The Hidden Drivers Behind Position Player Compensation: An Analysis of the 2011, 2012 and 2013 Free Agent Markets

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I) Introduction

Free Agency. Since Curt Flood's stand against Major League Baseball's unjust compensation system in 1970, the process of free agency has been marvelled at by players (and equally abhorred by team executives) for presenting the former with an opportunity to obtain their desired salaries. Having escaped arbitration, players enter a market of multiple bidders who, each in their own interest, vie for talent. With the presumed goal of winning as many games as possible, teams invest considerable amounts of time and effort in the process in order to find the best value available.

Although the previous paragraph describes a system which has existed for decades, the cogs in its machine are nothing but brand new. More specifically, due to the dramatic evolution in player evaluation over the last several years brought upon by the analytics movement, free agent compensation has also changed dramatically. Not only has the process changed since the publication of Michael Lewis' Moneyball in 2003, but it has continued to be as dynamic over the last three offseasons. Since Free Agency unquestionably has a significant impact on a team's activities (ranging from mundane payroll projections to life-or-death decisions over its ability to retain a generational talent), this research report will strive to shed light on the relationship between the latest collection of performance statistics, the runs-focused metrics, and free agent compensation for position players during the 2011, 2012 and 2013 offseasons. Following a brief discussion of said metrics and of the gathered data, multiple regression analysis will be applied to free agent contracts signed by position players during the 2011, 2012 and 2013 offseasons with the goal being to discover what variables have been valued by the market in determining a player's Average Annual Salary and the length of his contract.

II) Three Key Metrics: wRAA SD, UZR SD and BsR SD

Although baseball has the richest statistical tradition of any major sport, a recent focus on finding higher quality ways to evaluate player performance has been hugely successful in leading to the development of new metrics. While no one should ever suggest that more traditional statistics such as a player's batting average or fielding percentage are entirely worthless measures of his contributions, their shortcomings (valuing a home run as much as a single for the former, being extremely dependent on the expectations related to a player's range for the latter) are of some significance and must also be acknowledged.

A new development in player evaluation has been the focus on statistics measuring performance in terms of runs. Instead of viewing production in terms of an average (such as an On-Base Plus Slugging percentage), these statistics provide a more intuitive perspective on a player's impact on team performance given the relationship between runs and team wins. Since a position player fills three roles (being a hitter, fielder and baserunner), a runs-oriented statistic exists for each: Weighted Runs Above Average (wRAA) for hitting, Ultimate Zone Rating (UZR) for fielding and Baserunning Runs (BsR) for baserunning. However, all three share a common issue: since they are not rate statistics, they do not adjust for playing time. Therefore, for the purposes of player performance evaluation, this report will use modified versions of these three measures in order to correct for this flaw:

- **Standardized Weighted Runs Above Average (wRAA SD)**[1] indicates the number of offensive runs that a given player produces relative to the average player, adjusted for a playing time equal to 150 games
- **Standardized Ultimate Zone Rating (UZR SD)**, also known as UZR/150, measures the number of defensive runs prevented by a player compared to the average player at his position, assuming that his playing time is equal to 150 games
- **Standardized Baserunning Runs (BsR SD)**[2] uses FanGraphs' proprietary statistic, BsR, to determine the number of runs provided by a given player on the basepaths relative to an average player, then adjusts for a playing time of 150 games

III) The Data

The following analysis concerns all free agent contracts signed during the 2011, 2012 and 2013 offseasons by position players with at least 600 Plate Appearances and 1000 Fielding Innings over the three seasons prior to their Free Agency. Both criteria have been selected since they indicate that a player has participated in at least 25% of the opportunities of a typical 150-game player. Moreover, the analysis uses three-year averages (which place a premium on both statistical relevance and reliability) of performance statistics, as well as other player-related variables, to assess a player's performance level before he reached the market.

In addition, three adjustments have been made to the player sample:

- Free agent contracts for catchers and designated hitters have been omitted given the former's inability to be graded by UZR and the latter's compensation being tied solely to their hitting ability
- Extension contracts signed by position players with 6+ years of service time (the eligibility requirement for free agency) have been included in the analysis given the belief that the players would not have signed the contracts, given their alternative to test free agency, if they were not offered the prevailing market rate
- Derek Jeter and Paul Konerko's "sunset" contracts signed during the 2013 offseason were removed from the analysis due to the combination of two outlying factors: their precipitous decline in production, making a three year analysis of past performance irrelevant, and their very strong desires to remain with their respective clubs to finish their careers

The data used in the analysis originates from two sources: FanGraphs for player performance and Baseball-Reference for player contracts.

Lastly, the 5% confidence level is used to determine statistical significance.

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[1] For details on calculating wRAA SD, please consult Appendix A, Section I

[2] For details on calculating BsR SD, please consult Appendix A, Section II

IV) The Free Agent Market

A) The First Model: AAC regressed on wRAA SD, UZR SD and BsR SD

In order to catch a glimpse of the factors that might be shaping player compensation, a basic multiple regression model of three variables was considered: regressing Average Annual Compensation (AAC) on a player's wRAA SD, UZR SD and BsR SD for the last three seasons.

For 2011 contracts, the following results were obtained (sample size of 38 contracts):

```
Call:
lm(formula = AAC ~ wRAA.SD + UZR.SD + BsR.SD, data = COMP11)

Residuals:
    Min      1Q  Median      3Q     Max 
-6.3700 -2.0001  0.0984  2.3867  7.6371 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  5.21178    0.64263   8.110 1.86e-09 ***
wRAA.SD      0.30679    0.03940   7.786 4.64e-09 ***
UZR.SD       0.10767    0.08397   1.282    0.208    
BsR.SD       0.26577    0.21030   1.264    0.215    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.921 on 34 degrees of freedom
Multiple R-squared:  0.6482,	Adjusted R-squared:  0.6172 
F-statistic: 20.88 on 3 and 34 DF,  p-value: 7.524e-08
```

Interestingly, only the hitting variable, as opposed to two or all three variables, is deemed to be statistically significant (P-Value < 0.001) in explaining the variation in AAC. This finding could be brought upon by two possibilities: either executives during the 2011 offseason entirely disregarded defensive and baserunning performance when determining average annual salaries, or they used other metrics to gauge these skills. In order to assess the probability of the latter, another three variable model (containing wRAA.SD, Fielding Percentage and Average Stolen Bases) was tested. While Fielding Percentage appeared, conclusively, to not be related to the variation in AAC (P- Value = 0.9491), Average Stolen Bases were essentially significantly related to the latter (P-Value = 0.0552). Therefore, defensive skill appears to have been, on average, undervalued and Average Stolen Bases could have been used as a proxy for overall base running skill. Finally, the first model is successful in explaining 64.82% of the variation in average annual salaries, which represents a solid yet still lacking result.

An analysis of 2012 contracts yielded the following output (sample size of 21 contracts):

```
Call:
lm(formula = AAC ~ wRAA.SD + UZR.SD + BsR.SD, data = COMP12)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.1030 -1.4188 -0.2879  1.9198  5.1369 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)   4.7450     0.5343   8.881 8.55e-08 ***
wRAA.SD       0.4455     0.0423  10.532 7.20e-09 ***
UZR.SD        0.2146     0.0811   2.646    0.017 *  
BsR.SD        0.1547     0.1970   0.785    0.443    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.364 on 17 degrees of freedom
Multiple R-squared:  0.8812,	Adjusted R-squared:  0.8602 
F-statistic: 42.02 on 3 and 17 DF,  p-value: 4.448e-08
```

Although the smaller sample size leads to greater variability and a slightly inferior quality of results as compared to 2011, a few observations in relation to the 2011 offseason are interesting. As in 2011, batting skill is highly related to the variation in player compensation (P-Value = 0.00). However, the salary coefficient attached to a single unit of wRAA.SD has increased significantly from 0.30679 to 0.4455. For example, a player having produced an average of 10 wRAA.SD prior to becoming a free agent in 2012 would, on average, have received compensation of $4.455M related to this skill alone as compared to compensation of $3.0679M if he had entered the 2011 market. Once more, two explanations may account for this finding: the smaller sample size may lead to a distortion in the variable’s value or, more probably, the existence of a declining run environment in Major League Baseball may push teams to compensate hitting more richly.

Furthermore, the UZR SD variable has gone from being absolutely unrelated to player compensation in 2011 to significantly related (P-Value = 0.017) in 2012, perhaps underscoring teams’ adoption of the metric as a strong tool for player evaluation. It is also worth noting that its coefficient is equal to 0.2146, less than half that of wRAA SD. One may suggest that, since both statistics measure player performance in terms of runs, it is entirely nonsensical for one average run of wRAA SD to be valued significantly higher than one average run of BsR SD. However, even taking into account an undervaluation of defensive performance which has existed as long as the game itself, the much greater variability in hitting, than in defensive, performance (as measured in runs) could be what explains the difference in coefficients[3]. It is far from heretical to suggest that the more variability there is in some skill, the more uncertainty in performance exists and the greater the willingness of a team to pay a player who excels at it a high salary.

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[3] For data on the difference in dispersion of the three skills, see Appendix B

Additionally, baserunning now appears to be the skill which, on average, is overlooked (P-Value = 0.443). For the sake of comparison, the same model, with BsR SD replaced by Average Stolen Bases, also shows no evidence of a relationship between the former and AAC (P-Value = 0.2832).

Lastly, the wRAA SD, UZR SD and BsR SD model explains 88.12% of the variation in average annual player compensation (representing a 23.30% increase over 2011). While being mindful of the small sample size, these findings (most importantly the UZR SD variable's statistical significance) suggest that the adoption of runs-based performance metrics by teams, for the purposes of player evaluation and compensation, grew from 2011 to 2012.

For the 2013 offseason, the following output was obtained (sample size of 26 contracts):

```
Call:
lm(formula = AAC ~ wRAA.SD + UZR.SD + BsR.SD, data = COMP13)

Residuals:
   Min     1Q Median     3Q    Max 
-9.176 -1.001  0.221  2.251  4.618 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  5.78382    0.69407   8.333 2.98e-08 ***
wRAA.SD      0.39773    0.03896  10.208 8.29e-10 ***
UZR.SD       0.22249    0.07103   3.132  0.00485 ** 
BsR.SD       0.65809    0.24399   2.697  0.01316 *  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.371 on 22 degrees of freedom
Multiple R-squared:  0.8324,    Adjusted R-squared:  0.8095 
F-statistic: 36.42 on 3 and 22 DF,  p-value: 1.044e-08
```

Although the sample size is again less than ideal, the model provides striking results compared to previous offseasons by highlighting the statistical significance of all three runs-based variables (all three P-Values less than 0.02) in relation to average annual player compensation during the 2013 offseason. Moreover, the compensation coefficient for hitting is highly similar to the one found in 2012 (0.39773 compared to 0.4455) while that for defense is nearly identical (0.22249 compared 0.2146). Therefore, some degree of consistency in market AAC for hitting and defensive performance seems to have been achieved (at least for two consecutive years). Most importantly, there now also appears to be a significant relationship between BsR SD (P-Value = 0.01316) and average player compensation. However, the high coefficient of compensation linked to BsR SD (0.0.65809), given the lesser variability in baserunning performance, as compared to defensive performance, among major league players runs counter to the previous argument advocating for lesser compensation for less variable skills. While no irrefutable conclusion can be provided on the reasons for this observation, overcompensation for a previous neglect of baserunning skill as measured by BsR SD could explain it.

Finally, the model provides an explanation for 83.24% of the variation in average annual salaries, a very robust figure despite its decrease of 4.88% as compared to 2012.

Therefore, some evidence suggesting a continued change in the variables shaping free agent compensation, as well as the increasing market-wide adoption of standardized runs-based metrics exists over the last three offseasons.

B) The Second Model: Regressing AAC on Average Games, wRAA SD, UZR SD and BsR SD

Even though the increased use of standardized runs-based metrics is undoubtedly positive for teams as far as an efficient allocation of salaries is concerned, important consideration must still be granted to another variable when using them: players' ability to reach the 150 game mark. While the equalization of playing time is extremely useful in comparing players, team executives must simultaneously evaluate a player's ability to remain healthy in order to get a complete view of their value (especially since wins are determined on absolute, and not rate, statistics). Therefore, a four variable model, simply adding Average Games Played (AGP) to the previous First Model, is presented in order to evaluate the importance granted, on average, by the market to a player's average playing time over the last three seasons. Below is a table presenting the output linked to the AGP variable for all three offseasons:

Year	AGP (P-Value)
2011	0.449
2012	0.900
2013	0.154

Surprisingly, the variable's P-Values all exceed the 5% significance level quite substantially, indicating that Average Games Played is not significantly related to the variation in player AAC , when jointly considered with the three runs-based metrics, in either of the last three offseasons.

For the sake of comparison, Average Days Injured (ADI) and Average Days Injured Over 15 (ADI15) were used as other measures of a player's ability to remain on the field. Since a certain number of injury days may be considered "normal" by teams, only a player's injury days over a somewhat, though not entirely, arbitrary threshold of 15 days were tested in addition to the basic number of injury days.

Year	ADI (P-Value)	ADI15 (P-Value)
2011	0.151	0.167
2012	0.420	0.458
2013	0.315	0.367

Similarly to Average Games Played, ADI and ADI15 are not statistically significant in explaining the variation in free agent average compensation when considered jointly with the three runs-based metrics. Even though one possible cause for this observation is the fact that some element of Average Playing Time is reflected in the three runs-based metrics, an equally possible reality is that the market, on average, grants too much importance to performance that is standardized and too little to a player's ability to actually remain in the starting lineup.

C) The Relationship Between Contract Length and Average Annual Compensation

Since compensation only represents half of the equation when discussing free agent contracts, focus must also be attributed to the factors that impact the length of the agreements. Ironically, one variable stands out in attempting to explain Contract Length (CL): Average Annual Compensation. Simply put, the higher the level that a player performs at, the higher the AAC and CL that he is able to command. Since AAC represents a proxy for a player's performance level, an inference can be made that a higher AAC leads to greater negotiating leverage for a player, ultimately resulting in longer CL. In addition, teams are likely to want to retain the services of a player for more time the higher their production level (and, consequently, the higher their salary). Below is a table presenting the results of a regression of CL on AAC:

Year	Intercept	AAC (Coefficient)	AAC (P-Value)	R-Squared
2011	0.46563	0.30425	0.000	84.20%
2012	0.69568	0.20483	0.000	56.90%
2013	0.42138	0.28010	0.000	83.27%

Therefore, data for the three offseasons supports the significant relationship between CL and AAC (all P-Values = 0.000). Even though a significant difference exists in Intercept, AAC Coefficient and R-Squared between 2011 and 2012, the high degree of similarity between the 2011 and 2013 values of those same variables suggests that the former could simply be due to the smaller number of contracts signed during the 2012 offseason.

Most interestingly, average annual salaries explain over 80% of the variation in contract term in both 2011 and 2013 and every additional million dollars in AAC, on average, is related to an approximate 0.30 year increase in CL over the same years. For example, during the 2013 offseason, a $15M AAC player would have, on average, received a contract of 4.62 years while a $5M AAC player would have, on average, received 1.82 years.

D) Does Recent Injury History Impact Contract Length?

While Average Annual Compensation is without a doubt a logical factor in the determination of Contract Length, recent injury history appears to be an even more logical variable for team executives to consider. More specifically, the more injury days that a player has amassed in the recent past (in this case, the last three years), the more wary teams should be about his future health prospects, driving down the number of years granted to him. In order to assess the relationship between the two variables, CL was regressed on both Average Days Injured and Average Days Injured Over 15, with the results summarized below:

Year	Intercept	ADI (Coefficient)	ADI (P-Value)	R-Squared
2011	2.318172	-0.001867	0.897	0.00%
2012	1.9415442	0.0003529	0.983	0.00%
2013	3.17315	-0.01887	0.139	8.90%

The data shows categorical evidence of no significant relationship existing between ADI and Free Agent CL.

Year	Intercept	ADI15 (Coefficient)	ADI15 (P-Value)	R-Squared
2011	2.2578927	0.0003027	0.985	0.00%
2012	2.042804	-0.004656	0.812	0.30%
2013	2.96740	-0.01924	0.165	7.86%

Additionally, the same conclusion can be reached regarding ADI15 and Free Agent CL.

Therefore, recent injury history, measured in days, does not appear to have been, on average, a major consideration in determining the length of free agent contracts signed during the 2011, 2012 and 2013 offseasons. It is important to emphasize that this finding concerns signed contracts, as opposed to all contract offers which are not publicly available for analysis. Consequently, concluding that recent injury history is a variable that is not considered at all in free agent compensation would be incorrect. For example, a team (which ends up signing a free agent) might initially offer him a term which highly values recent injury history, only to get caught up in the heat of a bidding war and end up granting him a deal which only indicates valuing his standardized run numbers.

V) Conclusion

A diligent analysis of the 2011, 2012 and 2013 free agent markets for position players has yielded interesting findings on two aspects of free agent contracts: Average Annual Compensation and Contract Length. Firstly, the free agent market has shown considerable dynamism over the three-year period as the factors which guide AAC have changed. More specifically, evidence supports the increasing adoption of standardized runs-based performance metrics such as wRAA SD, UZR SD and BsR SD by market participants, as well as an increasing focus on the compensation of the two often overlooked skills, defense and baserunning. However, position player playing time does not appear to be as highly valued as these standardized metrics, which could certainly represent a significant market inefficiency. Secondly, an analysis of free agent contracts provides evidence of Average Annual Compensation, serving as a proxy for a player's performance level, having a significant bearing on Contract Length. Simultaneously, recent player injury history, somewhat surprisingly, does not appear to impact the term of free agent contracts signed during the 2011, 2012 and 2013 offseasons. Ultimately, the evolution of the Free Agent Market for position players over the last several years entails that it has a significant impact on a team's ability to compete. Not only has it grown in dollar size, but its complexity has also increased significantly. Prioritizing a sound understanding of it, as well as a constant updating of one's beliefs related to it, represents a distinct advantage.

Appendix A

I) wRAA SD

In order to calculate wRAA SD, a player's wRAA over a sample period (i.e. three seasons) is divided by his total Plate Appearances (PA), and then multiplied by the average number of PA for a 150-game player over the same sample period.

In practice, only a small number of players play exactly 150 games in a season. Therefore, the average number of PA per season for players having played between 138 and 162 games (two bookends for 150) is used as a proxy.

II) BsR SD

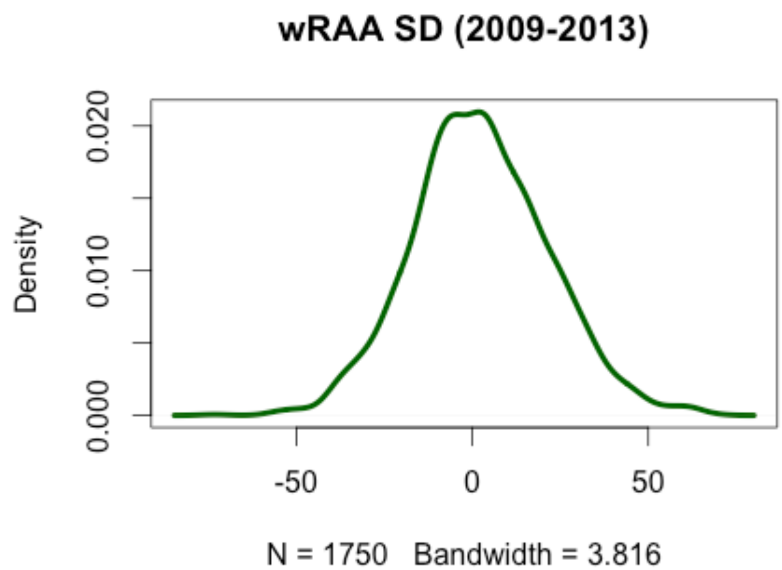
The calculation of BsR SD involves two steps:

- Firstly, a player's Baserunning Opportunities (BsOps) over a sample period (i.e. three seasons) is calculated by multiplying his On-Base Percentage (OBP), minus his home-run percentage, by his total number of PA. Firstly, OBP gives us the total opportunities had by a player to earn Baserunning Runs since he can only do so while on the basepaths. Secondly, home-run percentage (which is included in OBP) is subtracted since a player is can never truly show his baserunning skills after hitting one.
- Secondly, a player's BsR over a sample period (i.e. three seasons) is divided by his total BsOps, and then multiplied by the average number of BsOps for a 150 game player over the same sample period.

In practice, only a small number of players play exactly 150 games in a season. Therefore, the average number of BsOps per season for players having played between 138 and 162 games (two bookends for 150) is used.

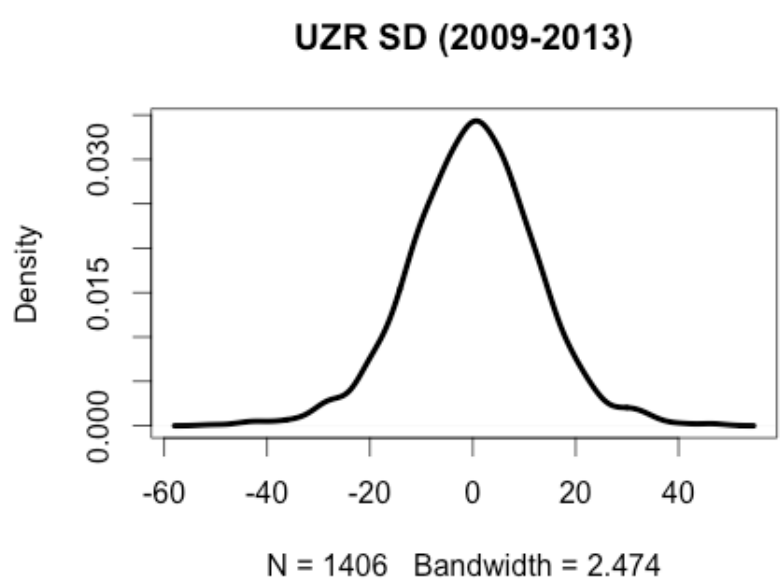
Appendix B

I) wRAA SD



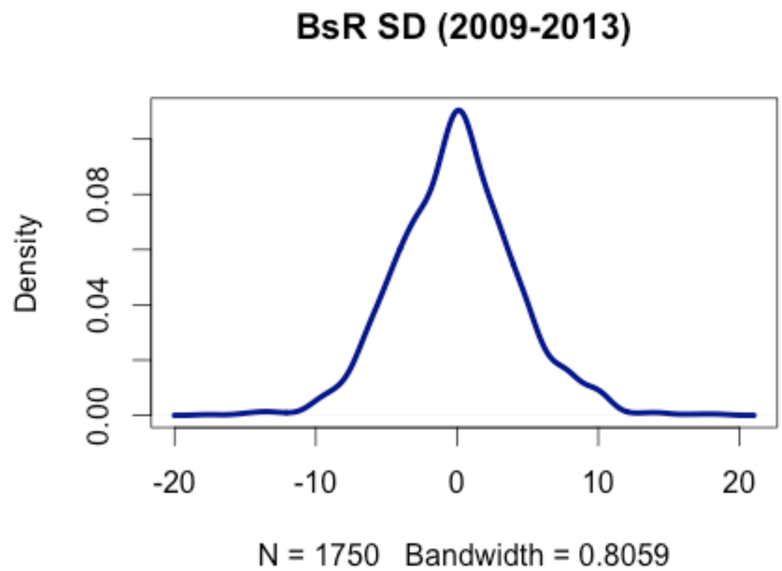
- Sample including the single season wRAA SD of players with at least 200 Plate Appearances
- wRAA SD (2009-2013) Mode: 0
- wRAA SD (2009-2013) Range (Density > 0.05): -40.0 to +35.0

II) UZR SD



- Sample including the single season UZR SD of players with at least 350 Defensive Innings
- UZR SD (2009-2013) Mode = 0
- UZR SD (2009-2013) Range (Density > 0.05) = -20.0 to +20.0

III) BsR SD



- Sample including the single season BsR SD of players with at least 200 Plate Appearances
- BsR SD (2009-2013) Mode = 0
- BsR SD (2009-2013) Range (Density > 0.05) = -10.0 to +10.0