

# Reference Point for the Baseball Players

Economic evaluation of the behavior of athletes

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# Motivation

- To make an economic explanation about the behavior of the athletes, with attention to how the firms : team owners evaluates their performance.
- In this study, I pick up that of baseball : Ample observable statistics indicating performance of the players, that are examined their efficiency w.r.t. making earn more scores, or wins.

# References

- Pope & Simonsohn (2011, Association for Psychological Science)  
“Round Numbers as Goals : Evidence From Baseball, SAT Takers, and the Lab”
- Hakes & Sauer (2006, Journal of Economic Perspectives)  
“An Economic Evaluation of the *Moneyball* Hypothesis”

# Pope & Simonsohn (2011)

- Verify that **round numbers** in performance scales act as **reference points**, by examining three practical studies.
- In the first study, they found that baseball players in MLB prefer finishing the season with a batting average(AVG) just above .300, to that with just below .300.
- Data : MLB player's play-by-play data from 1975 to 2008.  
Players with at least 200 at bat (打数) :  $N=8,817$

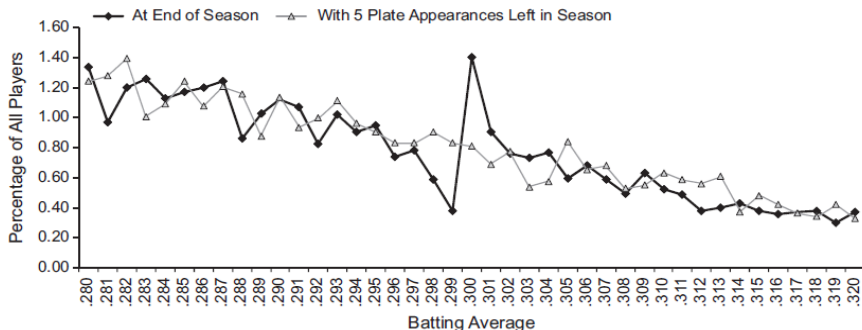
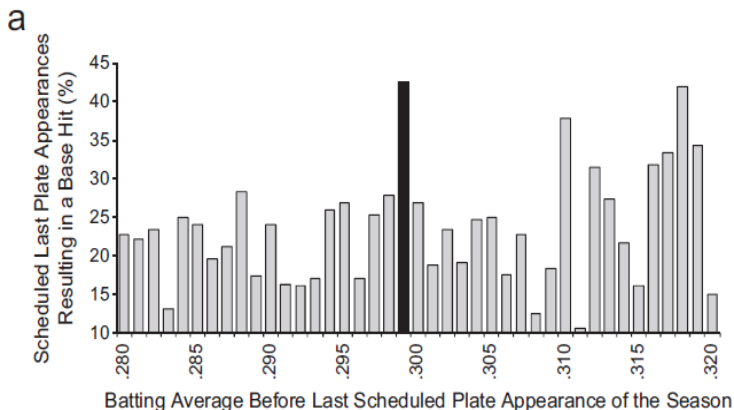


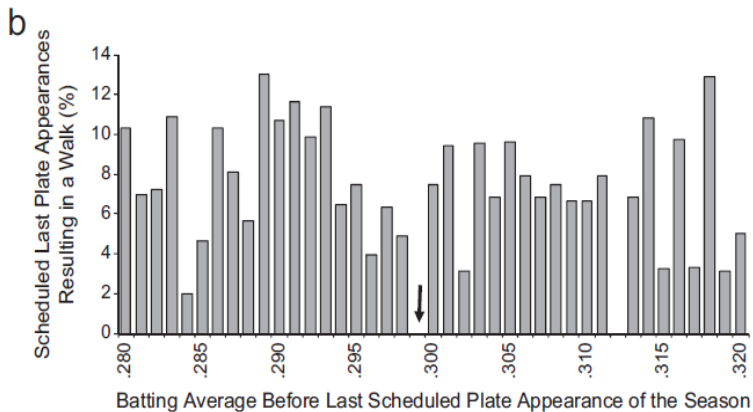
Fig. 1. Relative frequency of batting averages among Major League Baseball players between 1975 and 2008. Batting averages at the end of the baseball season and with five plate appearances left in the season are shown. The graph includes only player-seasons with at least 200 at bats.

- Players with  $.298$  or  $.299$  ( $0.97\%$ )  $<$  with  $.300$  or  $.301$  ( $2.30\%$ ),  $Z = 7.35$ ,  $p < .001$ .
- Control distribution : when 5 plate appearances left in the season.



- Players with AVG of .299 was likely to get a base hit(43%) than overall(22.8%) at their last PA.

$$Z = 3.62, p < .001.$$



- .298 or .299 players tend to walk (四球) than .300 or .301 players.

$$Z = 2.14, p = .032.$$

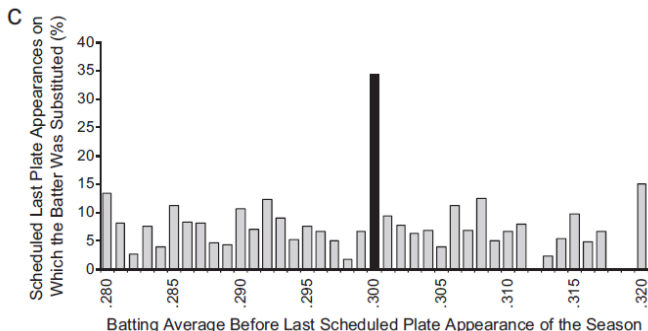


Fig. 2. Outcome of the last scheduled plate appearance of the season: percentage of plays resulting in (a) base hits, (b) walks (which cannot increase batting average), and (c) batter substitutions (pinch hitter brought in). Bars involved in tests of predictions are highlighted in black. The arrow in (b) emphasizes that not a single player with a batting average of .299 walked.

- If his AVG is just above .300, then he might end the season earlier by being substituted.

$$Z = 8.29 \text{ and } p < .001.$$



# Pope & Simonsohn

- The behavior of baseball players proved the existence of the reference point of round numbers, such as batting average of .300.
- Limitations:  
There were only one relevant round number.  
Action to improve their performance took place on the last plate appearance.

# Hakes & Sauer(2006)

- *“Moneyball Hypothesis”*  
: Michael Lewis’s claim that the valuation of skills in MLB player’s market was grossly inefficient.
- Members of the Society for American Baseball Research (In short, SABR) have studied that on-base percentage (OBP) plays more important role to consider the winning average than batting average, or slugging average.
- After the publication of “Moneyball,” OBP got regarded of more importance than before  
: Players with high batting averages or many homeruns are overestimated.

# Definition

$$\text{AVG} = \frac{\text{base-hits}}{\text{at-bats}}$$

$$\text{OBP} = \frac{\text{base-hits} + \text{walks} + \text{hit-by-pitches}}{\text{at-bats} + \text{walks} + \text{hit-by-pitches} + \text{sacrifice-flies}}$$

$$\text{SLG} = \frac{\text{singles} + 2 \times \text{doubles} + 3 \times \text{triples} + 4 \times \text{HRs}}{\text{at-bats}}$$

Table 1

## The Impact of On-Base and Slugging Percentage on Winning

	<i>Model</i>			
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
Constant	0.508 (0.114)	0.612 (0.073)	0.502 (0.099)	0.500 (0.005)
On-Base	3.294 (0.221)		2.141 (0.296)	2.032 (0.183)
On-Base against	-3.317 (0.196)		-1.892 (0.291)	-2.032 <sup>R</sup>
Slugging		1.731 (0.122)	0.802 (0.149)	0.900 (0.106)
Slugging against		-1.999 (0.112)	-1.005 (0.152)	-0.900 <sup>R</sup>
Number of observations	150	150	150	150
$R^2$	.825	.787	.885	.884

Hypothesis test of model 4,  $H^0$ : On-Base = Slugging

$F(1, 147) = 16.74$ ,  $p$ -value = 0.0001

*Source:* Retrosheet Game Logs, (<http://www.retrosheet.org>). The data were obtained free of charge from, and are copyrighted by, Retrosheet, 20 Sunset Rd., Newark, DE 19711.

*Notes:* Data are aggregate statistics for all 30 teams from 1999–2003. Coefficient estimates were obtained using ordinary least squares. Coefficients for annual 0/1 dummy variables are suppressed. Standard errors are in parentheses. Superscript “R” indicates that the coefficient was restricted to equal its counterpart in the regression. The  $p$ -value for the null hypothesis that restrictions are valid is 0.406 ( $F = 0.52$ ).

Table 3

## The Baseball Labor Market's Valuation of On-Base and Slugging Percentage

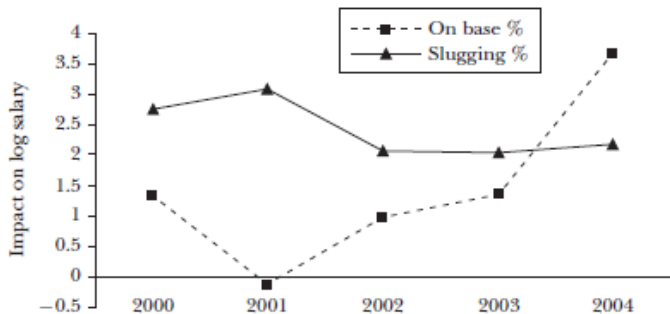
	<i>All Years</i>	<i>2000– 2003</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>
On-Base	1.360 (0.625)	0.842 (0.678)	1.334 (1.237)	−0.132 (1.230)	0.965 (1.489)	1.351 (1.596)	3.681 (1.598)
Slugging	2.392 (0.311)	2.453 (0.338)	2.754 (0.628)	3.102 (0.613)	2.080 (0.686)	2.047 (0.850)	2.175 (0.788)
Plate appearances	0.003 (0.000)	0.003 (0.000)	0.003 (0.000)	0.003 (0.000)	0.003 (0.000)	0.003 (0.000)	0.003 (0.000)
Arbitration eligible	1.255 (0.047)	1.242 (0.048)	1.293 (0.102)	1.106 (0.100)	1.323 (0.100)	1.249 (0.111)	1.323 (0.115)
Free agency	1.683 (0.044)	1.711 (0.185)	1.764 (0.096)	1.684 (0.092)	1.729 (0.097)	1.663 (0.107)	1.575 (0.105)
Catcher dummy	0.152 (0.056)	0.185 (0.061)	0.137 (0.124)	0.065 (0.116)	0.208 (0.122)	0.343 (0.134)	0.059 (0.133)
Infielder dummy	−0.029 (0.040)	−0.007 (0.044)	0.060 (0.087)	0.069 (0.083)	−0.087 (0.086)	−0.054 (0.095)	−0.100 (0.098)
Intercept	10.083 (0.170)	10.429 (0.178)	10.078 (0.360)	10.347 (0.321)	10.490 (0.358)	10.289 (0.387)	9.782 (0.414)
Observations	1736	1402	353	357	344	342	340
$R^2$	0.675	0.687	0.676	0.728	0.695	0.655	0.635
<i>Value of one-standard-deviation increase (in millions of dollars)</i>							
On-Base			0.14	0.16	0.17	0.19	0.49
Slugging			0.52	0.61	0.64	0.70	0.61

Source: Same as Table 2.

Notes: The dependent variable is  $\ln(\text{Salary})$  for year  $t$ , and performance variables are from year  $t - 1$ . 0/1 dummies for each year are included in the pooled regressions. Standard errors in parentheses. The sample includes all players with at least 130 plate appearances during the relevant season.

Figure 1

## Labor Market Returns to On-Base and Slugging Percentage Over Time



## Extension : Reference point of Other Indexes

- On-base percentage may be more important than batting average, when it comes to consider raising winning average, and it reflects players' effort in similar way to batting average.  
⇒ Round numbers in on-base percentage may act as reference point, as well as batting-average : .350 or .400.
- Moneyball hypothesis emphasized the importance of on-base percentage, rather than batting average :  
After the way to evaluation of the ability revised, players may diminish their effort to meet the reference point, AVG of .300.

# Extension : International Comparision

- In Nippon Professional Baseball (NPB), the contribution of the SABRmetrics is not recognized as much as in MLB :  
Evaluation of the players or players' preference may differ from that in MLB.
- Studies of evaluating performance in MLB  
“Contract Length and the Return to Performance in Major League Baseball” Krautmann & Oppenheimer(2002, Journal Of Sports Economics)  
“Analyzing Major League Baseball Player's Performance Based On Age And Experience” K.Ng(2017,Journal of Sports Economics & Management)



# Data

- Sortable team stats of Nippon Professional Baseball (NPB), from 2008 to 2017.  
: N=120
- Indexes : Winning average (勝率 : WA), Runs (得点 : R) Runs allowed (失点 : RA) , Batting average (AVG), On-base percentage (出塁率 : OBP) Slugging percentage(長打率 : SLG)

# Model

- Confirm that also in NPB, OBP contributes better to the Win Average than AVG or SLG.  
Applying OLS,

$$WA_i = \beta \mathbf{X}_i + RA_i + u_i$$

$$R_i = \gamma \mathbf{X}_i + v_i$$

$WA_i$  : Win average of team  $i$

$R_i$  : Runs of team  $i$

$\mathbf{X}_i$  : OBP, SLG and AVG of the team  $i$

# Results: Winning Averages

Table: Contribution to winning averages

	<i>Dependent variable:</i>	
	WA	
	(1)	(2)
OBP	1.448*** (0.316)	
AVG		1.194*** (0.425)
SLG	1.257*** (0.146)	1.369*** (0.170)
RA	-0.001*** (0.00004)	-0.001*** (0.00004)
Constant	-0.024 (0.074)	0.100 (0.072)
Observations	120	120
R <sup>2</sup>	0.825	0.807
Adjusted R <sup>2</sup>	0.821	0.802
Residual Std. Error (df = 116)	0.031	0.032
F Statistic (df = 3; 116)	182.732***	161.505***

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

# Results:Runs

Table: Contribution to runs

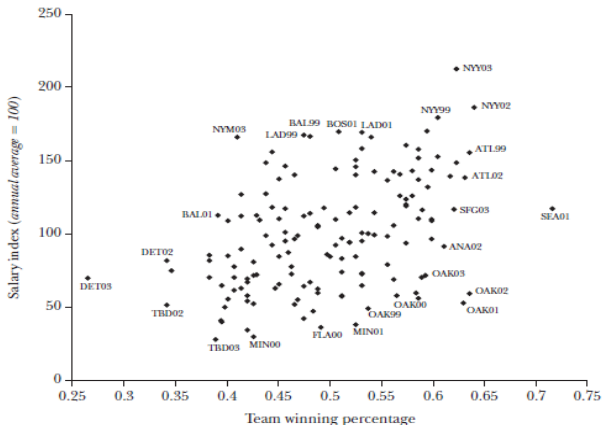
	<i>Dependent variable:</i>	
	R	
	(1)	(2)
OBP	2,213.855*** (225.357)	
AVG		1,786.436*** (354.230)
SLG	1,650.727*** (99.793)	1,818.552*** (137.220)
Constant	-774.218*** (51.748)	-583.790*** (58.846)
Observations	120	120
R <sup>2</sup>	0.918	0.877
Adjusted R <sup>2</sup>	0.917	0.875
Residual Std. Error (df = 117)	21.897	26.809
F Statistic (df = 2; 117)	656.783***	418.676***

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Figure 2

Frontier for Efficient Conversion of Team Salary into Team Winning Percentage, 1999–2003



Source: Won-loss records from [www.baseball-reference.com](http://www.baseball-reference.com). Team salaries from SABR, (<http://businessofbaseball.com/data.htm>).

Notes: Teams near the frontiers of efficient and inefficient conversion are given a team-year label, with the last two digits indicating the year. Teams near the frontiers are Atlanta (ATL), Anaheim (ANA), Baltimore (BAL), Boston (BOS), Detroit (DET), Florida (FLA), Los Angeles Dodgers (LAD), Minnesota (MIN), Oakland (OAK), New York Mets (NYM), New York Yankees (NYN), Seattle (SEA), San Francisco Giants (SFG), and Tampa Bay Devil Rays (TBD). All years for Oakland are included.