Did Humidifying the Baseball Decrease the Number of Homers at Coors Field?

Howard Penn

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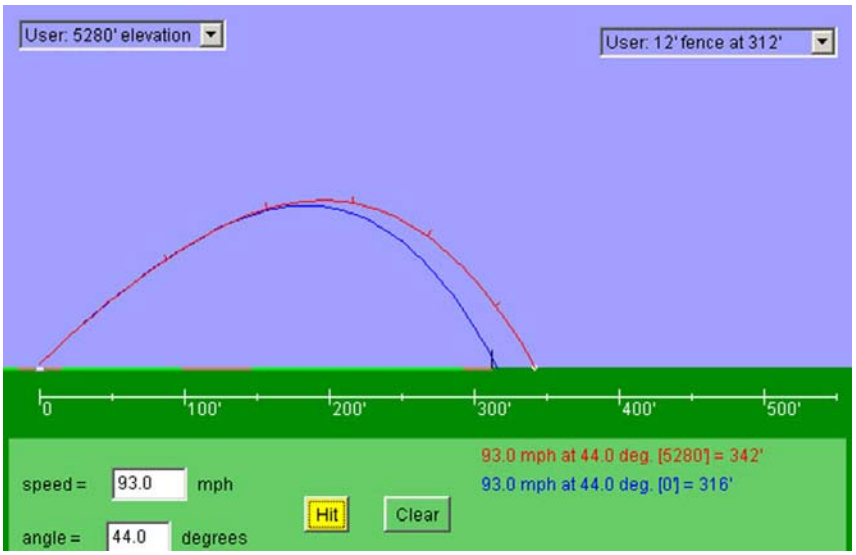
Figure 1

Abstract

Because Coors Field in Denver is one mile above sea level, a baseball hit there will travel about 10% farther than one hit with the same force and angle at sea level. To partially nullify this effect in 2002 the Colorado Rockies began humidifying the balls use there. In this paper we show that doing so statistically reduced the number of home runs hit there.

Introduction

Coors Field, where the Colorado Rockies play, has always been regarded as a home run friendly ballpark. It is at an altitude of approximately 5280 feet. According to the *Physics of Baseball* [1], a batted ball travels approximately 10% farther at that altitude than at sea level. Figure 2 compares the flight of two batted balls with the same initial speed, angle of elevation, and wind speed. The lower curve represents the path if the ball is hit at sea level and the upper curve shows the path at an altitude of 5280 feet. In the latter case the ball clears the fence but not in the former.



[5] ©James Carr http://faculty.tcc.fl.edu/scma/carrj/Java/baseball4.html

Figure 2

The Rockies were aware of this when Coors field was built. The ballpark has among the largest average dimensions of any major league ballpark. Figure 3 is a photo of opening day [4]

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Figure 3

Table 1 shows a comparison of the distance and height of the fences at Coors with Safeco Field in Seattle, AT&T Ballpark in San Francisco, and Yankee Stadium (both the old and new Yankee Stadiums have the identical dimensions) [3]. Safeco and AT&T are considered to be ballparks that favor pitchers.

Stadium	LF	HT	LC	HT	CF	HT	RC	HT	RF	HT
Coors Field	347	8	390	8	415	8	375	17	350	17
Safeco Field	331	8	390	8	405	8	386	8	326	8
AT&T (2004)	339	8	364	11	399	8	421	8	309	25
Yankee Stadium	318	8	399	7	408	13.83	353	14.5	314	10

Table 1

In an attempt to compensate for the extra distance that batted balls fly, in 2002 the Rockies began humidifying the baseballs. They keep them in a room where the temperature is 70 degrees and the humidity is 50%, conditions that are similar to those at ballparks at sea level. The idea is that the humidity will make the baseballs slightly larger and softer, so they would not fly as far. Figure 4 shows Jay Alves, the vice president of marketing in the Humidor.

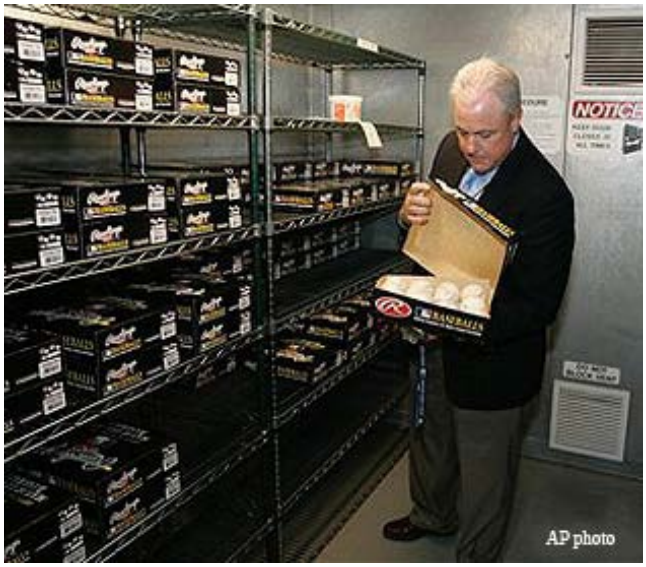

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Figure 4

The Numbers

From 1999 to 2001, 816 home runs were hit at Coors Field (an average 272 per year). From 2002 to 2008, 1380 home runs were hit there [6, 7] (an average 197.1 per year), a decrease of nearly 75 home runs per year. Most papers about this [2] conclude that humidifying decreases the number of home runs. We claim that the analysis is not sufficient. The Rockies could have traded for better pitchers, giving up home run hitters

in the exchange. Anyone who follows baseball would consider that unlikely. Maybe testing for performance enhancing drugs cut down the number of home runs throughout baseball. Perhaps the balls were different in the latter years. A deeper analysis is needed to determine whether the humidifying was the cause of the decrease in home runs.

A Useful Statistic

The possible factors can be accounted for by comparing the number of home runs hit in Rockies home games by both teams with the number hit in away games. Teams play 81 home and 81 away games. The opponents are, more or less, the same for both. (There are a few inter-league games where the Rockies play a team only at home or only away.) The opponent's pitchers and batters are the same and the Rockies have the same players for both home and away games. Therefore, if the ballpark and baseballs are homer neutral, then home runs should be just as likely to be hit at home or away. Hence the proportion of homers hit in home games should have a binomial distribution with mean p=0.5. From 1999 to 2001 the number of home runs in Rockies away games was 478. This gives the percentage of home runs in home games as 63.06%.

We can now use the large sample test for population proportion [8]:

$$H_0 : p = p_0$$

$$z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$$

$$H_a : p > p_0 \text{ is } P(Z \quad z).$$

We are testing the hypothesis that $p_0 = 0.5$. The alternate hypothesis, H_a, is that the proportion of home runs at Coors Field is significantly more that 0.5. The computation of z is the normal approximation to the binomial distribution, whose value indicates how many standard deviations the data is above the assumed mean. The value of P is the probability that a set of random data will have a z value greater than or equal to the one computed. This represents the significance level of the hypothesis test. In statistics, the null hypothesis is usually rejected if P is less than 0.05. The data for 1999-2001 gives z = 9.40 and $P(Z \quad 9.40) < 10^{-10}$. This result is significant and we can conclude that before 2002 Coors Field was definitely a ball park that favored homers. The number of home runs for 2002-2008 in away games is 1178. So 53.95% were hit in home games. This data gives z = 4.00 and $P(Z \quad 4.00) \cup 0.000032,$ which is still significant.

The data indicate that we can be virtually certain that Coors Field was a home run friendly ballpark before the team began humidifying baseballs. Although the percentage of home runs in home games has dropped remarkably, the ballpark remains a statistically significant home run friendly ballpark.

Comparing the two sets of data

The computations by themselves do not tell us if the drop in percentage is statistically significant. In order to determine that we may use the significance test for comparing two proportions [8]:

$$H_0 : p_1 = p_2$$

$$z = \frac{\hat{p}_1 - \hat{p}_2}{SE_{D_p}}$$

where the pooled standard error is

$$SE_{D_p} = \sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

where

$$\hat{p} = \frac{X_1 + X_2}{n_1 + n_2}$$

$H_a : p_1 > p_2$ is $P(Z \quad z)$.

With our data we get

$$z = \frac{\frac{816}{1294} - \frac{1386}{2558}}{0.0168882942} = 5.40$$

and

$$P(Z \quad 5.40) \cup 3.43 \leftarrow 10^{-8}.$$

The null hypothesis is that there is no significant difference between the percentages of home runs hit in home games. The alternate hypothesis is that the difference is significant and unlikely to have occurred by chance. The pooled standard deviation combines both sets of data, with $\hat{p}$ as the percentage of home runs in Rockies games at home over the entire time period. This data produces a significance level of $3.43 \leftarrow 10^{-8}$, which is so low that we can conclude that humidifying the baseball has decreased the number of home runs.

Summary of Conclusions

Before the Rockies began humidifying baseballs, Coors Field was an extraordinarily home run friendly ballpark. Since using the humidor, the ballpark remains home run friendly despite the drop in percentage. The drop is statistically significant.

The assumption that the away games are fair is not completely correct. The Rockies are in the same division as the San Francisco Giants and the San Diego Padres. Both of their home ballparks are statistically significantly difficult ballparks to hit home runs. Given the unbalanced schedule, this affects the percentage of home runs hit in the Rockies home games. At the same time, the fact that the other two teams play a good number of away games at Coors Field negatively affects the percentage of the season total home runs that are hit in their home games.

Exercises

Two teams with traditionally pitcher friendly ballparks have taken steps to increase the number of home runs in their teams home games. In 2004, the San Francisco Giants moved the center field fence at AT&T Park in from 404 feet to 399 feet. In 2003, the Detroit Tigers moved the left center field fence in from 395 feet to 370 feet [3]. Did that significantly increase the number of home runs? In 2009 the Yankees opened the new Yankee Stadium across the street from the old one. Its dimensions are exactly the same and the ballpark was designed to make it look like the old one. Yet the feeling among sportscasters is the number of home runs has increased. Is the new stadium statistically more homer friendly than the old one?

The data [9]

Team	Home	Away
Giants 1999-2003	574	861
Giants 2004-2008	665	779
Tigers 1999-2002	388	572
Tigers 2003-2008	1050	1166
Yankees 1999-2008	1898	1993
Yankees 2009		

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Howard Penn received his B.A. in Mathematics from Indiana University in 1968 and his Masters and PhD in Mathematics from the University of Michigan in 1969 and 1973. Since receiving his final degree, he has taught at the United States Naval Academy where he now holds the rank of Professor. He is one of the pioneers is the use of computer graphics in the teaching of mathematics, having written the program, MPP, which was widely used internationally. He is also interested in finding applications of the mathematics to areas that many students will find interesting. Outside of mathematics, he is well known amateur photographer with special interests in wildlife, landscapes and abstract photography. His work may be viewed at www.flickr.com/photos/howardpennphoto