Calculating fWAR for pitchers:

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Overview + fully worked out example!

Calculating fWAR is much easier than calculating bWAR!

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and the works of Neil Weinberg and Fangraphs

Macro Processes

1) Pick a stat, any stat
   - ↳ Pick a stat to compare a pitcher to league average → ex) FIP, RA9, DRA

2) Compare to league average
   - ↳ Find how many runs better or worse than league average this pitcher is.

3) Runs Per Game → Wins Per Game
   - ↳ We must convert our units from runs to wins, as we are solving for Wins Above Replacement.

4) Above Average → Above Replacement
   - ↳ Same as the step above, we must convert our units from Above Average to Above Replacement because we are solving for Wins Above Replacement.

5) Final Adjustments
   - ↳ Accounting for high leverage and finite allocation of WAR.

Part A: Variable/Statistic Collecting

a) MLB-wide.

ERA
HR
BB
HBP
K
IFFB
IP
RA9

b) League-specific (AL/NL)

HR
BB
HBP
K
IFFB
IP

c) Pitcher-Specific:

HR
BB
HBP
K
IFFB
G
GS
IP

PF (Park Factor)

LI (Leverage Index)

Only required for relievers

Part B: Calculating and Solving

What we're solving for:

1) IF FIP Constant
2) IFFIP
3) FIPR9
4) pFIPR9
5) lgIFFIP → NL IFFIP
6) lg FIPR9 → NL FIPR9
7) RAAP9
8) dRPW
9) WPGAA
10) Replacement Level
11) WPGAR
12) pWAR
13) leverage Adjustment
14) WAR adjustment

1) **ifFIP Constant:** Used to incorporate infield fly balls (IFFB) into the calculation of FIP (Fielding Independent Pitching, more on this in the next slide) because IFFBs are just as effective as strikeouts.

$$\text{ifFIP Constant} = \text{MLB ERA} - ((13 \cdot \text{MLB HR}) + (3 \cdot (\text{MLB BB} + \text{MLB HBP})) - (2 \cdot (\text{MLB K} + \text{MLB IFFB}))) / \text{MLB IP})$$

Note that the ifFIP Constant will be the same for all pitchers in a given year

Ex: ifFIP in 2016 for all pitchers = 3.342...

ifFIP in 2023 for all pitchers = 3.464...

2) **ifFIP:** FIP, with IFFBs also counting as strikeouts. FIP, like ERA, is a measurement of pitcher performance but is preferred by sabermetricians because it only accounts for variables the pitcher is directly responsible for (HR, BB, HBP, K, and IP).

$$ifFIP = ((13 \cdot HR) + (3 \cdot (BB + HBP)) - (2 \cdot (K + IFFB))) / IP + ifFIP\ Constant$$

3) **FIPR9:** FIP, as we have calculated it, is on a scale of ERA (note that we used ERA in our calculation of the ifFIP Constant). We want to change our FIP to be in terms of RA9 (Runs Allowed Per 9 Innings) because it will establish our units in terms of Runs Allowed and will help us convert from runs to wins later. This step is converting our FIP to be on the same scale as RA9.

$$FIPR9 = ifFIP + (mLB\ RA9 - mLB\ ERA)$$

4) **pFIPR9:** This step takes FIPR9 and adjusts its value to account for the pitcher's home ballpark. We do this to account for potentially high or low scoring run environments that our pitcher may pitch in.

$$pFIPR9 = FIPR9 / (PF / 100)$$

This value is our pitcher's FIP on a scale of RA9 and accounting for IFFBs and their ballpark

Ex) If our pitcher pitches in Coors Field, they will very likely give up more runs than an average pitcher pitching in an average ballpark, not because they are a bad pitcher, but because it is so easy to score runs at Coors Field. This adjustment will compensate for this hypothetical pitcher's tough ballpark environment.

5) lg ifFIP : ifFIP of the entire league (NL or AL) that this pitcher pitches in.

$$lg\ ifFIP = ((13 \cdot lgHR) + (3 \cdot (lgBB + lgHBP)) - (2 \cdot (lgK + lgIFFB))) / lgIP + ifFIP\ Constant$$

6) lg FIPR9: FIPR9 of the league (NL or AL) this pitcher pitches in. We calculate this so we can compare our pitcher to league average.

$$lg\ FIPR9 = lg\ ifFIP + (MLB\ RA9 - MLB\ ERA)$$

7) RAAP9 : Runs Above Average Per 9 Innings. This value is how many runs our pitcher prevents more or less than the league average pitcher. Now we will need to convert our units from Runs and Above Average to Wins and Above Replacement.

$$RAAP9 = lg\ FIPR9 - pFIPR9$$

8) dRPW : Dynamic Runs Per Win. Runs Per Win will let us convert from runs to wins so we can eventually solve Wins Above Replacement. Runs Per Win is approximately how many runs equals one win, and is usually a value around 10. For bad pitchers, Runs Per Win will be higher because more runs will be required to win the game. For good pitchers, Runs Per Win will be lower because good pitchers will not allow many runs, making their team require fewer runs to win the game. Because pitchers directly influence how many runs are needed per win, we use the following dynamic equation:

$$dRPW = (([([(18 - IP/G) \cdot (lgFIPR9)] + [(IP/G) \cdot pFIPR9])/18] + 2) \cdot 1.5$$

- 18: Avg # innings pitched per game
- IP/G: Reflects how much this pitcher contributes to games. More IP = More impact
- lgFIPR9: how good the average pitcher is at preventing runs.
- pFIPR9: how good this pitcher is at preventing runs.
- 2: Similar to Pythagorean win %, this is how we convert runs → wins

9) **WPGAA:** Wins Per Game Above Average. This is how many wins our pitcher is responsible for above or below league average. Values here will likely be quite low. In this step, we are cancelling and changing units.

Per 9 = Per game

WPGAA = RAAP9 / dRPW

$$\frac{\text{Runs Above Avg Per 9}}{\text{dynamic Runs Per Win}}$$

↓

Wins Above Avg Per Game

We can ignore the "dynamic", it's not a value

As shown above, by dividing RAAP9 by dRPW, we cancel the unit of Runs and create a new metric, WPGAA. We are now one step closer to calculating WAR because Runs is not a unit of WAR, Wins is.

10) **Replacement Level:** So far, we have been calculating values relative to league average. We will now find a value to allow us to convert from league average to replacement level. Replacement level is a caliber of player below average, a player that will suffice, but not succeed. A team full of replacement level players, according to sabermetricians, will have a win percentage of .294 and thus have a record of (48-114)

$$\text{Replacement Level} = 0.03 \cdot (1 - GS/G) + 0.12 \cdot (GS/G)$$

Different weights are applied based upon appearances as a starter vs appearances as a reliever. If you are entirely a reliever, your replacement level will be 0.03. If you are entirely a starter, your replacement level will be 0.12. These values reflect that starting pitchers are more valuable and more difficult to replace than relievers.

11) **WPGAR:** Wins Per Game Above Replacement. WPGAR is the amount of Wins Per Game our pitcher has above a replacement level player. In this step, we are converting our units from Above Average to Above Replacement.

$$\text{WPGAR} = \text{WPGAA} + \text{Replacement Level}$$

We simply add WPGAA and Replacement Level. Ex) If our pitcher has 2.7 Wins Per Game Above Average, then they will have an even higher number of Wins Per Game Above Replacement because an average player is better than a replacement level player. The value of Replacement Level is on a scale of Wins, so we can just add the two values.

12) pWAR : Preliminary WAR, or Pre-Adjusted WAR. Note that this is not an official statistic, but is a necessary arithmetic step to calculate Fangraphs' final WAR value. In this step, we are multiplying by (IP / 9) to cancel out the "per game" units in the equation.

$$pWAR = WPGAR \cdot \left(\frac{IP}{9}\right)$$

$$\frac{\cancel{\text{Wins Per Game}}\ \text{Above Replacement}}{\#\ \cancel{\text{Games}}} \rightarrow \text{Wins Above Replacement}$$

(IP / 9) = Total number of games our pitcher pitched.
Ex) IP = 154. 154 / 9 = 17 total games pitched by our pitcher

13) Leverage Adjustment: In this step, we are solving for the Leverage Index Multiplier. This step accounts for game leverage situations. A pitcher will get a higher Leverage Index multiplier if they often pitch in high leverage situations. This rewards closers and other late inning relievers, as they are more valuable than other, replacement level, relievers.

$$LI\ multiplier = (1 + gmLI) / 2$$

1

Game Leverage Index, can be found under Win Probability in a player's page

$$LI\ multiplier \cdot pWAR = pWAR$$

Multiply current pWAR by LI multiplier to account for leverage. This is your new pWAR value.

14) **WAR Correction**

This is the final adjustment before we calculate our final WAR value. This adjustment is required to ensure that 1,000 total WAR is assigned each season, split 57%/43% between position players and pitchers. This means that 430 total WAR will be assigned to pitchers.

$$\text{WAR correction} = (\text{WAR/IP} \cdot \text{IP})$$

WARIP will be always be a value between -0.0007 and -0.0012. Fangraphs unfortunately does not show how to find or calculate this value.

15) **WAR** : Wins Above Replacement. This final value is the number of wins that a team will gain by having this player on their team instead of a replacement player. A player's WAR (ex: 4.2) is the number of games a player helped their team win.

$$\text{WAR} = \text{pWAR} + \text{WAR correction}$$