Should pitchers bat 9th?

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Notes provide additional information and were reminders during the presentation. They are not supposed to be anything close to a complete text of the presentation or thorough discussion of the subject.

Use Acrobat Readers ability to enlarge what appears on the screen if you have trouble reading a graph or table.

Why Bat Pitcher #8 (or #7)?

- Increase expected scoring:
  - *The Book* by Tom Tango, 2 others
  - *Operations Research* paper by Bukiet, others
  - *Journal of Heuristics* paper by Sokol
- Above assume no pinch hitters
- Pitchers rarely hit whole game now
  - "Pinch hitters" may be better than #8 hitter
  - May be late inning advantage if they hit #8
  - Will analyze 2006 National League

Tom Tango's book (p. 147) uses his Markov runs per game model for "typical" NL hitters by batting position and finds an increase in scoring of 0.012 runs per game if pitcher hits 8^{th} and #8 hitter bats 9^{th}. This advantage is 1.9 runs/season, which is not likely enough to produce an extra win (based on 10 extra runs for one more win).

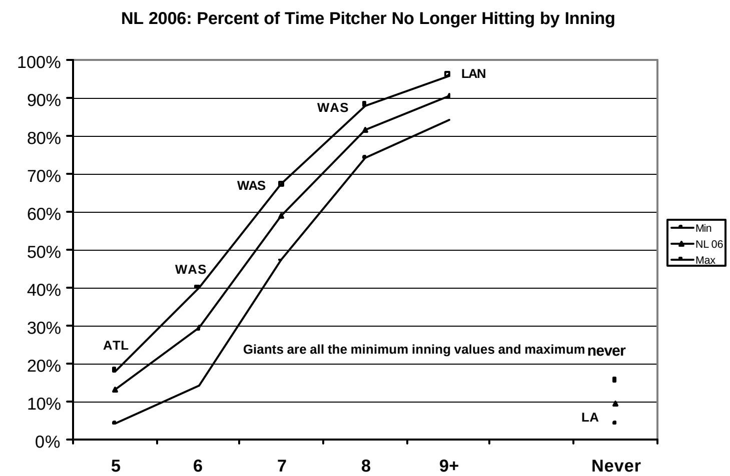
"A Markov Chain Approach to Baseball" by Bukiet, Harold, and Palacios, *Operations Research*, 1997

"A Robust Heuristic for Batting Order Optimization Under Uncertainty" by Joel Sokol, *Journal of Heuristics*, 2003

These papers also change how the top of the order hits. Idea is to give better hitters more at bats and keep pitcher away from them so they have more men on when they come up.

I asked Bukiet and Sokol to analyze where the pitcher should bat when pinch hitters are considered.

Pitchers Usually Do Not Bat Late in the Game



More than half of the time by the 7th inning pitchers are not hitting (except for Giants at 47%) and by the 8th they will be hitting less than 25% of time (26% for Giants). That indicates it is worth considering late inning effects of where the pitcher bats with the substitute hitters considered.

The three points in the lower right are 100% less the 9+ values and are games when the #9 spot always has a pitcher hitting. Note that does not mean the starting pitcher had a complete game.

Analytical Approach

- Look at last year's National League teams
- Lineup of totals by batting order position avoids small PA numbers by some players
- Pitchers' replacement hitters are non-P #9 hitters in NL parks
- Use Markov model to estimate effects on runs scored per game, in innings
- If pitcher hits 8th (7th), #8 (&#7) moved down
- Data source: retrosheet.org

Rather than worry about specific lineups for each team, I used the totals by lineup position. That avoids the problem of which of two players who had a similar playing time to use and the problem of no "regular" for a position not having very many plate appearances. I also looked at the NL 2006 totals and did the analysis on that "team".

The replacement or substitute hitters for the study are all the non-pitchers who hit in the #9 spot in NL parks. This will miss a few cases where there was a double switch followed by a pinch hitter for the pitcher or another double switch later in the game. The teams' substitute hitters had about 200-250 plate appearances.

Markov Process Model

- Based on probabilities of going from one runners/outs situation to another
- Calculates number of runs per 9 innings
- Can allow pitcher to bat before inning n, then be replaced (n=5, 6, 7, 8, 9, never)
- Also useful for analysis of strategies and batting order optimization

I have used the Markov model extensively for baseball strategy analysis, batting order optimization, and have given several talks on the subject at SABR meetings.

The model version used incorporates ML averages (84-92) for several events on the bases and some other events. None of that is going to have much of an effect on the analysis because we are interested in differences between lineups when the pitcher bats other than last. Inaccuracies in the model will cancel out when we subtract one estimate of scoring from another.

Pitcher Replacement Hitters Compared to Team's #7, #8

	Team's # 7 hitters			Team's # 8 hitters		
	OBP	SLG	OPS	OBP	SLG	OPS
NYN	-0.054	-0.136	-0.189	-0.047	**-0.102**	**-0.148**
PHI	**-0.082**	-0.099	-0.181	-0.052	0.018	-0.034
ATL	-0.016	-0.019	-0.035	-0.018	0.058	0.040
FLO	**0.040**	0.021	0.061	0.031	0.017	0.048
WAS	-0.004	-0.052	-0.056	0.006	0.054	0.060
SLN	-0.052	-0.118	-0.169	**-0.075**	-0.072	**-0.146**
HOU	-0.018	0.016	-0.003	-0.021	0.046	0.024
CIN	-0.001	0.023	0.022	0.021	0.069	0.090
MIL	0.017	0.006	0.023	**0.033**	**0.085**	**0.118**
PIT	-0.021	0.023	0.002	-0.039	0.035	-0.004
CHN	0.000	-0.015	-0.016	0.015	0.054	0.068
SDN	0.028	**0.035**	**0.063**	0.032	0.031	0.063
LAN	-0.058	-0.058	-0.116	-0.051	0.003	-0.048
SFN	-0.005	0.002	-0.003	-0.022	-0.033	-0.055
COL	0.002	-0.028	-0.026	-0.016	-0.001	-0.017
ARI	-0.050	**-0.181**	**-0.231**	-0.050	-0.079	**-0.129**
Median	-0.011	-0.017	-0.021	-0.020	0.024	0.010

The blue numbers are cases when the replacement hitters for the pitchers have better stats than the team's #7 or #8 hitters totals. The bolded ones are the best The red ones show the worst or near worst cases for the replacement hitters.

In general, the replacement hitters are weaker than the teams' #7 hitters. They have a little lower OBP compared to the #8 hitters, but a little higher SLG.

We see that the Brewers are the team with the pitchers' replacement hitters the best in comparison to their #8 and are also better than #7 hitters. Padres and Marlins also are blue all the way across and Reds are very close. Mets, Cards, Diamondbacks are the opposite with no positive (blue) values.

NL, 3 Best, 3 Worst

	# 7 hitters			# 8 hitters			P Replacements		
	OBP	SLG	OPS	OBP	SLG	OPS	OBP	SLG	OPS
NL06	0.323	0.424	0.747	0.321	0.376	0.697	0.306	0.390	0.696
MIL	0.354	0.459	0.813	0.338	0.380	0.718	0.371	0.465	0.836
SDN	0.299	0.382	0.681	0.295	0.386	0.681	0.327	0.417	0.744
FLO	0.306	0.390	0.696	0.315	0.394	0.709	0.346	0.411	0.757
NYN	0.311	0.395	0.706	0.304	0.361	0.665	0.257	0.259	0.517
SLN	0.307	0.398	0.705	0.330	0.352	0.682	0.255	0.280	0.536
ARI	0.357	0.529	0.886	0.357	0.427	0.784	0.307	0.348	0.655

- Best, worst are comparisons (prior slide)
- Cards replacements not much better than pitchers (OBP: 0.224, SLG: 0.222)

Cardinals pitchers OBP by far best in league (Padres 0.193 is second), and their SLG (less than OBP!) is 4th (Cubs 0.252, Padres, Giants, 0.226).

For replacement hitters:

Brewers had best OBP and 3rd best SLG (CIN, 0.500, ATL 0.481). Cards and Mets had two lowest OBP, SLG

Table provides some context for the comparisons.

First Thoughts

- Advantage of getting stronger hitters (compared to #8 hitters) up earlier
- Particularly in late innings of close games
- Trade off with pitcher hitting higher in order for part of game
- Overall scoring may be improved
- Brewers looked like good candidate to benefit from pitcher hitting 8th

Will focus first on overall scoring. In other words, is the tradeoff between having the pitcher hit higher in the order, which will lead to some extra plate appearances, overcome and then some by having better hitters (their replacements compared to the weak #7 or #8 hitters) come up earlier in later innings?

Brewers substitute hitters have greatest advantages in all three categories compared to their #8 hitters.

Brewers Scoring if Pitcher Bats 7^{th} or 8^{th}

Markov Model Runs per Game

	Pitcher bats			vs. #9 slot	
Sub. Inn.	7	8	9	7	8
5	5.011	5.029	5.048	-0.036	-0.019
6	4.934	4.943	4.950	-0.016	-0.008
7	4.845	4.862	4.873	-0.028	-0.012
8	4.759	4.772	4.779	-0.020	-0.007
9	4.674	4.690	4.697	-0.023	-0.007
Never	4.587	4.603	4.608	-0.021	-0.005

Sub. Inn. is the earliest inning pitcher does not bat

- Scoring lower if P not batting last
- Not what was expected
- Better “pinch hitters” needed?

Explain table.

Substitute inning is the earliest inning in which P is not allowed to hit. Values show how much pitchers’ hitting lowers scoring as they bat more, but ignores how well they are pitching and the availability of pinch hitters.

Differences are not very large (.019 x 162 = 3 runs per season if P bats 8th, but no advantage to not hitting pitcher last.

(Bukiet and Sokol also find Brewers pitcher should hit #9)

What’s going on? Maybe a larger advantage for the replacement hitters is needed, so lets assume they all hit like Ted Williams in 1941! Will do the analysis using the NL as a whole in the next slide.

What if Replacement Hitters are Ted Williams in 1941?

	Williams 1941 as P Replacement					NL 2006 Replacement Hitters				
	Pitcher bats			vs. #9 slot		Pitcher bats			vs. #9 slot	
Sub. Inn.	7	8	9	7	8	7	8	9	7	8
5	5.647	5.669	5.704	-0.057	-0.035	5.096	5.116	5.130	-0.034	-0.015
6	5.491	5.494	5.506	-0.015	-0.012	5.042	5.054	5.061	-0.019	-0.007
7	5.310	5.330	5.349	-0.040	-0.020	4.977	4.996	5.005	-0.028	-0.010
8	5.137	5.148	5.159	-0.022	-0.011	4.916	4.932	4.938	-0.022	-0.007
9	4.963	4.983	4.993	-0.030	-0.010	4.855	4.873	4.880	-0.025	-0.007
Never	4.793	4.810	4.815	-0.022	-0.005	4.793	4.810	4.815	-0.022	-0.005

- Table based on total 2006 NL
- Scoring still lower if P not batting last
- Very strong pinch hitters no “help”

The disadvantage of not hitting the pitcher last gets larger when compared to the actual total NL pinch hitters (shown in right side of table)

Clearly, my first thoughts are not right. Does any NL 2006 team gain from not batting pitcher last?

What About Other Teams?

- Cardinals only one improved if P not #9

Markov Model Runs per Game					
	Pitcher bats			vs. #9 slot	
Sub. Inn.	7	8	9	7	8
5	5.046	5.066	5.069	-0.023	-0.003
6	5.015	5.031	5.028	-0.013	0.003
7	4.979	4.999	4.997	-0.018	0.002
8	4.944	4.962	4.958	-0.013	0.005
9	4.910	4.930	4.925	-0.014	0.006
Never	4.874	4.894	4.886	-0.012	0.007

- Very small gain (1 run/162 G or less)
- Bukiet model: similar findings

The only one is the Cards, and the difference is quite small. Bukiet did a similar analysis with his Markov model, which has some meaningful differences from mine, and obtained the same result: only the Cards might increase scoring, but by a small amount. Sokol, whose Markov model also has some important differences, also found the Cardinals pitcher should bat 8th, and that is the case for the Cubs and Phils. In all cases, difference in runs per season is small and unlikely to produce an extra win.

Is there something about that team of interest?

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LAN	-0.058	-0.058	-0.116	-0.051	0.003	-0.048
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COL	0.002	-0.028	-0.026	-0.016	-0.001	-0.017
ARI	-0.050	**-0.181**	**-0.231**	-0.050	-0.079	**-0.129**
Median	-0.011	-0.017	-0.021	-0.020	0.024	0.010

Same slide as shown previously. Note that the Cards had the largest OBP disadvantage compared to #8 hitters and almost the largest OPS (just behind the Mets) one. They also have a substantial SLG "shortfall".

My previous studies show changes in OBP have a larger influence on scoring than changes in SLG (about twice as much per point), so the Cards are really weaker than the Mets for replacement hitters.

Likely Explanation

- Keeping weaker hitters away from strong ones at top of order improves scoring
  - Want men on when better hitters bat
  - Williams 1941: want him at #9 to give top 3 (and not #8 in 9 spot) shot at driving him in
  - Cards had worst substitutes so small advantage to letting better #8s bat 9th
  - Bukiet, Sokol use this to find optimal lineups

This is a similar concept to that presented in Bukiet, Harold, Palacios paper. Sokol paper carries the concept further and classifies players by ranking batters in lineup by their abilities to get on base and/or drive in runs. He then provides guidelines (a “heuristic”) for constructing the lineup that implies the weakest hitter should not necessarily bat last in an optimal batting order.

Late Inning Considerations

Brewers scoring probabilities

Pitcher still hitting

Scoring at least one run

	Pitcher batting slot:			Compare to #9 slot:	
Lead off	9	8	7	8	7
1	29.4%	29.4%	29.4%	0.0%	0.0%
2	31.9%	31.9%	31.5%	0.0%	-0.4%
3	33.0%	32.6%	30.9%	-0.3%	-2.1%
4	33.4%	32.0%	29.5%	-1.4%	-4.0%
5	29.0%	27.0%	26.1%	-2.0%	-2.8%
6	25.2%	24.7%	25.0%	-0.6%	-0.2%
7	23.1%	23.3%	22.1%	0.3%	-1.0%
8	22.6%	21.2%	27.9%	-1.4%	5.3%
9	21.9%	27.6%	27.6%	5.7%	5.7%

Pitcher no longer hitting

Scoring at least one run

	Pitcher batting slot:			Compare to #9 slot:	
Lead off	9	8	7	8	7
1	29.4%	29.4%	29.4%	0.0%	0.0%
2	31.9%	31.9%	31.9%	0.0%	0.0%
3	33.0%	33.1%	33.3%	0.1%	0.3%
4	33.9%	34.4%	34.5%	0.6%	0.6%
5	31.5%	32.0%	31.9%	0.5%	0.4%
6	30.3%	30.4%	30.5%	0.2%	0.3%
7	29.1%	29.1%	29.1%	0.0%	0.1%
8	28.4%	28.3%	27.9%	-0.2%	-0.5%
9	28.8%	27.6%	27.6%	-1.3%	-1.3%

Cardinals scoring probabilities

Pitcher still hitting

Scoring at least one run

	Pitcher batting slot:			Compare to #9 slot:	
Lead off	9	8	7	8	7
1	34.9%	34.9%	34.9%	0.0%	0.0%
2	36.6%	36.6%	36.3%	0.0%	-0.3%
3	36.5%	36.3%	34.8%	-0.2%	-1.7%
4	30.8%	29.6%	27.5%	-1.2%	-3.4%
5	26.3%	24.5%	23.7%	-1.8%	-2.7%
6	21.9%	21.3%	21.7%	-0.6%	-0.3%
7	22.2%	22.3%	21.0%	0.1%	-1.3%
8	23.6%	22.0%	27.5%	-1.6%	4.0%
9	25.5%	31.0%	31.0%	5.6%	5.6%

Pitcher no longer hitting

Scoring at least one run

	Pitcher batting slot:			Compare to #9 slot:	
Lead off	9	8	7	8	7
1	34.9%	34.9%	34.9%	0.0%	0.0%
2	36.6%	36.6%	36.5%	0.0%	-0.1%
3	36.5%	36.4%	35.5%	-0.1%	-1.0%
4	31.0%	30.3%	29.1%	-0.7%	-1.9%
5	27.0%	26.1%	25.6%	-0.9%	-1.4%
6	23.6%	23.4%	23.6%	-0.2%	0.0%
7	24.2%	24.1%	24.3%	0.0%	0.1%
8	25.4%	25.4%	27.5%	-0.1%	2.1%
9	28.7%	31.0%	31.0%	2.3%	2.3%

Note: order of pitcher batting positions is reversed from prior tables

Sums of all comparison columns in these tables is close to 0 (max is 0.5% for Brewers with pitcher batting 7 compared to 9). If we assume roughly equally likely for any lineup position to be leading off in a late inning, these imply there is little tactical advantage from the pitcher's batting slot.

Results are similar for other scoring probabilities (scoring exactly 1, 2, 3 runs, scoring 4 or more), but the differences by leadoff slot get smaller as the number of runs increases. That is because to score lots of runs, just about the whole lineup will have to hit. There is some advantage to having higher OBP players hit earlier to increase chances of a longer inning.

Interesting comparisons between the two teams effects of the pitcher not batting last.

These probabilities are likely not all that interesting because in addition to not showing any real advantage or disadvantage based on where the pitcher bats, managers will try to get their most "useful" PH up in late innings based on the score, runners and outs, and the opponent (potential) pitcher.

Conclusions

- Pitcher might as well bat last
  - Modeled gains in cases when #8 is better are very small, likely statistically insignificant
  - No apparent late inning advantage if P not #9
  - Based on no change at top of order
- Stronger pinch hitters support #9 for P
- May not be true for “optimal” lineups
  - Move better hitters towards top of order
  - Hit P #8 (or #7) to keep them away

Based on “average” performance, there seems to be no good reason not to bat the pitcher ninth if current practices at the top of the order are followed. Even in cases where it may be an advantage for P to bat 8, expected gains are small, so other things not considered, such as potential double switches, may be more important

Also, there does not appear to be a late inning advantage to having the pitcher hit earlier based on average performance of the replacement hitters.

That leaves open the possibility that strengthening the top of the order by moving down a not very strong #1 or #2 hitter and moving up the #3 and #4 hitters would be helped further by batting the pitcher 8th (or maybe 7th). The Bukiet and Sokol papers (see next page for URLs) discuss this issue.

Web sites, e-mail

www.pankin.com/baseball.htm

has details about Markov model and other baseball studies

Bukiet, Harold, Palacios paper:
http://m.njit.edu/~bukiet/Papers/ball.pdf

Sokol paper:

http://www2.isye.gatech.edu/~jsokol/boouu.pdf

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Plan to post slides, notes on my web site

Bukiet's computations referred to in this presentation were assisted by Kevin Fritz, HS student; Michael Hourican, NJIT undergraduate and Michael Grover, Williams College undergraduate