Eras in baseball: Change point analysis fun title.

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Abstract

Baseball is some weird and wild shit.

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1 Introduction

The first professional baseball team in the United States, the Cinicnnati Red Stockings, was formed in 1869 (Rothenberg (n.d.)). Many leagues came and went in the late 1800s, but National League (NL), formed in 1876, emerged as the predominant league of the time. A few decades later, the American League (AL) began growing in popularity and eventually reached an agreement with the NL to be the two major leagues of baseball with the winner of each league playing in the World Series starting in 1903.

Throughout the history of baseball in the United States, the game has gone through many changes and distinct eras. For example, the time period between approximately 1900-1919 is often referred to as the "Dead Ball Era" and was marked by low scoring games and dominant pitching. Another more recent example would be the "Steroid Era" which lasted from approximately 1994 through 2005 and was characterized by a rapid increase in power hitting largely attributed to players using performance enhancing drugs.

While many baseball writers have attempted to define the different eras of baseball, there has also been some academic work that has sought to empirically define eras in baseball. Groothius, Rotthoff, and Strazicich (2017) looked for structural breaks in univariate times series of performance measures over the period from 1871-2020. They analyzed four statistics: slugging percentage (SLG, home run (HR) rate, batting average (BA), and runs batted in (RBI) rate. For each of these statistics, the computed the mean and standard deviation (SD) across all players who had at least 100 at bats in a given season to yield a univariate time series for each of these statistics. They then used the Lagrange Multiplier (LM) unit root test proposed in (**LeeandStrazicich2003?**) to find structural breaks. They identified structural breaks in slugging percentage in 1921 and 1992, the first of which marks the end of the Dead Ball Era and the latter corresponding to the start of the steroid era.

H. and R. (2005) looks for structural changes in competitive balance of the two league American and National. Use methods from Andrews1993, Bai1997, 1999 and Bai and Perron 1998 and 2003 to look for break points between 1901 -1999. Theuy measure competitive balance in two ways: 1) Noll 1988 and Scully 1989 and 2) Lee (2004). They find break point sin competitive balance in 1912, 1926, and 1933 for the NL and in 1926 and 1957 in the AL.

Baseball is not the only sport where this type of analysis has been applied. I. (2004) looked for structural changes in soccer using data from British soccer leagues through 1996. Fort R. (2007) looked for structural breaks in major North American sports other than baseballl; that is basketball (NBA), hockey (NHL), and American football (NFL). WHAT DID THEY FIND?

All of the previous work mentioned here focuses on ***univariate*** In contrast to their methods, we use more modern methods Double CUSUM Binary Segmentation algorithm (H. Cho

(2016)) and the Sparsified Binary Segmentation algorithm (H. Cho and Fryzlewicz (2014)).

Just Notes: Palacios-Huerta I. (2004). Structural changes during a Century of the World's most popular sport. Statistical Methods and Applications, 13, 241–258 I. (2004) Structural Breaks in soccer

Nieswiadomy (2012) Was there a structural break in Barry Bonds's Bat? Looking for structural breaks in Bonds OPS times series. Use the uni root test on monthly data from 86-07. The identify break points in June 1993 and Sept 2000.

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https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1465-7295.2007.00026.x Fort and Lee 2007: Looks for structural breaks in NBA, NHL, and NFL

https://www.baseball-reference.com/bullpen/History_of_baseball_in_the_United_States

https://thesportjournal.org/article/examining-perceptions-of-baseballs-eras/

SOME MORE STUFF

https://pubmed.ncbi.nlm.nih.gov/30747582/?

The goal of this work is to use multivariate change point analysis to identify change points in MLB as a whole to objectively identify eras in the games history, but also to look for change points to identify team specific eras.

The work that is the most closely related to our own is that of Groothius, Rotthoff, and Strazicich (2017), which looked for structural breaks (Note: the terms "structural breaks" and "change points" are used interchangeably in this manuscript) in univariate times series.

univariate time series of the means and SD's of several statistics (i.e. SLUG, HR rate, RBI rate, and batting average) to look for structural breaks via the Lagrange Multiplier (LM) unit root test (**LeeandStrazicich2003?**). Notably they find structural breaks in slugging percentage in 1921 and 1992. In contrast to their methods, we use more modern methods Double CUSUM Binary Segmentation algorithm (H. Cho (2016)) and the Sparsified Binary Segmentation algorithm (H. Cho and Fryzlewicz (2014)).

Woltring and Jubenville (2018) From Woltring: "Baseball has endured much change over the course of its history, and because of constant change, the modern era of baseball has been segmented into six distinct sub-eras. A common list presented at Baseball-Reference described the eras as the Dead Ball Era (1901-1919), the Live Ball Era (1920-1941), the Integration Era (1942-1960), the Expansion Era (1961-1976), the Free Agency Era (1977-1993)

and the Long Ball/Steroid Era (1994-2005) (17). This study runs through the 2011 season and a seventh era will be added and labeled the Post Steroid Era (2006-2011)"

Deadball era: https://sabr.org/journal/article/the-rise-and-fall-of-the-deadball-era/

http://mlb.mlb.com/mlb/history/mlb_history_people.jsp?story=com

https://www.nytimes.com/2011/09/25/sports/baseball/scoring-in-baseball-returns-to-dead-ball-levels.html?_r=1&

https://bleacherreport.com/articles/1676509-the-evolution-of-the-baseball-from-the-dead-ball-era-through-today

(**FortLee2014?**): Fort R., Lee Y. H. (2006). Stationarity and major league baseball attendance analysis. Journal of Sports Economics, 7, 408–415.

Fort R., Lee Y. H. (2007). Structural change, competitive balance, and the rest of the major leagues. Economic Inquiry, 45, 519–532.

Lee Y. H., Fort R. (2005). Structural change in baseball's competitive balance: The great depression, team location, and racial integration. Economic Inquiry, 43, 158–169.

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degruyter.com/document/doi/10.1515/1559-0410.1305/html

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Fort, Rodney and Young Hoon Lee (2006). "Stationarity and Major League Baseball Attendance Analysis." Journal of Sports Economics, 7 (4), 408–415.

Fort, Rodney and Young Hoon Lee (2007). "Structural Change, Competitive Balance, and the Rest of the Major Leagues." Economic Inquiry, 45 (3), 519-532.

Lee, Young Hoon, and Rodney Fort (2005). "Structural Change in Baseball's Competitive Balance: The Great Depression, Team Location, and Racial Integration." Economic Inquiry,

43, 158-169.

Sommers, P. (2008). "The Changing Hitting Performance Profile in Major League Baseball, 1966-2006." Journal of Sports Economics, 9, 435-440.

Berry, Reese, and Larkey (1999) they talk about bridging eras.

When did the steroids era start: https://www.espn.com/mlb/topics/_/page/the-steroids-era#:~:text=Unlike%20other%20MLB%20%22eras%2C%22,leaguewide%20PED%20testing%20until%202003.

Traditional wisdom: 1900-1919 dead ball era

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https://www.baseball-reference.com/bullpen/Deadball_Era 1901-1920

Mound was lowered in december 1968.
https://www.baseball-reference.com/bullpen/Pitcher%27s_mound

https://www.espn.com/mlb/story/_/id/33238595/major-league-baseball-stops-testing-players-steroids-nearly-20-years-report-says

https://www.semanticscholar.org/paper/Was-There-a-Structural-Break-in-Barry-Bonds's-Bat-Nieswiadomy-Strazicich/0a32effa10a3d26ea4675efcca3f13229efe0f7d

2 Methods

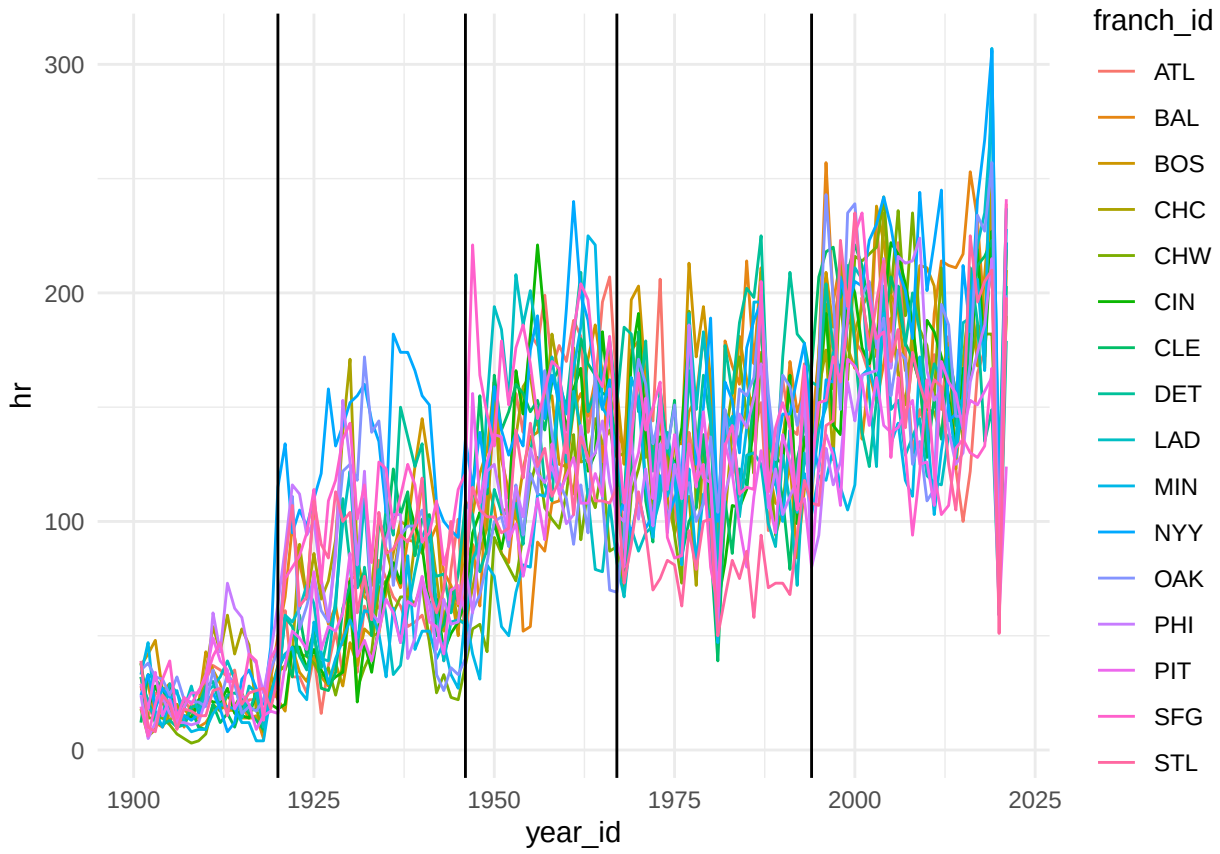
H. Cho and Fryzlewicz (2014) and H. Cho (2016)

R Pacakge: Haeran Cho and Fryzlewicz (2018)

3 Results

```
## [1] 20 46 67 94
```

```
##  b
## 48
```



3.1 Results

franch_id	threshold	years
NYY	4.801818	1918
BOS	4.427752	1917
BOS	4.427752	1929
BOS	4.427752	1948
BOS	4.427752	1994
LAD	4.776867	1919
LAD	4.776867	1955
ATL	5.393778	1918
ATL	5.393778	1949
CHW	4.326192	1918
CHC	4.277577	1919
CHC	4.277577	1940
CIN	4.249476	1929
CIN	4.249476	1952
CLE	4.405339	1920

franch_id	threshold	years
CLE	4.405339	1939
DET	3.926054	1927
DET	3.926054	1940
BAL	4.641706	1919
BAL	4.641706	1942
SFG	4.319634	1919
SFG	4.319634	1937
OAK	3.819294	1920
OAK	3.819294	1936
OAK	3.819294	1951
PHI	4.123104	1918
PHI	4.123104	1937
PIT	4.175793	1920
PIT	4.175793	1946
STL	5.444239	1919
STL	5.444239	1941
MIN	4.498666	1919
MIN	4.498666	1942

NYY 1918: Babe Ruth got to the Yankees in 1920. And starting in 1919 they had exactly one losing seasons between 1919 and 1965.
BOS 1917, 1929, 1948, 1994: Their last world series win in the 1900s was in 1918.
I don't know 1929. 1948 there was a big jump in runs?
1994: Strike year.

LAD: 1919, 1955

ATL 1918 1949

CHW: 1919: Blaack Sox Scandal

CHC: 1919 1940 1940: War.

Cin: 1929 1952

CLE 1920 1939 Cleveland won the world series in 1920. Major change in offensive output.

DET 1927 1940

BAL 1919 1942

SFG 1919 1937

OAK 1920 1936 1951

PHI 1918 1937

PIT 1920 1946

STL 1919 1941

MIN 1919 1942

Pearl Harbor was 1941. So US was in war in 1942.

Acknowledgements

We thank Michael Lopez for suggesting we do "something with change point analysis."

Supplementary Material

All code for reproducing the analyses in this paper is publicly available at https://github.com/menawhalen/baseball_cpt

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