

# In search of the "last-ups" advantage in baseball

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# A traditional baseball truth...

In baseball, the rule that the home team bats last was only codified in 1950; prior to that, the home team chose whether to bat last or first. Still, the belief that batting last conferred a strategic advantage was well-established long before:

"The Brooklyn team won their first game of their Western tour today, after a close and exciting contest, in which the rule of being last at the bat was again shown to be of conspicuous advantage... The home team had but one inning left to play, while Brooklyn - owing to being last at the bat - had two, and the confidence the knowledge of this fact gave them was inspiring, and on this occasion, as on others, it gave them the victory." - Henry Chadwick, Brooklyn Eagle, June 29, 1888.



This belief is sufficiently ingrained in the minds of professionals that it is often referred to without need for justification:



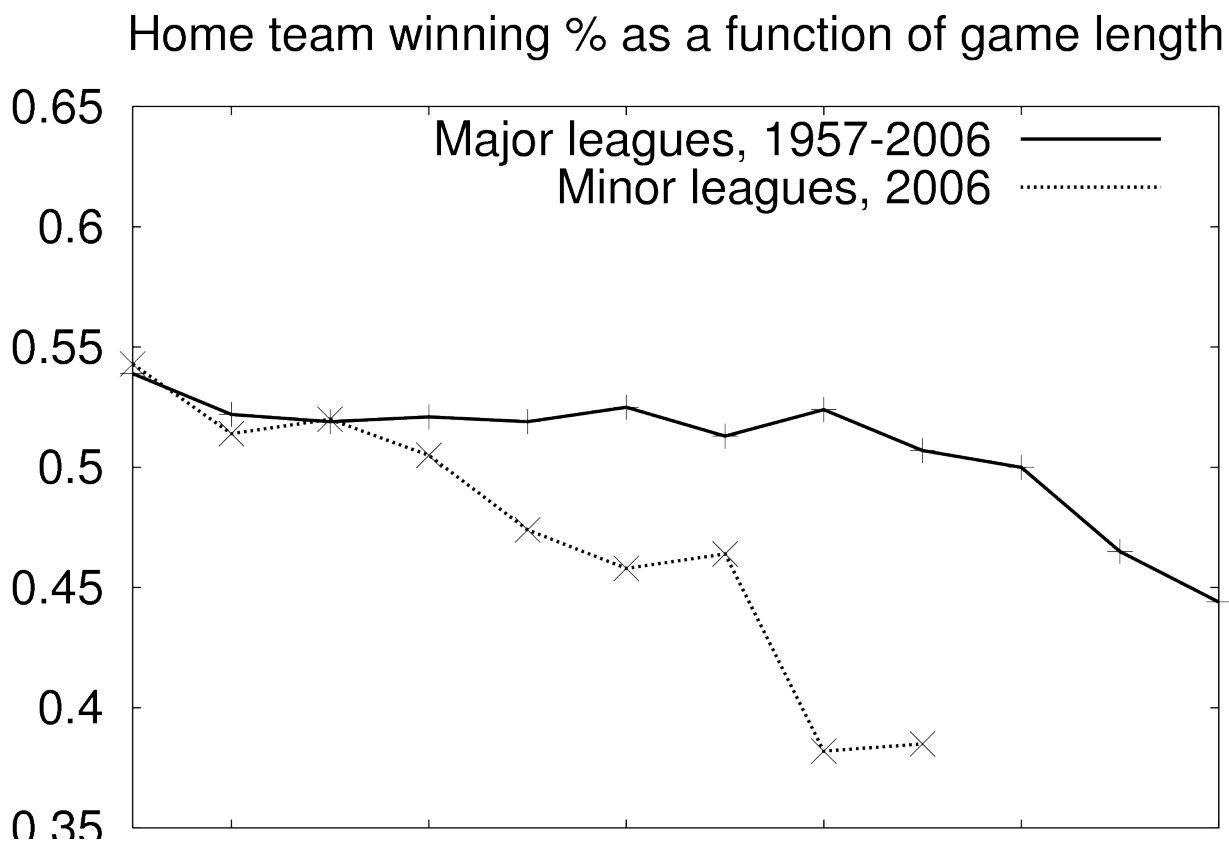
"It's tough to lose in an extra-inning game at home because you have the advantage of batting last, but we didn't get the hits when we needed them." - Joe Torre, manager of the New York Yankees, after losing to the Anaheim Angels on August 21, 2002.

## ... or is it?

Evidence in favor of such an advantage is hard to come by.

Phil Lowry, an expert on "marathon" baseball games, reports that 56% of games lasting 20 or more innings are won by the visiting team. His data includes games from all levels, from high school up, and across all countries.

In professional baseball in North America, a similar pattern appears; conditional on the length of the game, the chance the home team wins decreases as the game gets longer:



# Possible Explanations

The trend of visiting teams winning longer games is not what would be expected if there is a significant advantage to batting last. However, there are at least two possible confounds:

- Selection bias. Since home teams win more than half the time, the fact the game goes into extra innings is evidence in favor of a stronger visiting team.
- Strategic error. There may be a strategic advantage to batting last, but baseball is a sufficiently complicated game that managers are unable to systematically exploit the advantage.

We do not observe in professional baseball the natural experiment we would like to see, in which the team batting last is assigned at random; the number of neutral-site games, or games in which the "home" team actually plays the game at the "visitor's" park, is small.

Two studies examine the last-ups advantage in closely related domains; neither find evidence in support of such an advantage.

- Courneya and Carron (Journal of Sport and Exercise Psychology 1990): doubleheaders in a municipal softball league.
- Simon and Simonoff (The American Statistician 2006): NCAA College World Series games played at neutral sites.

# A game-theoretic approach

A model of baseball as a dynamic Markov game complements these empirical approaches.

The current "state" of the game is represented by a 7-dimensional vector:

- The inning (innings 9 and greater are considered the same inning)
- The half-inning (top or bottom)
- The lead (or deficit) of the team currently at bat
- The number of outs in the half-inning
- The set of bases which are occupied
- The position in the batting order of the next batter due up, for both teams.

At appropriate states, strategic actions are possible. Three are considered, reflecting the three types of strategies possible (defensive, offensive, or simultaneous-move):

- At any state, the defense may intentionally walk the batter. The batter takes first base, and all forced runners advance.
- With a runner on first only, second only, or first and second only, the offense may bunt. The batter is out, and all runners advance one base safely.
- With a runner on first only, the offense and defense engage in a simultaneous-move stage game which models the pitcher-runner interaction on potential stolen base attempts.

This game has a (Markov) Nash equilibrium, which, since the game is constant sum, gives a well-defined notion of "optimal" strategy. The equilibrium appears to be unique for parameterizations considered.

# Calibrating the model

When no strategy is employed, the outcome of the batter's turn at bat, and therefore the state transition to the next state, is determined randomly, using a two-stage approach:

- First, the type of outcome is realized; one of the set { single, double, triple, home run, walk, strikeout, generic out }
- Conditional on the type of outcome, the advancement of any runners is determined.

Outcome probabilities are a function of the position of the current batter in the order. These are calibrated to the aggregate batting performance of each lineup slot in each league over the period 1974-1992, based on Retrosheet data.

Advancement probabilities are independent of lineup slot, and are calibrated to frequencies based on Retrosheet data from 1974 to 1992.

Since there is a home-field advantage that is separate from the effects of batting first or last, two variations are considered:

- Games between two identical, equally-matched teams;
- Games where the visiting team's batting performance is calibrated to overall visiting team totals from 1974-1992, and the home team's to the overall home team totals.

# Results

**Result 1.** Using the strategies considered, there is no clear or significant advantage to batting first or last.

This result is driven by the fact that, holding fixed other considerations (outs, runners on base, lead or deficit), the strategic incentives in the top half or bottom half of the same inning are similar. Therefore, the selected strategy is almost always the same whether in the top half or bottom half. In cases where optimal strategy does differ, it does so because the team is close to indifferent between choices.

The magnitudes of the change in probability of winning are on the order of one additional win or loss in about ten 162-game seasons.

**Result 2.** The effects on probability of winning are driven by endgame factors.

The model can be solved for games of lengths other than 9 innings. In short games, the margins are larger.

**Result 3.** The narrowness of the margins is not a result of the strategies being trivial or irrelevant.

Allowing only one team to use a strategy results in a significant advantage for that team. For example, allowing only one team to attempt to steal bases gives an advantage of about two wins per 162 game season.

SB	IBB	SH	American League	National League
no	no	no	.50000	.50000
yes	no	no	.49990	.49989
no	yes	no	.49983	.49974
yes	yes	no	.49972	.49961
no	no	yes	.50056	.50068
yes	no	yes	.50044	.50048
no	yes	yes	.50017	.50015
yes	yes	yes	.50005	.49995

**Table 1.** Probability the last-batting team wins a game between identical teams, given the set of stage-game actions available (SB=stolen base, IBB=intentional walk, SH=sacrifice bunt).



			American League		National League	
SB	IBB	SH	last	first	last	first
no	no	no	.52891	.52891	.52789	.52789
yes	no	no	.53141	<b>.53161</b>	.53046	<b>.53068</b>
no	yes	no	.52874	<b>.52907</b>	.52763	<b>.52816</b>
yes	yes	no	.53123	<b>.53179</b>	.53018	<b>.53096</b>
no	no	yes	<b>.52939</b>	.52827	<b>.52846</b>	.52711
yes	no	yes	<b>.53188</b>	.53099	<b>.53096</b>	.52999
no	yes	yes	<b>.52899</b>	.52866	<b>.52793</b>	.52763
yes	yes	yes	<b>.53148</b>	.53138	.53042	<b>.53052</b>

**Table 2.** Winning percentage of home team when batting last or first, respectively, for each of the combinations of stage-game actions available. Cells in bold indicate the higher winning percentage.

# Behavioral hypotheses

- In the 19th century, when home teams could choose whether to bat first or last, batting first was fairly common. At the time, one, or very few, balls were used in a game; batting first offered the opportunity to hit a more resilient ball.
- In 1894, the home team batted first in roughly half of all games; by ten years later, the home team batted last in almost all games. Preferences were manager-specific; most of the batting-first proponents retired around the turn of the century.
- The calculations suggest the belief that batting last is an advantage is costless -- unless it results in misunderstanding of the strategic incentives, and therefore suboptimal behavior.
- For instance: with no outs, runner on first only, down by a run, the home team bunts significantly more often than the visiting team, even though this is generally a poor strategic choice.
- A behavioral hypothesis is that the origin of the belief lies in a framing effect. People may conflate having the opportunity to add to one's score with having the opportunity to influence outcomes.
- What is important is not having the last opportunity to score, but having the last opportunity to make decisions. Clearly, the team on defense is not a passive participant, but rather behaves strategically.
- Laboratory experiments in decision-making may shed light on this possibility.

# Directions

- The model does not include tactical player substitutions. The considerations involving pinch-hitting or defensive substitutions are different if a team is batting first or last. (For instance, consider the use of the closer.) The Markov approach used here can be extended to incorporate player substitutions, but the state space and therefore computational time increases rapidly.
- The stolen base interaction has the most significant impact on the results. The choices in that interaction affect the distribution of outcomes on every play that occurs in the relevant states. This suggests to look more carefully at decisions that are made more often in a game.
- New technology now offers significantly more data on pitch selection. With hundreds of pitches in a game, this could have a significant impact. Perhaps we have been looking in the wrong place all these years for where strategic choice is most important in baseball?
- If pitch selection is, in fact, an important strategic choice, this would imply that there is an advantage to batting *first*.
- If true, baseball people may have been holding mutually-contradictory beliefs for years: Batting last is an advantage, but the ability of a catcher (or manager) to "call a game" is important.