Decision Shares: Part I − Team

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As presented by Bill James, Win Shares attempts to distribute a baseball team's actual wins between the players who created them. However, James did not publish a method to distribute the associated Loss Shares. In this paper the Win Shares methodology and model are generalized into Decision Shares, which includes a system for distributing both Win Shares and Loss Shares between a team's offense and defense. The factor of 3 used by James in Win Shares will not be retained in Decision Shares.

Win Shares:

The key to James's division of wins between offense and defense is the realization that wins scale almost linearly with additional runs scored (or prevented) for an average team. For instance, in a 4.5 RPG league, a team which, over the entire season, scores 4.5 runs more than average and allows 4.5 runs less than average will win 82 games. A team which over the entire season scores 9.0 runs more than average and allows 9.0 runs less than average will win 83 games.

Marginal Runs

"Marginal runs" is the term for the number of runs scored or prevented above a "marginal" reference level.

$MR_{OFF} = (R - x*PF*LgRPO*Outs)$

$MR_{DEF} = ((1+x)*PF*LgRPO*Outs - RA)$

$MR = MR_{OFF} + MR_{DEF}$

When x=0.5 each run created by the offense is worth the same as a run prevented by the defense. James chose to use x=0.52 because he believed that pitchers were undervalued when x=0.5.

The total number of marginal runs (MR) for team is divided by the number of actual wins (W). This linear run−to−win converter will be used to convert marginal runs into wins.

Absolute Wins

$W_{OFF} = MR_{OFF} / (MR/W)$

$W_{DEF} = MR_{DEF} / (MR/W)$

$W_{OFF} = (R - x*PF*LgRPO*Outs) / (MR/W)$

$W_{DEF} = ((1+x)*PF*LgRPO*Outs - RA) / (MR/W)$

Note: Although James insists Win Shares calculates absolute wins, the above equations are clearly net wins (and runs) above a certain reference level. The 'absolute win' vs 'net win' paradox will be answered separately. When x=1 the reference level is league average; when x~=0.85 the reference level is normal replacement level; when x=0.52 the reference level is James's original sub−replacement level used in Win Shares.

Loss Shares

The following equation for Wins Above Average defines WAA and is valid regardless of the system used to calculate the quantities.

$$WAA = (W-L)/2$$

James derived equations for "absolute" wins for offense and defense. Using the same linear conversion for marginal runs above a reference level to absolute wins with the reference level of league average (x=1.0 in the "absolute wins" equations) gives:

$$WAA_{OFF} = (R - PF*LgRPO*Outs) / (MR/W)$$

$$WAA_{DEF} = (PF*LgRPO*Outs - RA) / (MR/W)$$

There is only one unknown in the WAA equation, losses. Rearranging the WAA equation yields:

$$L = W - 2*WAA$$

We can now solve directly for losses.

<u>Offense</u>

$$L_{OFF} = W_{OFF} - 2*WAA_{OFF}$$

$$L_{OFF} = [(R - x*PF*LgRPO*Outs) - 2*(R - PF*LgRPO*Outs)] / (MR/W)$$

$$L_{OFF} = [(2-x)*PF*LgRPO*Outs-R] / (MR/W)$$

<u>Defense</u>

$$L_{DEF} = W_{DEF} - 2*WAA_{DEF}$$

$$L_{DEF} = [((1+x)*PF*LgRPO*Outs) - RA) - 2*(PF*LgRPO*Outs - RA)] / (MR/W)$$

$$L_{DEF} = [RA - (1-x)*PF*LgRPO*Outs] / (MR/W)$$

When two teams play, the matchups are (Tm 1 Offense vs Tm 2 Defense) and (Tm 2 Defense vs Tm 1 Offense). Any marginal runs that are scored by Tm 1 Offense decreases the marginal runs prevented by Tm 2 Defense by an equal amount.   Baseball is a zero−sum game. Thus, any increase in the wins for the offense of Team 1 is balanced by an increase in the losses for the defense of Team 2.

$$W1_{OFF} = L2_{DEF}$$

Furthermore, for this game (or series), both teams have the same (MR/W) and PF and that R1=RA2.

$$[(R1 - x*PF*LgRPO*Outs) / (MR/W)] = [(RA2 - (1-x)*PF*LgRPO*Outs) / (MR/W)]$$

In order to satisfy the above constraints, x=0.5.

The offensive and defensive wins and losses are calculated, using the correct value for x, as follows:

<u>Offense</u>

$$W_{OFF} = (R - 0.5*PF*LgRPO*Outs) / (MR/W)$$

L_{OFF} = (1.5*PF*LgRPO*Outs−R) / (MR/W)

Defense

W_{DEF} = (1.5*PF*LgRPO*Outs − RA) / (MR/W)

L_{DEF} = (RA − 0.5*PF*LgRPO*Outs) / (MR/W)

Decisions

The number of games is simply the sum of wins and losses.

G = W + L

Offense

G_{OFF} = W_{OFF} + L_{OFF}

G_{OFF} = [(R − 0.5*PF*LgRPO*Outs) + (1.5*PF*LgRPO*Outs − R)] / (MR/W)

G_{OFF} = (PF*LgRPO*Outs) / (MR/W)

Defense

G_{DEF} = W_{DEF} + L_{DEF}

G_{DEF} = [(1.5*PF*LgRPO*Outs − RA) + (RA − 0.5*PF*LgRPO*Outs)] / (MR/W)

G_{DEF} = (PF*LgRPO*Outs) / (MR/W)

For simplicity in the above algebraic manipulation, a team's offensive and defensive outs were assumed to be equal.

Winning Percentage

Offense

Win%$_{OFF}$ = W_{OFF} / G_{OFF}

Win%$_{OFF}$ = (R − 0.5*PF*LgRPO*Outs) / (PF*LgRPO*Outs)

Win%$_{OFF}$ = [(R) / (PF*LgRPO*Outs)] − [(0.5*PF*LgRPO*Outs) / (PF*LgRPO*Outs)]

Win%$_{OFF}$ = [(RPO*Outs) / (PF*LgRPO*Outs)] − 0.5

Win%$_{OFF}$ = [RPO / (PF*LgRPO)] − 0.5

Win%$_{OFF}$ = (*RPO+) − 0.5

When the offense is performing at a league average rate, *RPO+ = 1.0 and Win%OFF = 0.5. For a very strong offense, an *RPO+ >= 1.5 produces a Win%OFF >= 100%. For a very weak offense, an *RPO+ <= 0.5 produces a Win%OFF <= 0%.

Defense

$Win\%_{DEF}$ = WDEF / GDEF

$Win\%_{DEF}$ = (1.5*PF*LgRPO*Outs − RA) / (PF*LgRPO*Outs)

$Win\%_{DEF}$ = [(1.5*PF*LgRPO*Outs) / (PF*LgRPO*Outs)] − [(RA) / (PF*LgRPO*Outs)]

$Win\%_{DEF}$ = 1.5 − [(RPO*Outs) / (PF*LgRPO*Outs)]

$Win\%_{DEF}$ = 1.5 − [RPO / (PF*LgRPO)]

$Win\%_{DEF}$ = 1.5 − 1/(*ARA+)

ARA stands for All Run Average, which is simply (earned runs + unearned runs) per 9 innings. An average defense will have an *ARA+ = 1.0, which corresponds to a Win%DEF = .5. For a very strong defense, an *ARA+ >= 2 produces a Win%DEF >= 100%. For a very weak defense, an *ARA+ <= 0.667 produces a Win%DEF <= 0%.

Overall Team

Now that we have the offensive and defensive winning percentages we can determine what the linear Decision Shares system estimates team winning percentage to be.

$Win\%_{TM}$ = 0.5 * $Win\%_{OFF}$ + 0.5 * $Win\%_{DEF}$

$Win\%_{TM}$ = 0.5*[R/(PF*LgR) − 0.5] + 0.5*[1.5−1/(PF*LgR/R)]

$Win\%_{TM}$ = [0.5*(R−RA) + 0.5*PF*LgR] / (PF*LgR)

$Win\%_{TM}$ = 0.5 + (R−RA)/(2*PF*LgR)

Equation Summary

Offense

W_{OFF} = (R − 0.5*PF*LgRPO*Outs) / (MR/W)

L_{OFF} = (1.5*PF*LgRPO*Outs−R) / (MR/W)

G_{OFF} = (PF*LgRPO*Outs) / (MR/W)

$Win\%_{OFF}$ = (*RPO+) − 0.5

Defense

W_{DEF} = (1.5*PF*LgRPO*Outs − RA) / (MR/W)

L_{DEF} = (RA − 0.5*PF*LgRPO*Outs) / (MR/W)

G_{OFF} = (PF*LgRPO*Outs) / (MR/W)

$Win\%_{DEF}$ = 1.5 − 1/(*ARA+)

Team

$MR = MR_{OFF} + MR_{DEF}$

$Win\%_{TM} = 0.5 + (R-RA)/(2*PF*LgR)$

As you can see in the graph below, this team winning percentage model is very accurate within the range of most actual baseball teams. However, for extreme teams outside the winning percentage range of about .350 to .650, the model becomes progressively worse.