Exit Speed and Home Runs

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A recent article entitled "A Baseball Mystery: The Home Run Is Back, And No One Knows Why", by Rob Arthur and Ben Lindbergh, noted the increase in home runs during the 2015 season. Moreover, there was a decided increase in home runs per batted ball after the All-Star Game. That increase was accompanied, and perhaps caused, by a small ~1 mph increase in the mean exit speed. The authors speculated about various reasons that might explain the post-ASG increase. I won't have anything new to add to the possible reasons in this article. Instead, I want to focus on a very specific question:

How does it happen that a small increase in exit speed can lead to a relatively large increase in home run production?

To answer this question, I used Statcast data from the months of June and August, 2015. The relevant parameters are given in the table below. As you can see, the mean exit speed for August was 0.8 mph greater than for June, while the number of home runs for August was 13% greater than for June,. The August number has been scaled by 0.972 to normalize to the slightly smaller number of batted balls in June.

Month	Batted Balls	Mean Exit Speed (mph)	Home Runs	Calculated Home Runs
June	18346	88.1	742	721
June-shifted	18346	89.1	742	828
August	18876	88.9	838	847

Everything you need to know about the analysis is found in the figures below. The top plot shows the distribution of exit speeds for the two months, where **v6** (black) refers to June and **v8norm** (blue) refers to August (normalized). I'll get to the red curve shortly. The dashed curve labeled **phr** is the probability density for hitting a home run, directly computed from the Statcast data. That is, for each bucket of exit speed, **phr** is the ratio of batted balls resulting in home runs to all batted balls. For clarity, all curves have been smoothed using a cubic spline technique.

The plots show a clear excess of batted balls with exit speeds above 96 mph for August relative to June, whereas the opposite is true for exit speeds below 96 mph. If the June curve is shifted upward by 1 mph, obtaining **v6s**, the resulting distribution (the red curve) overlaps almost perfectly with August On the other hand, the home run probability curve shows that it is precisely the exit speeds above 96 mph that are most likely to result in home runs.

This is apparent by the curves in the lower plot, which were obtained by multiplying the exit speed distributions by the home run probability for each bucket of exit speed, so that the area under each curve is the expected number of home runs, labeled "Calculated Home Runs" in the table. The August and June-shifted curves overlap perfectly and have a distinct excess relative to the June curve. Indeed, the August and June-shifted numbers in the table are virtually identical.

This result confirms that a 1 mph change in mean exit speed can account for essentially all of the 13% change in home runs. The essential point is that the exit speed distribution falls off rapidly just in the region that is important for home runs. As a result, a tiny change in mean exit speed can lead to much larger changes in the number of home runs. A similar conclusion was reached in an analysis I did a few years ago about the possible effect of steroids on home run production.