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Offensive Explosion: An Analysis of Trends in Hitting Production in Major League Baseball

By Laura Schreck & Eric Sickles

Abstract

2014 was a record year for pitchers followed by an abrupt reversal in trends with offensive numbers increasing steadily in 2015 and 2016, culminating with a record-setting year for hitters in 2017. This article explores similar offensive explosions throughout the history of Major League Baseball in order to draw parallels to the current extraordinary increase in offense. Evidence of this increase is provided by analyzing the trends of ten separate statistical categories, as well as the statistical trends of the top forty hitters, and twenty pitchers in Major League Baseball. This analysis and research provides the context for discussing possible reasons for such a profound offensive explosion; from steroid use to possibly tampering with the manufacturing of the baseball itself, this article discusses the implications of a dramatically changing baseball landscape where offense reigns supreme.

Introduction

1968 was considered the “year of the pitcher,” because of a league-wide statistics for batting average (AVG), on-base percentage (OPS), home runs per game (HR/G), earned run average (ERA), walks and hits per inning pitched (WHIP), and bases on balls per game (BB/G) the had never been as low. Forty-six years later, baseball pundits lauded 2014 as a second coming as offensive stats returned to the abysmal level of those in 1968; pitchers once again claimed the year. The glaring difference between 1968 and 2014 however, is that the original year of the pitcher in 1968 was intrinsically anomalous. In other words, there was no significant trend that would lead one to infer such a dramatically favorable year for pitchers. In 1969,

statistics generally returned to a level more reflective of those and 1967 and before. The cause may have been the MLB making the decision to lower the mound height to the contemporary ten inches. On the other hand, there is clearly a pitcher friendly trend in the leading years that hits its apex of pitcher dominance in 2014. Indeed, data from the past ten years show a trend that favors pitchers in several different measures of pitcher efficiency – batting average (AVG), earned run average (ERA), home runs allowed (HR), walks and hits per innings pitched (WHIP), on base plus slugging percentage (OPS), bases on balls per game (BB/G), and runs per game (R/G).

This begs the question: What can account for the trends that favors the pitcher up to 2014 and its abrupt reversal in 2015? Notably, Robert Manfred became Commissioner in 2015 and baseballs used in Major League games and manufactured by Rawlings needed to be redesigned in order to accommodate his signature. This redesign was not intended to otherwise alter the ball, yet still, Manfred joked, “Actually, if there is a surge in offense, we’ll all be happy” (Waldstein, 2015). Manfred’s wish was manifested in the 2015, 2016, and 2017 seasons. As the 2017 season set record offensive numbers raising additional questions about the baseballs, pitcher Justin Verlander stated, “I know Mr. Manfred said the balls haven’t changed, but I think there’s enough information out there to say that’s not true. Whether he has the say-so or not, I don’t know” (Kernan, 2017).

Literature Review

Despite Commissioner Manfred “joking” about a surge in offense, MLB executives have had the goal of increasing offensive output since the game's infancy. Green (2011) describes professional baseball executives’ first efforts at increasing offensive production. In 1884, the

Chicago White Stockings played at Lake Front Park where the fences were just under 200 feet from home plate. As if playing in a park smaller than a standard Little League field wasn't enough to substantially increase power statistics, the organization made the decision to count balls hit over the fence as home runs rather than doubles. This resulted in tripling the number of home runs from the previous year. From this point on, home runs would increase consistently until their 19th century peak of 760 home runs in 1890 (Green, 2011).

Perhaps the most comprehensive research done on the topic of offensive potency in professional baseball was done by David Vincent in his book *Home Run: The Definitive History of Baseball's Ultimate Weapon*. In Vincent's work, he outlines the effect of several rule changes in the 1920's that greatly impact offensive production. The 19th century, affectionately referred to as the "Dead Ball Era," ended with Roger Conner atop the career leaders in home runs with just 138. Despite this, prior to the 1920 season, league-wide home run production had been significantly lower than home run production in the prior century. This led to three rule changes before the 1920 season that aimed to increase offensive production in order to balance out the dominance of "dead ball" pitching and defense. The first of these rules was judging whether a home run was fair or foul not by where the ball landed, but by where it crossed over the fence. This revolutionary rule did not last long however, on June 25, 1920, with under 60 games played, the rule was changed back to its 1919 version, thus returning the judgement of a home run by where it "disappears from view" (Vincent, 2006). The rule would not return again to its present form until 1928.

The second rule change affected the way that walk-off home runs were scored. Previously, only the number of bases needed to score a run would be awarded. In other words, if

the game was tied and a runner was on second base, a ball hit out of the park became a double, since, when the runner on second scored, the game ended (Vincent 2006). This new rule allowed walk-off home runs to be scored as such. Interestingly though, Babe Ruth is the only player that hit a would be walk off home run prior to 1920, and also hit one in 1920.

The third, and perhaps, most hitter friendly rule change in 1920 was the elimination of “trick pitches” such as spitballs, or mudballs. This rule would evolve to allow registered spitballers to be grandfathered in to continue to be allowed to throw such pitches. Though these rules have had long term effects on the level of offensive production since their 1920’s conception, one key change to the game of baseball was fundamental when looking to the cause of the 1920’s power boom: the baseball.

The “Live Ball” era of baseball began in 1920 when baseball manufacturers began importing a higher quality wool from Australia, allowing the baseballs to be more tightly wound. This change in the manufacturing process made the balls more elastic and thus allowed them to travel farther. This new baseball resulted in the home run production rate more than doubling in just ten years from 1920 to 1930 (Vincent, 2006).

Similar to 1920, 2015 saw a several rule changes prior to the start of the season. However, where the 1920’s rule changes were specifically designed to increase offensive production, 2015’s rule changes were focused primarily on increasing the pace of play. This contrasts the previously mentioned rule change in 1969 that lowered the mound in an explicit effort to increase offense. The efforts to increase the pace of play were done by adding a clock to que hitters and pitchers alike as to when an at-bat is to begin (similarly to a play clock in football). Players would also allegedly be fined if they removed both feet from the batter’s box

during an at-bat, though little evidence can be found regarding how much, or how frequently, players have been fined for such offenses. A minor amendment to the existing instant replay rules was also added, stating that managers would no longer be required to leave the dugout in order to challenge a play. Less specific to pace of play alterations, Major League Baseball did increase the number of challengeable plays, as well as allowing managers to keep their challenges after every overturned call, rather than the pre-2015 version of the rule that stated managers would only keep their challenge after one overturned call (MLB, 2015).

If one were to disregard pace of play, then naturally another 1920's strategy to increase the game's offense may be presented, the ball itself. The issue of a "live ball" or a "juiced ball" came into question again when the season of 1987 yielded unprecedented production with the bats. Infamously named the "Rabbit Ball Year", the conspiracy of a juiced ball gained so much steam that the MLB conducted their own internal tests to determine whether or not their baseballs had been tampered with in the hopes of increased offense output. Not surprisingly, despite the unusually high level of offense, the MLB concluded that there was nothing unusual, or "juiced" about the baseballs at that time (Moore, 2016).

In what is the most contemporary examination of the MLB's possible attempt to increase offense, Lindbergh and Lichtman (2017) mention that in 2015, Rob Manfred took the reigns as MLB Commissioner from Bud Selig. By the time the second half of the 2015 season rolled around in mid-July, Manfred had implemented a new baseball, altered slightly to accommodate his signature that was larger than Bud Selig's. While this change was allegedly only cosmetic, there is no denying that in the second half of the season, offensive production increased intensely. Strikingly similar to 1987, the MLB conducted yet another internal investigation to

determine if the Manfred baseball was indeed made to launch. Again, similarly to 1987, in 2015 the BRC and MLB alike both determined that not only were the baseballs not juiced, but they were in fact 95% confident that the results were comparable to previous compliance data (Lichtman & Lindbergh, 2017).

Still, another possible explanation for the increased amount of home runs specifically that many scholars point to is the “new age” style of hitting where emphasis is placed on fly balls. In theory, more fly balls would translate to more home runs given the fact that a ball must have certain amount of loft to carry enough distance to get over the fence. This would explain the dramatic increase in home runs, if more fly balls were in fact being hit. In reality, 2015 actually saw a lower percent of fly balls hit compared to 2014 (Fangraphs, 2017).

Further, Lichtman and Lindbergh (2017) they make considerable note that in addition to the Baseball Research Center and MLB’s independent study, Washington State University conducted their own study to determine if the coefficient of restitution (COR) measurements, essentially a measure of a baseball’s bounciness, were truly different. The study found that Manfred’s new baseball traveled, on average, and additional 7.1 feet. (Lichtman & Lindbergh, 2017).

Where the previous research has provided substantial explanation of previous instances where the MLB has made efforts to increase the offensive aspect of America’s Pastime, our own research hopes to shed light on the current rise in offense that has greatly affected the game of baseball.

Method

Using data on pitcher efficiency from 2004-2017, we ran one sample t-tests to determine the likelihood that the 2014 data represented an outstanding year for pitching. We examined four key statistics using one sample t-tests for the 20 top performing pitchers and five for top 40 performing batters in 2014 to see if the same trends held true for their performance as was generally seen in the entire league.

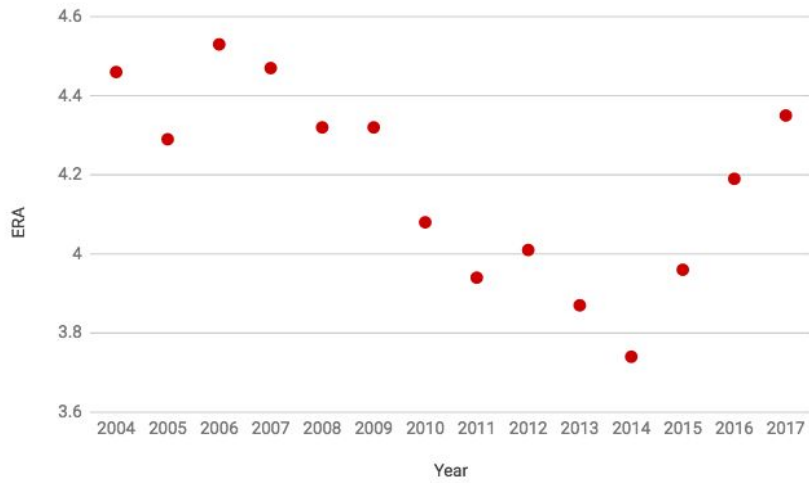
Data

We gathered statistical data measuring league-wide pitcher performance between 2004 and 2017 in seven key areas - ERA, R/G, HR, WHIP, AVG, OPS, and BB/G, - from baseballreference.com. The league-wide data gathered begins in 2004 in order to best reflect the period of statistical honesty that follows the “Steroid Era” of the early, to mid-2000’s; which included offensive production that skyrocketed as a result of illegal use of performance enhancing drugs. Additional data examined included data from the top 20 pitchers and top 40 hitters of 2014 as determined by WAR to determine whether trends for all players had an equal impact on the statistics of top performers as well as the home run by pitch type from baseballsavant.com.

Results

Earned runs represent runs charged to the pitcher scaled to nine innings pitched and is an indicator of pitcher efficiency (see Figure 1).

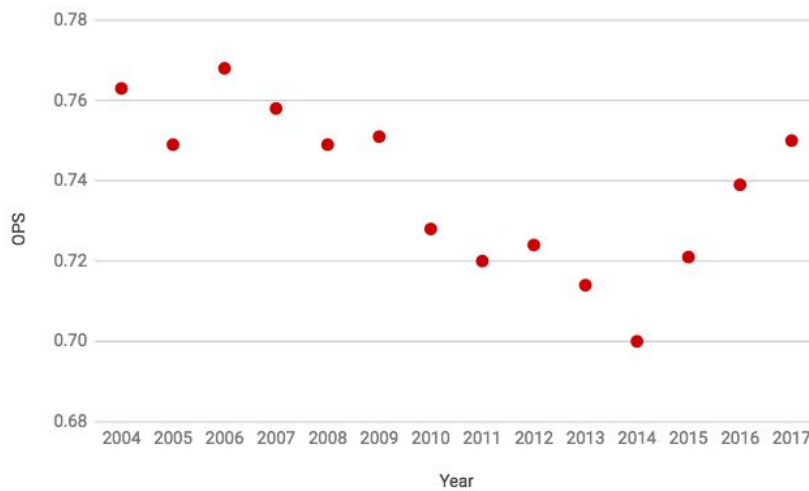
Figure 1: Earned Run Average, 2004-2017



One sample t-tests ($p < 0.0001$) indicated a significant difference in ERA in 2014 compared to the 2004-2017 sample.

On-base plus slugging percentage is yet another way to examine whether batters make it on base along with slugging as a percentage rather than scaled by innings (see Figure 2).

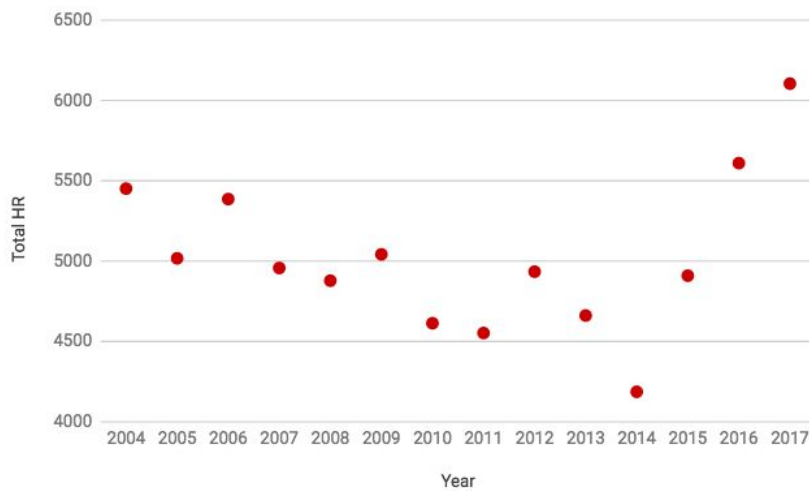
Figure 2: On Base plus Slugging Percentage, 2004-2017



One sample t-tests ($p < 0.0001$) indicated a significant difference in OPS in 2014 compared to the 2004-2017 sample.

Total home runs measure how often the ball is being hit out of the ball park, a moment when the batter completely bests the pitcher (see Figure 3).

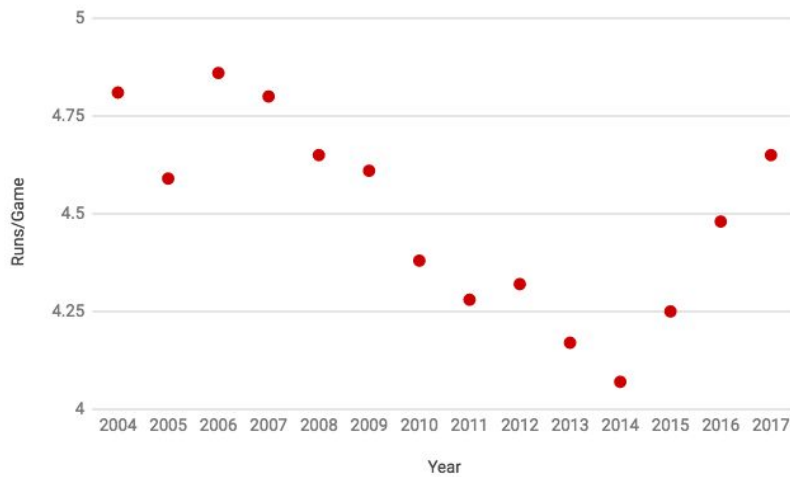
Figure 3: Home Runs, 2004-2017



One sample t-tests ($p < 0.0001$) indicated a significant difference in HR in 2014 compared to the 2004-2017 sample. A time series analysis shows a break in the data between 2014 and 2015.

Runs per game is another way to examine pitcher efficiency through how many runs are being scored scaled to games (see Figure 4).

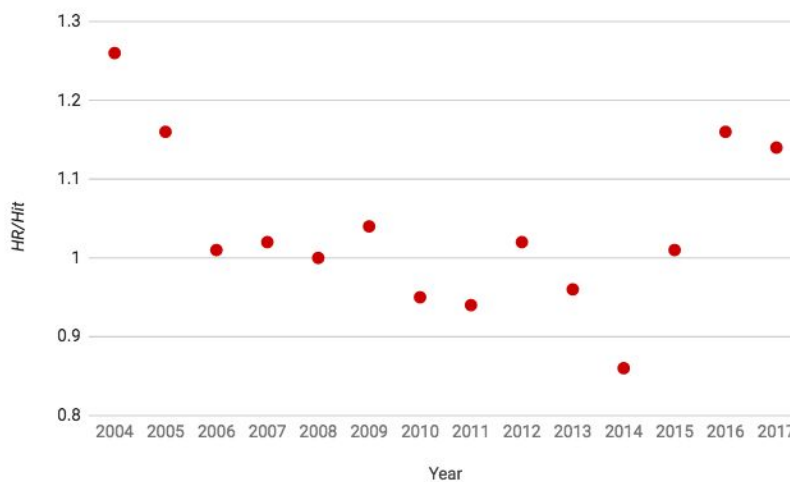
Figure 4: Runs/Game, 2004-2017



One sample t-tests ($p < 0.0001$) indicated a significant difference in HR/Hit Allowed in 2014 compared to the 2004-2017 sample.

The home run to hit allowed ratio offers further detail of pitcher efficiency as it represents home runs as a proportion of total hits allowed (see Figure 5).

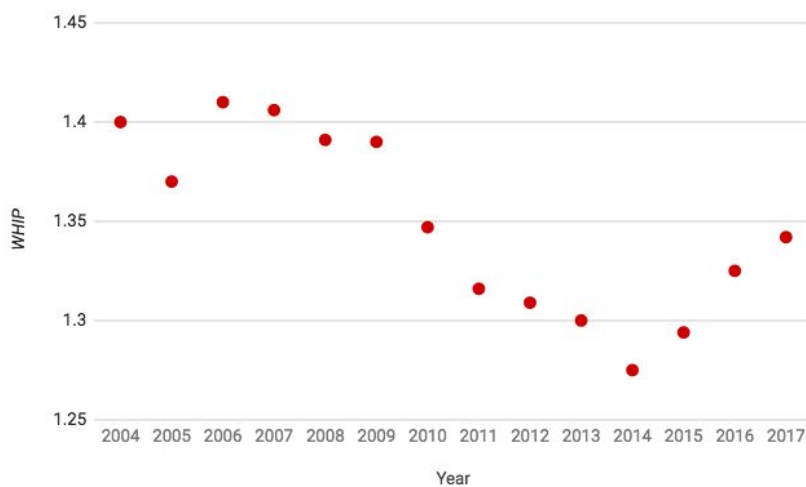
Figure 5: Home Runs per Hits Allowed, 2004-2017



One sample t-tests ($p < 0.0001$) indicated a significant difference in HR/Hit Allowed in 2014 compared to the 2004-2017 sample. Moreover, the graph shows the same trend of steadily decreasing between 2004 and 2014 with a reversal of this trend between 2014 and 2015.

WHIP represents the walks and hits per inning pitched and serves as yet another marker of a pitcher's dominance over batters in terms of keeping them off base (see Figure 6).

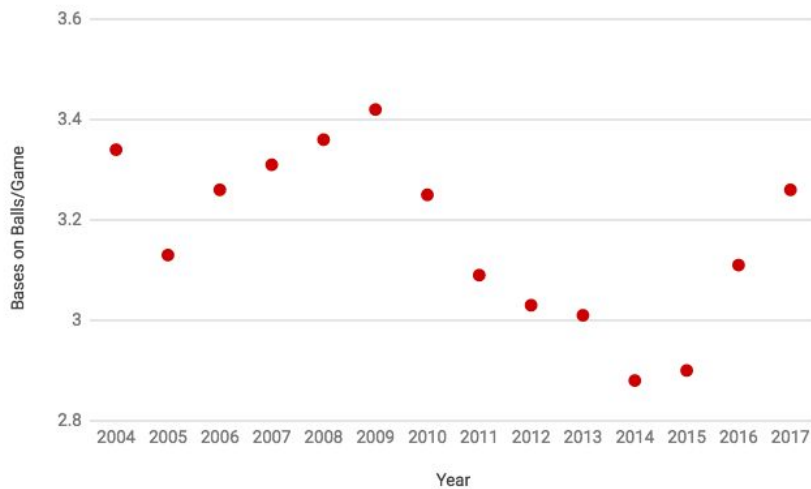
Figure 6: Walks and Hits per Innings Pitched, 2004-2017



One sample t-tests ($p < 0.0001$) indicated a significant difference in WHIP in 2014 compared to the 2004-2017 sample.

Bases on balls per game show how often the runner is allowed on base by the pitcher's failure to throw strikes that the batter does not swing at. It is also a measure of the plate discipline of the hitters (see Figure 7).

Figure 7: Bases on Balls per Game, 2004-2017



One sample t-tests ($p < 0.0001$) indicated a significant difference in BB in 2014 compared to the 2004-2017 sample.

There are several factors to be considered that cannot account for either the anomaly of 2014 or the reversal of the trends favoring pitching in 2015.

The only ballpark to change its dimensions in 2015 was Citi Field, bringing in the right field fence by 10 feet; while this did result in 38 additional home runs, it represents only 5% of the 723 run increase in 2015 and the additional 701 in 2016. Admittedly, this change in dimensions was brought about due to analytics which suggested this shift would result in more home runs for the Mets (Rohan, 2014). While changing dimensions of ballparks to increase offensive production for the home team may be the next frontier in analytics, this cannot explain the offensive explosion of 2015. Likewise, Marlins Park was adjusted to create more offense, bringing in the center field fence by 11 feet and lowering walls (Frisaro, 2015). In 2017, the Braves moved from Turner Field to the newly opened SunTrust Park. The dimensions of SunTrust compared to Turner Field are 5 feet shorter in left center, 15 feet shorter in right center,

and 5 feet closer in the right field corner with the decreased dimensions of right field compensated for by a seven and a half foot higher wall.

Some pundits have suggested that the increasing number of home runs in 2015, 2016, and 2017 can be attributed to hitters catching up to the increasing velocity of pitchers. To examine this theory, home runs as a percentage of pitch type are examined (see Table 1).

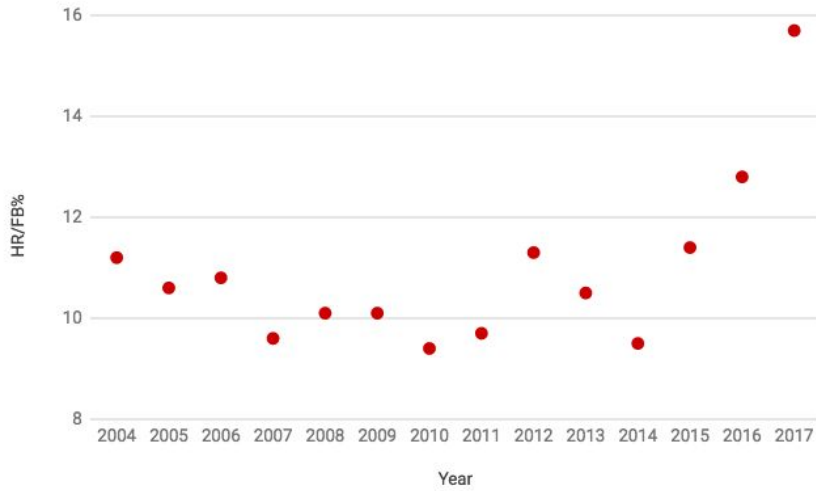
Table 1: Home Runs as a Percentage of Pitch Type, 2009-2017

	Fastball HR	Slider HR	Changeup HR	Sinker HR	Curve Ball HR
2017	0.8908%	0.8095%	0.9129%	0.8375%	0.6235%
2016	0.8325%	0.7669%	0.8583%	0.7316%	0.5887%
2015	0.7483%	0.6356%	0.7391%	0.6769%	0.5548%
2014	0.6217%	0.5858%	0.6736%	0.5461%	0.4827%
2013	0.7017%	0.6484%	0.7273%	0.5875%	0.4682%
2012	0.7422%	0.6808%	0.8068%	0.6519%	0.4978%
2011	0.6745%	0.6279%	0.7089%	0.6515%	0.4152%
2010	0.6828%	0.6025%	0.7132%	0.6252%	0.5350%
2009	0.7653%	0.6541%	0.7571%	0.6725%	0.4845%

In 2015, 2016, and 2017, there are increases in the percentage hit in every pitch type; the increase is not limited to fast balls. One-sample t-tests reveal that 2017 was a statistically significant anomalous year for every pitch type: fastball ($p < 0.0006$), slider ($p < 0.004$), changeup ($p < 0.0005$), sinker ($p < 0.0003$), and curveball ($p < 0.0011$).

Data regarding the percentage of home runs per fly ball thrown do not mirror the trends seen in the other data. The increase in 2015, 2016, and 2017 suggests that balls are traveling farther (see Figure 8).

Figure 8: Home Run/Fly Ball Percentage, 2004-2017



Interestingly, the swinging strike percentage has also been trending upward every year since 2010 (see Figure 9). The data does not follow the same trend negating the possibility that batters began offering at more pitches since 2014; likewise, strikeouts have increased steadily since 2005 (see Figure 10).

Figure 9: Swinging Strike Percentage, 2004-2016

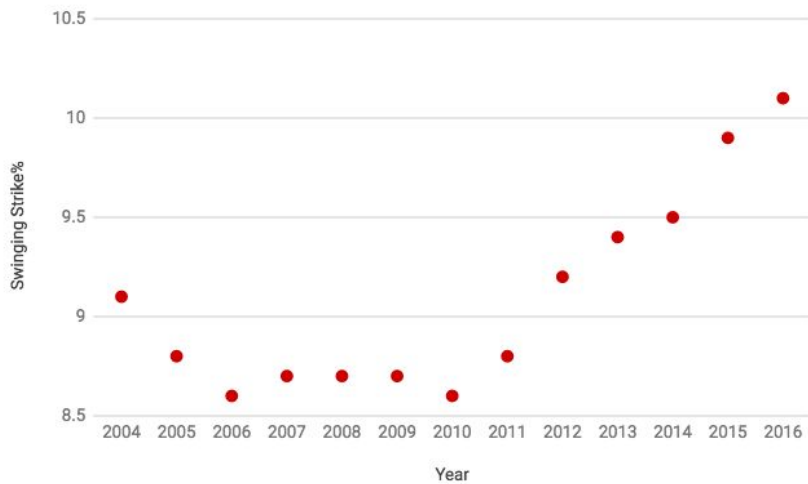
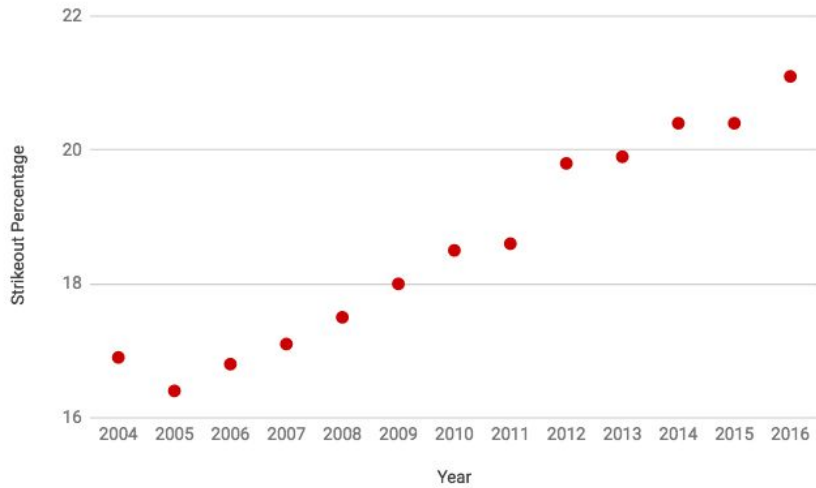


Figure 10: Strikeouts Percentage, 2004-2017



To examine whether the trends seen across all of Major League Baseball hold true for the top performing pitchers, AVG, WHIP, ERA, and HR/9 data was collected for the top 20 pitchers of 2014 as determined by WAR values (see Table 2).

Table 2: Top 20 Pitchers of 2014 Performance, 2014-2017

	AVG	WHIP	ERA	HR/9
2014	.229	1.09	2.77	.654
2015	.235	1.17	3.23	.904
2016	.238	1.18	3.56	1.075
2017	.232	1.17	3.66	1.132

This data reveals negligible increases in opponent AVG (and WHIP suggesting consistency in these elite pitchers' effectiveness based on one sample t-tests. However, there is a marked increase in ERA ($p < 0.0314$) and HR/9 ($p < 0.0305$) within this group of elite pitchers that is likely not due to chance fluctuations from one season to the next.

Similarly, to examine whether the trends seen across all of Major League Baseball hold true for the top performing hitters, AVG, OBP, OPS, HR, and SO data were collected for the top 40 hitters of 2014 as determined by WAR values (see Table 3).

Table 3: Top 40 Hitters of 2014, 2014-2017

	AVG	OBP	OPS	HR	SO
2014	0.291	0.362	0.833	20.10	106.38
2015	0.275	0.344	0.797	18.45	93.38
2016	0.270	0.344	0.792	20.63	104.35
2017	0.267	0.349	0.792	19.45	90.58

Data from the hitters does not show the same trends as the data from the pitchers. In fact, it shows slight decreases which may well be due to chance based on one-sample t-tests

Discussion

The data shows a clear trend between 2004-2014 of increasing pitcher dominance. This trend is abruptly reversed in 2015, most remarkably in the category of home runs.

Certain explanations can be dismissed based on the data available. The changing dimensions of the two ballparks, Citi Field and Marlins Park, and switch from Turner Field to SunTrust Park, are not sufficient to explain the offensive increases of the past three seasons. This leads to look to the plausible explanations based on previous increases in offense. Historically, home runs have increased for three reasons: rule change, use of steroids, and changes in the baseball itself.

There have been no rule changes in 2015, 2016, and 2017 that would increase offense as rule changes pertained to pace of play.

Major League Baseball only releases results of failed steroid exams. Details of which players are tested and what the test specifically screens for are not released. Given the sudden improvement in hitting performance, performance enhancing substances as an explanation cannot be dismissed out of hand. Fewer players have been suspended for failed testing between 2015-2017 than between 2012-2014 (Verducci, 2017). However, insufficient data is available to make any claims beyond commenting that this is a possible explanation for the significant increase in offense.

Measures of plate discipline - bases on balls, swinging strikes percentage, and strikeouts - do not suggest that there has been an increase in batters' skills in this area. Given that plate discipline does not seem to be increasing, the bases on balls coupled with increasing home runs and earned runs suggests pitcher control is decreasing. Such a statistically significant shift in pitcher control is likely not due to an overall decrease in pitching skill. Home runs are up on every pitch type so increased velocity is not a likely explanation.

The performance of the top 20 pitchers of 2014 is illuminating as to the changes that have occurred. Their opponent average and WHIP have remained steady but there was been a statistically significant increase in their ERA and HR/9. They remain equally effective at keeping the ball out of play; the only difference is that the balls are travelling out of the park (ie. they are travelling a greater distance). The Washington State University study that suggested that the new baseballs, on average, travelled an additional 7.1 feet, could explain this phenomenon. Additionally, the top 40 hitters of 2014 actually show a non-significant decrease in performance between 2014 and 2017.

Given the shift in the numbers, it is not possible to ignore what the players, particularly the pitchers, are saying. Cy Young winning pitcher Justin Verlander stated, “So on one hand you can have somebody say that manufactures the ball, they’re not different. And on the other hand you can say that the people that have held a ball in their hand their entire life, saying it’s different, you value one over the other. You take your pick. (Kernan, 2017). While Rawlings does insist that they continue to manufacture the balls within the specified parameters, this does not preclude a shift in the average. That is to say it is possible for a ball to still fall within the acceptable parameters can still favor one end of the spectrum such that it will travel further.

Conclusion

Having examined multiple possible explanations, the historical record offers the best potential explanations for what is clearly and offensive surge with the increase in homeruns being most notable. It is no secret that the Commissioner of Baseball has made increased offense a goal. The data supports that offense has increased in ways not due to changes in rules or dimensions. This leaves the explanations of steroid usage or a change in the composition of the baseballs.

Ultimately, Major League Baseball can choose to make changes to promote offense in order to make the sport more marketable and appeal to a larger audience. In the past, these changes have been made with transparency. It is not necessarily wrong to alter the baseball to promote offense but if such a change has occurred, there are significant implication for teams. To remain competitive, they will need to change their approach in building a team. Alternately, teams built around pitching

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