Rethinking WAR for Pitchers

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WAR (wins above replacement) is a fundamental statistic for valuing pitchers, and has recently been proposed to determine arbitration salaries [2]. So, it is of utmost importance to use a WAR statistic that accurately captures a pitcher's contribution to his team.

Current popular implementations of WAR for pitchers, implemented by Fangraphs [1] and Baseball Reference [3], have serious issues. First, these implementations of WAR focus on a pitcher's earned runs averaged over his innings pitched, completely ignoring variance. This is problematic because high-variance and low-variance pitchers shouldn't have the same WAR. Furthermore, current implementations of WAR fail to take into account the convexity of WAR. In other words, the WAR of a pitcher's total number of earned runs over a season should not be equal to the sum of the WAR added by each of a pitcher's individual games, but current implementations treat these two quantities as equal. Lastly, current WAR formulas are extremely convoluted.

Therefore, we propose a new way to compute WAR, which fixes the aforementioned problems and has a much more natural interpretation and understandable derivation.

To compute our WAR, we examine each of a pitcher's games individually. A pitcher's win probability added during game i is defined as the difference in his team's win probability just after his last pitch (time t_1) and just before his first pitch of the game (time t_0). We use statistical techniques to estimate this difference in win probability as a function of the pitcher's earned runs, number of (partial) innings pitched, and the base-runner configuration at the time the pitcher starts and finishes pitching. Then, we compute the expected win probability added during game i from time t_0 to t_1 by a hypothetical replacement level pitcher. A pitcher's WAR in game i is thus defined as the difference between his win probability added and that of the hypothetical replacement level pitcher. A pitcher's WAR over the whole season is thus defined as the sum of his WAR over all his individual games.

We conclude our study by comparing our WAR to previous versions of WAR. We anticipate that the WAR of low-variance pitchers won't change much, and the WAR of high-variance pitchers will, which will lead to a new WAR-ranking of pitchers.

Although we don't yet take into account many of the adjustments that previous implementations of WAR do, such as park adjustments and fielding adjustments, there are natural ways to extend our analysis in order to account for these effects. Despite these drawbacks, our method for computing WAR is an improvement over previous implementations, and should lay the foundation for a more robust, understandable, and accurate version of WAR.

References

[1] Piper Slowinski. Fangraphs. War for pitchers. `https://library.fangraphs.com/war/calculating-war-pitchers/`.

[2] Dayn Perry. Mlb proposes determining arbitration salaries by using the war statistic, per report. `https://www.cbssports.com/mlb/news/mlb-proposes-determining-arbitration-salaries-by-using-the-war-statistic-per-report/` (2021/11/11).

[3] Baseball Reference. Pitcher war calculations and details. `https://www.baseball-reference.com/about/war_explained_pitch.shtml` (2011/03/03).