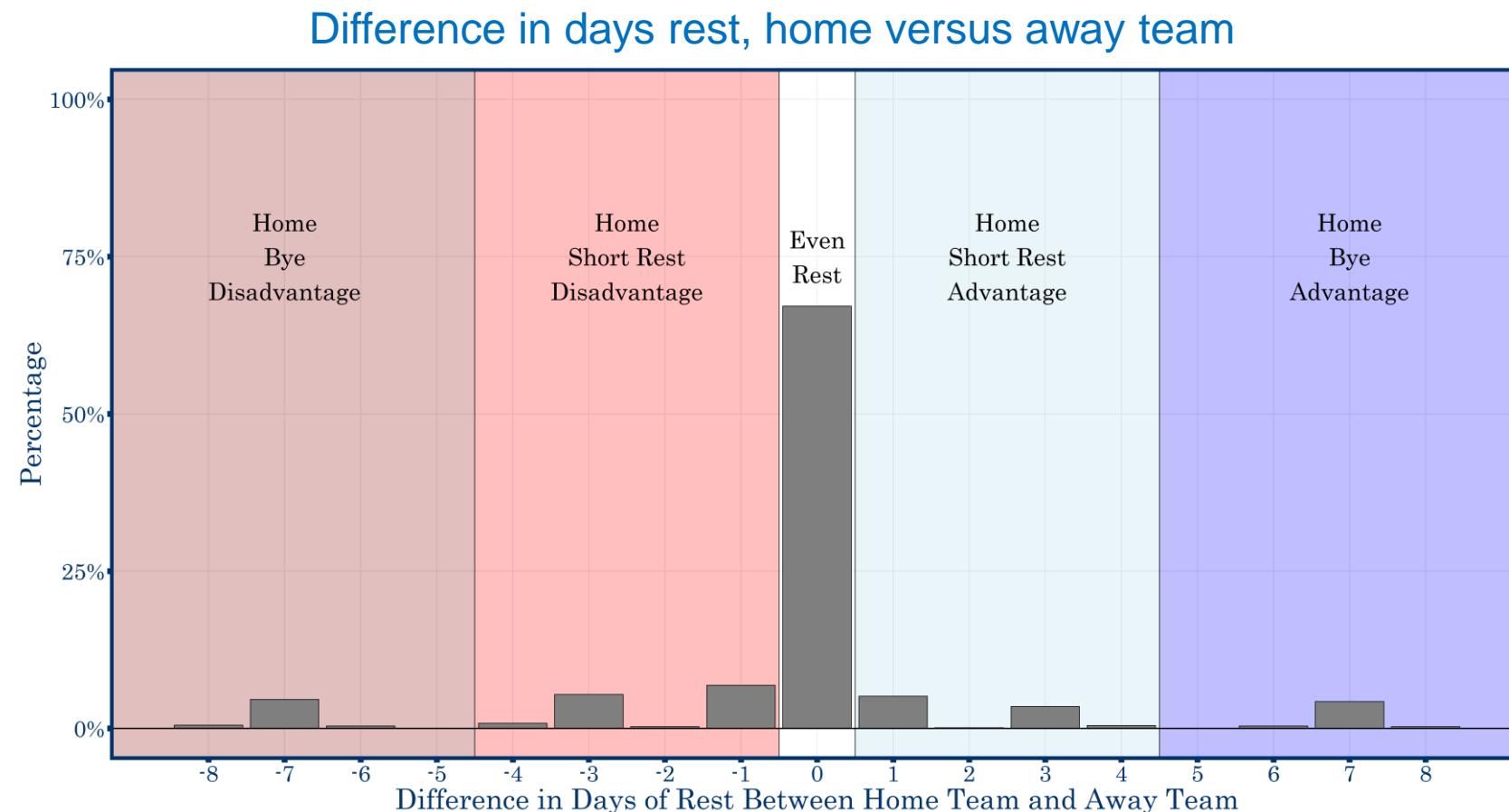
BY GREGORY J. MATTHEWS
Loyola University Chicago
AND

BY BENJAMIN S. BAUMER
Smith College

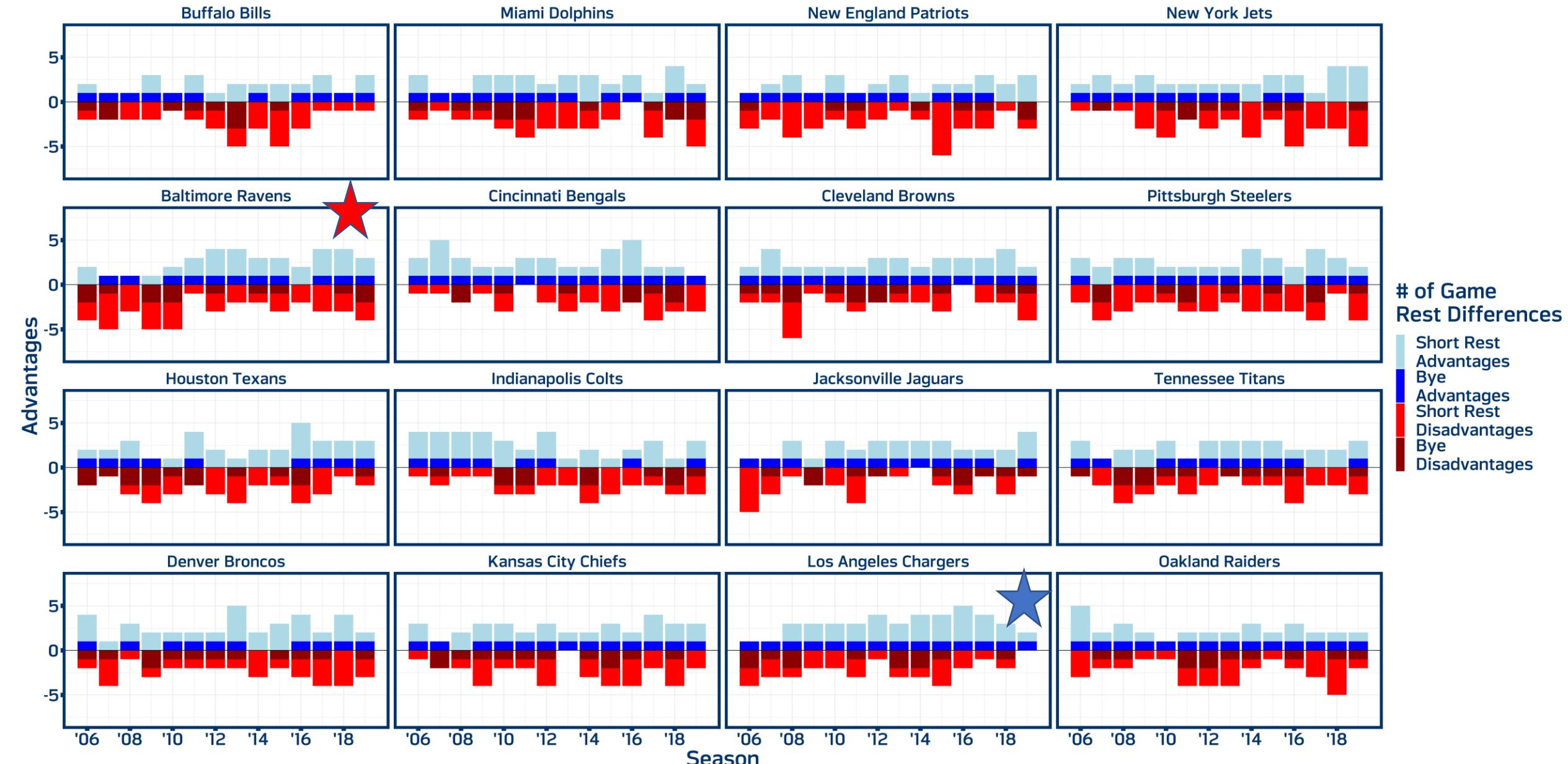
Statistical applications in sports have long centered on how to best separate signal (e.g. team talent) from random noise. However, most of this work has concentrated on a single sport, and the development of meaningful cross-sport comparisons has been impeded by the difficulty of translating luck from one sport to another. In this manuscript, we develop Bayesian state-space models using betting market data that can be uniformly applied across sporting organizations to better understand the role of randomness in game outcomes. These models can be used to extract estimates of team strength, the between-season, within-season, and game-to-game variability of team strengths, as well each team's home advantage. We implement our approach across a decade of play in each of the National Football League (NFL), National Hockey League (NHL), National Basketball Association (NBA), and Major League Baseball (MLB), finding that the NBA demonstrates both the largest dispersion in talent and the largest home advantage, while the NHL and MLB stand out for their relative randomness in game outcomes. We conclude by proposing new metrics for judging competitiveness across sports leagues, both within the regular season and using traditional postseason tournament formats. Although we focus on sports, we discuss a number of other situations in which our generalizable models might be usefully applied.

Example: Game factors

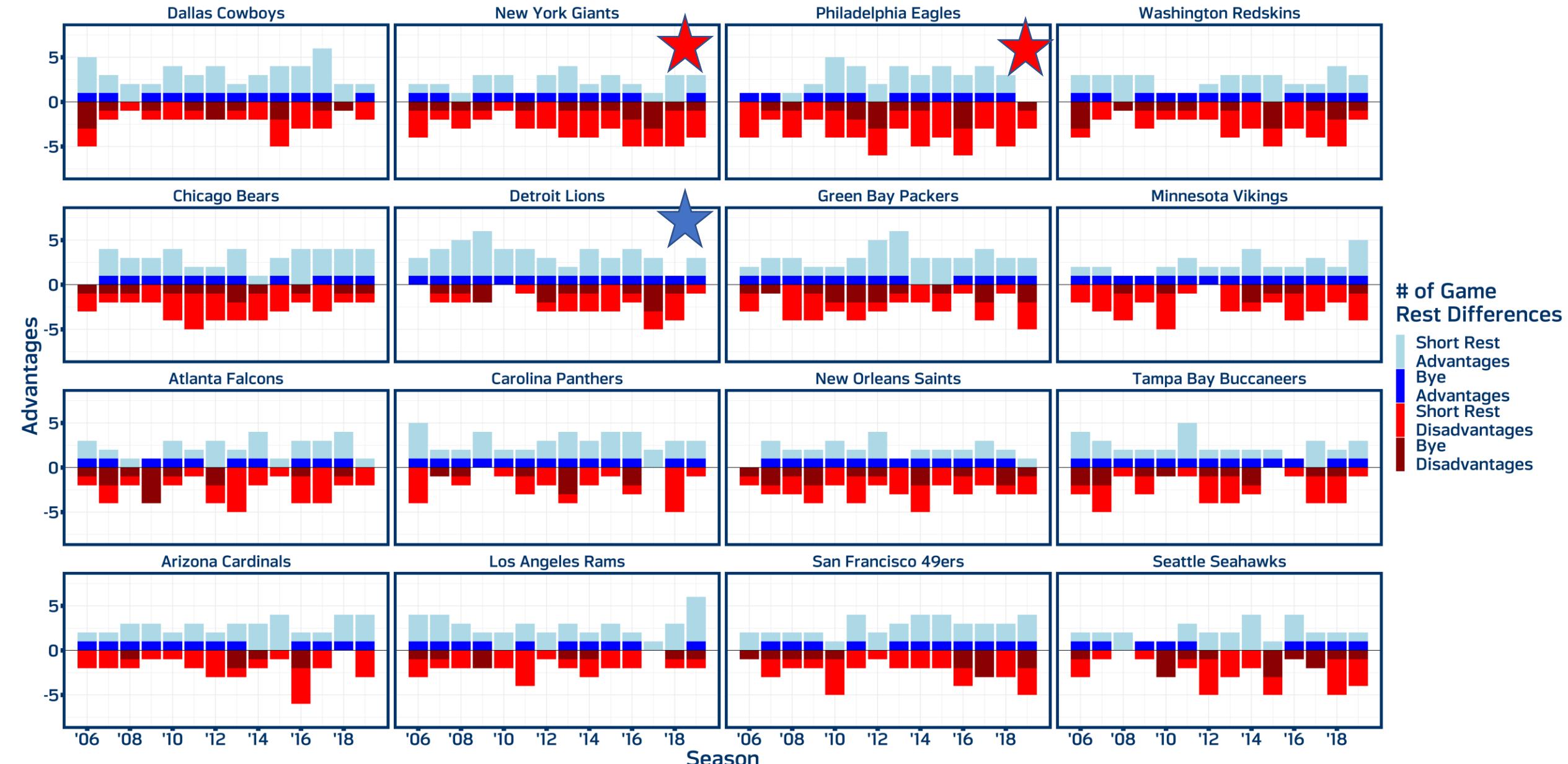
What is the impact of bye, rest, and travel advantages within an NFL schedule?



Rest Comparisons (AFC)



Rest Comparisons (NFC)





Equation (example)

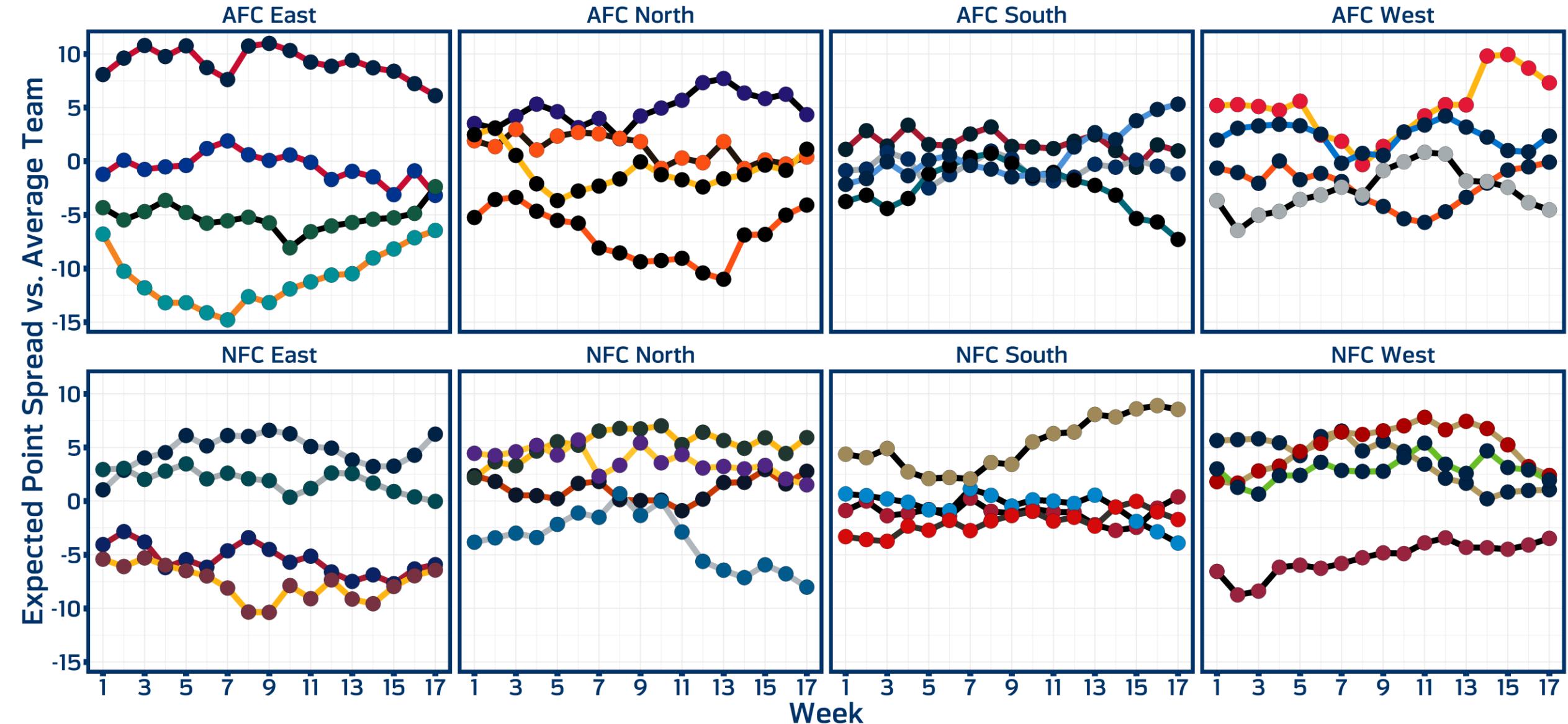
$$E[\text{logit}(P_{(s,k)ij})] = \theta_{(s,k)i} - \theta_{(s,k)j} + \alpha_h \text{home}_i + \alpha_{sR} \text{shortRest}_i + \alpha_{bR} \text{byeRest}_i$$

Value	Description
$P_{(s,k)ij}$	betting line implied probability that team i will beat team j during season s and week k
$\theta_{(s,k)i}$	team strength of team i during season s and week k
$\theta_{(s,k)j}$	team strength of team j during season s and week k
α_h	home advantage constant
home_i	1 if team i has home advantage, 0 if at neutral site
α_{sR}	short rest advantage constant
shortRest_i	equals 1 if team i has short rest advantage, 0 if team i has neither short rest advantage nor disadvantage, or -1 if team i has short rest disadvantage
α_{bR}	bye rest advantage constant
byeRest_i	equals 1 if team i has bye rest advantage, 0 if team i has neither bye rest advantage nor disadvantage, or -1 if team i has bye rest disadvantage

Team strengths



NFL Team Strengths by Week of Season - 2019



Model Estimates



+0.36 pts for **short** rest.



+0.67 pts for **bye** rest.



+2.15 pts for home team.



+0 pts for **0** miles of travel advantage.



+0.69 pts for **500** miles of travel advantage.

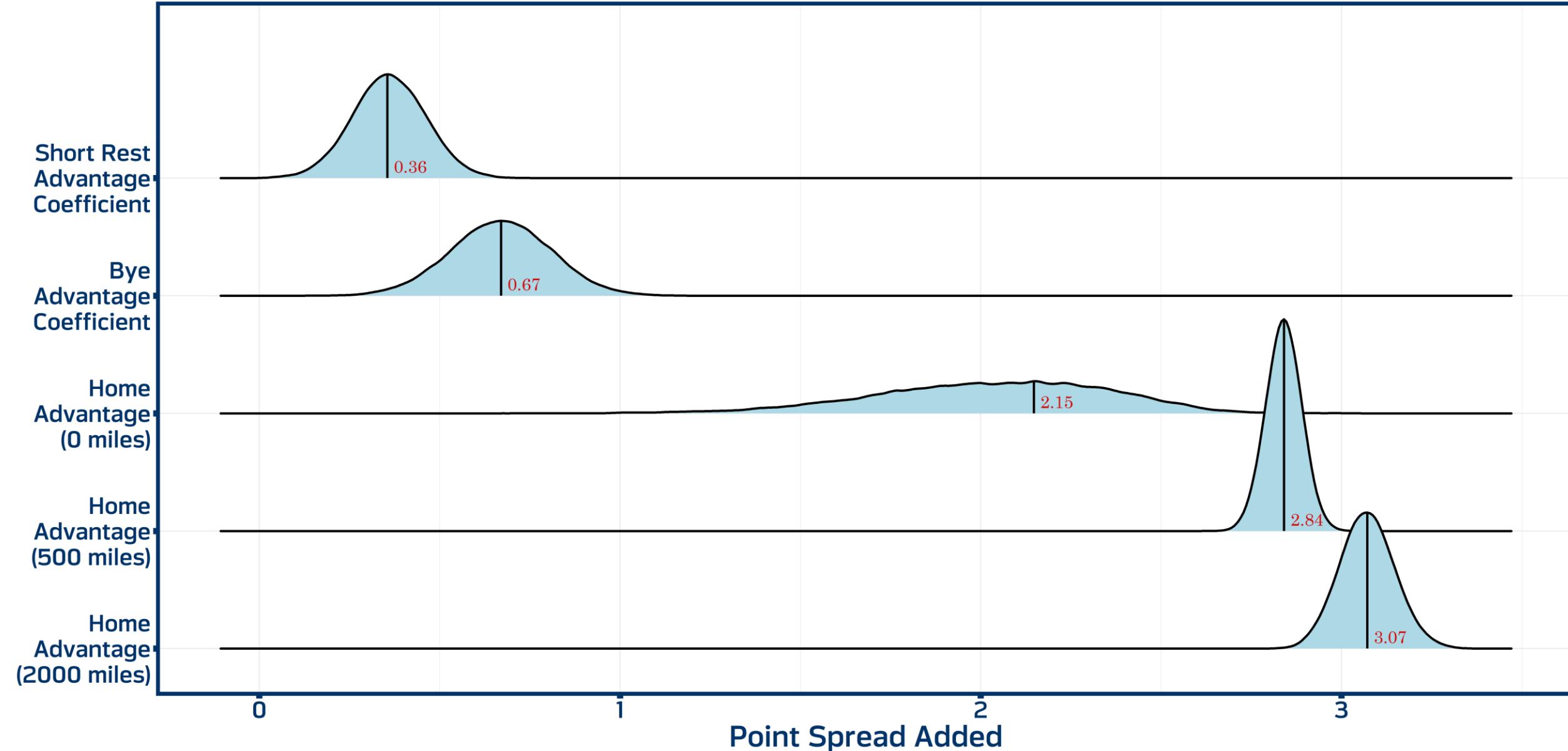


+0.92 pts for **2000** miles of travel advantage.

Model results



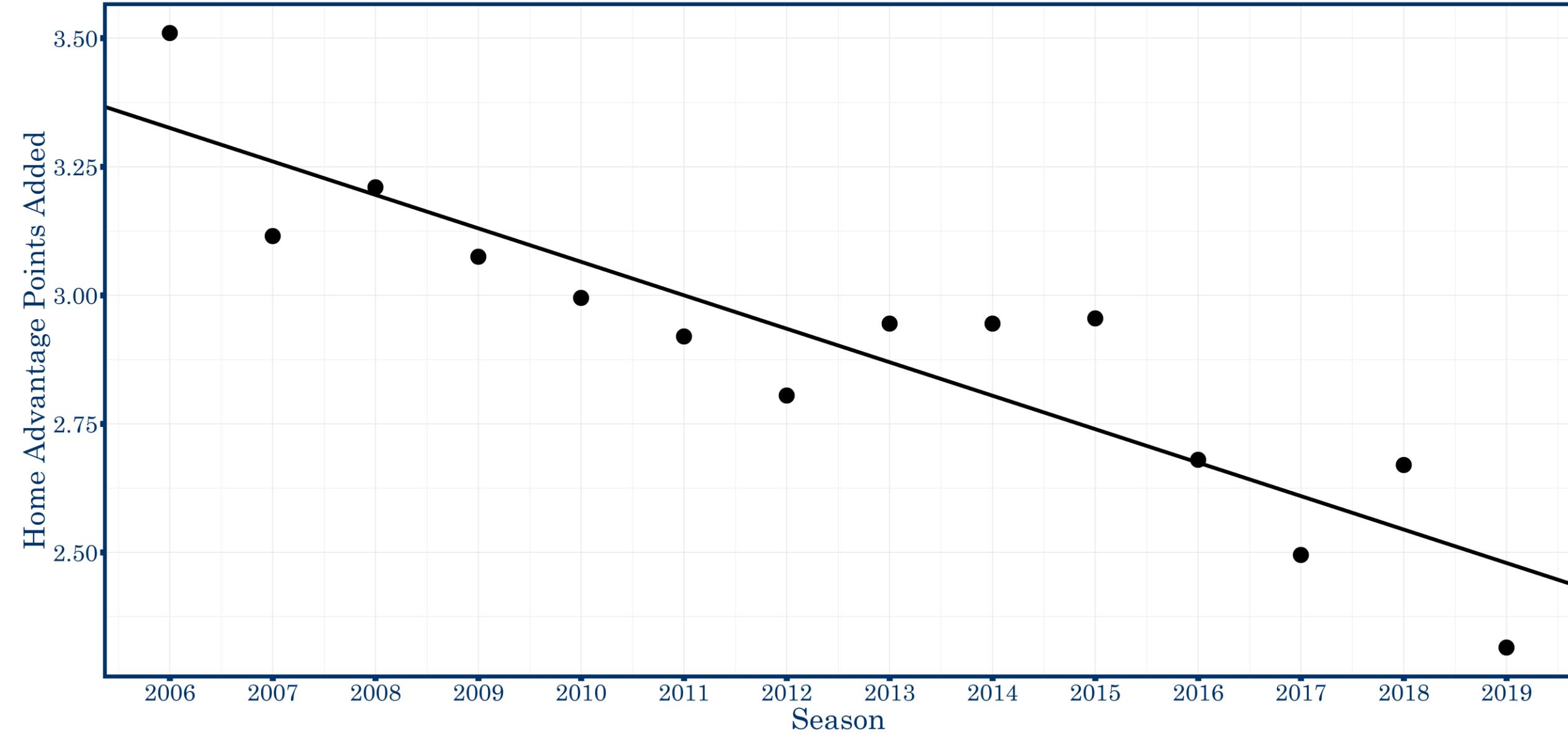
Density of Posterior Draws of Coefficients



Changes over time

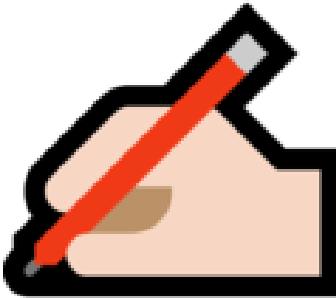


Change of Home Advantage Points Added





Summary and final thoughts



Less impactful

Hypothesis testing

p-values

Traditional plots

Sometimes impactful

Machine Learning

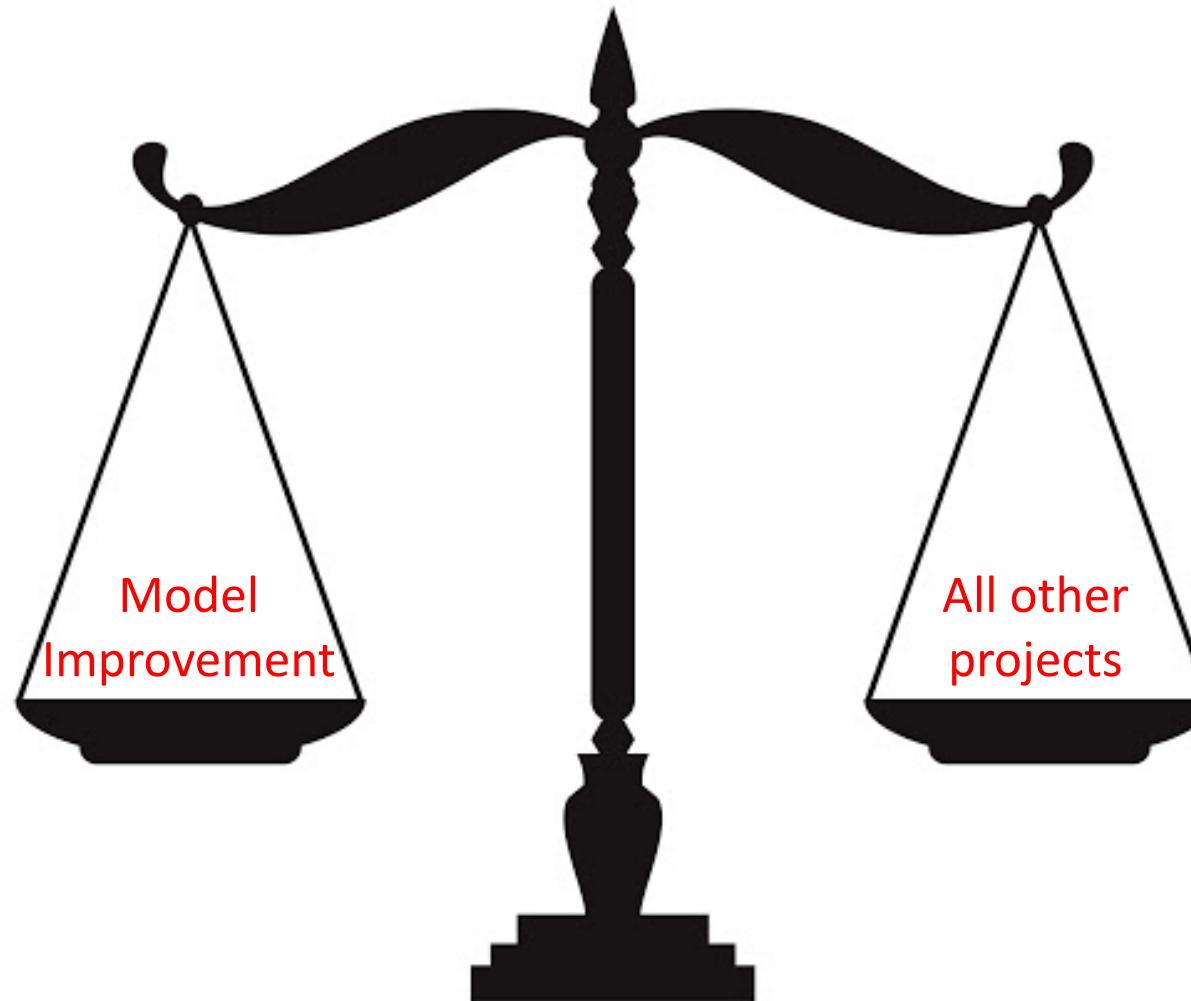
Most impactful

Finding best estimand

Relatable metrics

Beeswarm, Joy/Ridge plots

The biggest constraint: ⏰



You can be pretty good at sports analytics if you know the best denominator



Darren Rovell  @darrenrovell · Aug 9, 2019

Attack win/cover probability all you want. Now is not one of those times. Home teams, when down at least 3, going into the bottom of the 9th won 5 of 507 games this season, according to [@ESPNStatsInfo](#). Odds of the Mets winning in that spot, from real data, is less than 1 percent.

26

55

185



Michael Lopez @StatsbyLopez · Aug 9, 2019

I too like to include possible 10-run comebacks in my **denominator**

2



27



You can be pretty good at sports analytics if you know the best denominator



Mark Dominik 
@MarkdominikNFL

NFL kickers are 44/45 on Field Goals from 32-33 yards this year, but have missed an astounding 48 extra points from that same distance.

2:14 PM · Nov 21, 2016 · Twitter for iPhone

2.2K Retweets and comments **2.1K** Likes

Lessons learned



How can you (or your students) get involved?



Lessons learned



How can you (or your students) get involved?

OBJECTIVES	2019	2020
1. Pipeline for club hires	1800 sign-ups 125 entrants 8 finalists	2190 entrants 32 countries 6 college finalists
2. Serve core fans	160 attendees	225 attendees
3. Spur innovation	11 NFL hires	3 NFL hires (to-date)
4. Support partners	  	\$75k prize Promo video (link) Real time scoring 

Lessons learned



How can you (or your students) get involved?

2021 version coming in September



Lessons learned



We spend most of the time replicating the ideas or code of others



Lessons learned



We spend most of the time replicating the ideas or code of others



Burke, Causey, FO, nflscrapR, etc



Ben & Greg, Glickman & Stern, Romer, etc

JQAS/special issue, Hockey Graphs/谱写 friends, tidyverse,





Thank You

<https://statsbylopez.netlify.com/>

@StatsByLopez

