Inside the Strike Zone: MLB Umpire Accuracy Factors

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Introduction

- Home-plate umpires must accurately place a pitch in an imaginary box (the strike zone) as it crosses a three-dimensional plane (home plate)
- Every batter has their own strike zone
- Some fans have advocated for an automated ball-strike system (ABS), which utilizes camera tracking to determine whether a pitch is a ball or strike
- Some previous literature has investigated the effect of umpires on baseball outcomes and studied the prospective impact of ABS use in MLB, but no existing literature analyzes the impact of in-game factors on umpire call accuracy

This research aims to investigate which in-game factors influence the accuracy of an umpire's call in MLB games

Data & Methods

- We pulled every pitch in 2023 regular season from Statcast via pybaseball using a custom python script which filters the data to include only balls and called strikes
- The script then measures ball placement against each player's relative strike zone and the call the umpire made to determine whether the call was correct, and then plots the results
- This data is then exported to SPSS to run a binary logistic regression of the following independent variables on an indicator variable of whether the call was correct:

Variable Definitions

	Variable Name	Variable Definition*
DV	correct_call	Binary variable where 0 is an incorrect call, and 1 is a correct call.
IV	balls	Pre-pitch number of balls in count.
IV	strikes	Pre-pitch number of strikes in count.
IV	horizontal_mvmt	Absolute value of the horizontal movement in feet from the catcher's perspective.
IV	vertical_mvmt	Absolute value of the vertical movement in feet from the catcher's perspective.
IV	horizontal_pos	Horizontal position of the ball when it crosses home plate from the catcher's perspective.
IV	vertical_pos	Vertical position of the ball when it crosses home plate from the catcher's perspective.
IV	perceived_speed	Derived speed based on the extension of the pitcher's release.
IV	preasure_proxy	The change in Run Expectancy before the pitch and after the pitch.

*Variable definitions are a modified version of Statcast CSV documentation
DV: Dependent variable
IV: Independent variable

Results

Model Summary

Cox & Snell R Square	Nagelkerke R Square
0.005	0.013

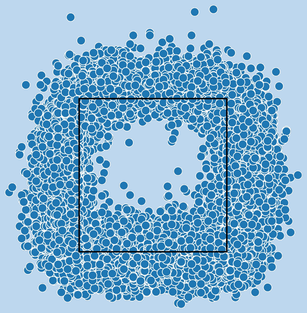
Correct Call Frequency

	N	%
0	26409	7.4
1	332072	92.6

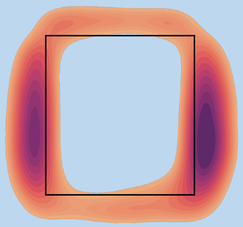
Logistic Regression on Correct Calls

Variable	Coefficient	S.E.	Sig.	Odds Ratio
balls	0.002	0.008	0.846	1.002
strikes	0.314	0.009	<.001	1.369
horizontal_mvmt	0.007	0.015	0.657	1.007
vertical_mvmt	-0.041	0.015	0.007	0.960
horizontal_pos	-0.036	0.007	<.001	0.964
vertical_pos	-0.095	0.006	<.001	0.910
perceived_speed	-0.004	0.001	<.001	0.996
preasure_proxy	-2.016	0.104	<.001	0.134
Constant	3.053	0.094	<.001	21.180

2023 Missed Calls
Scatter Plot



2023 Missed Calls
Kernel Density Estimate Plot



- Umpires make the correct call 92.6% of the time and make the incorrect call 7.4% of the time
  - Average of over 11 missed calls per game over all 2023 MLB games
  - Umpire accuracy has improved in past years
- Model explains almost none of the variation in correct calls
  - Cox & Snell R-Square and Nagelkerke R-Square are both near zero
  - This is likely due to ball position being included in the model as independent variables
- Some individual variables are significant at a $p > 0.01$ level: strikes, vertical_mvmt, horizontal_pos, vertical_pos, perceived_speed, and preasure_proxy

Discussion

What does it mean for these individual variables to be significant?

- strikes: umpires are 36.9% more likely to make a correct call for every additional strike in the count
- vertical_mvmt: umpires are less likely to make a correct call the more a ball moves downward from the pitcher to the catcher
- horizontal_pos: umpires are less likely to make a correct call the further to the right a ball is from their perspective, as seen in the density plot
- vertical_pos: umpires are less likely to make a correct call the higher the ball is from their perspective
- perceived_speed: umpires are 0.4% less likely to make a correct call for every one MPH increase in pitch speed
- preasure_proxy: umpires 8.6% less likely to make a correct call for every 0.1 increase in run expectancy

Limitations

- This data does not have unique identifiers for each umpire, meaning it cannot be seen whether the results are skewed by a group of consistently bad umpires
- The data does not include factors outside of each individual event state

Future Implications

- There is **a clear avenue for the inclusion of more nuanced variables or potential interaction effects** to enhance the model's explanatory power, ensuring a more comprehensive understanding of the factors influencing umpire decision-making in critical game situations
  - Future research should consider variables outside of the game data, including pitcher and umpire specific statistics
- **The feasibility of ABS in MLB should be analyzed further** on a technical level and on the umpiring profession as a whole
- Conduct similar research in other sports that utilize human refereeing, such as offsides and icing in the hockey or first downs in American football