Salary Determination of a Free Agent in the National Basketball Association

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Abstract:

Both statistical and financial factors are used to determine a free agent NBA player's salary. By looking at a player's production from the previous season and the NBA team's financial situation, the results are consistent with the hypothesis that the three-point shot and free throws are the two major statistics that determine how much a free agent will make in their next season. From an NBA team's financial perspective, it is significant to note that players who decide to switch teams make less money, which is in line with the NBA's CBA. Using these variables to create the model based on 2018 and 2019 NBA player statistics and salaries and 2019 team revenue, it was found that the three-point shot and free throws are important statistical factors that determine a player's salary.

Introduction:

In 2016, the NBA signed a 9-year, $24 billion television contract that caused a significant increase in league revenue. An increase in league revenue allows players to get an increase in their yearly salaries. Around the same time that the new television contract was signed, the NBA began adapting to a new style of basketball started by the Golden State Warriors. Their system emphasized shooting more three-point shots efficiently, as well as significantly improved efficiency in free throws. Their small ball lineup has led to analysts calling this time "the era of the guards" since they are the ones mainly responsible for shooting three-pointers traditionally. When determining an NBA player's salary, player performance and team revenue are the broad variables to analyze. Therefore, the model will show NBA salary as the dependent variable while field goal percentage, free throw percentage, three-point percentage, rebounds, assists, steals,

blocks, turnovers, and NBA team revenue will be the independent variable. An independent variable from the team revenue aspect to analyze is if switching teams has an impact on player salary since the NBA's CBA suggests that is the case. With the NBA in "the era of the guards", there is also an independent variable for a player's position to see if being a guard has a significant impact on a player's salary. Looking deeper at position impact on salary, shooting guards are traditionally known to shoot the most three-pointers, so shooting guards are an independent variable as well. The source for players' salaries was ESPN, basketballreference.com to get data on players' stats, and statistica.com to record team revenues.

Empirical Model:

Below is the model to determine the salary of a free-agent NBA player:

$$Salary = S_1 + S_2\,(FG\%) + S_3\,(FT\%) + S_4\,(3PT\%) + S_5\,(REB) + S_6\,(AST) + S_7\,(STL) + S_8\,(BLK) - S_9\,(TOV) - S_{10}\,(POS) - S_{11}\,(SG) - S_{12}\,(DEC) + S_{13}\,(REV) + \varepsilon$$

The Ss represent the coefficient of determination for each variable in the regression output. For the FG% (field goal percentage), FT% (free throw percentage), and 3PT% (three-point percentage) variables, those values were inserted into the equation as decimals from the dataset. REB (rebounds), AST (assists), STL (steals), BLK (blocks), and TOV (turnovers) values will be inserted as-is from the dataset. These variables are represented as dummy variables: POS, SG, and DEC. The POS (position) variable creates a distinction between guards and forwards. For this model, 0 represents guards and 1 represents forwards. If the player is a forward, we predict that they will make less money than a guard would. The SG (shooting guard) variable identifies free agents that are listed as shooting guards. In the model, 0 represents players listed as shooting guards and 1 represents all the other positions. The prediction is that players of other positions will make less money than shooting guards. Finally, the DEC (decision) variable represents a

free agent's decision to move to a new team. 0 represents the free agent resigning with his original team and 1 represents the free agent signing with a new team. If a player signs with a new team, the expectation is they will make less money than if they stayed with their original team.

Data:

Free agents coming off an injury (eg. DeMarcus Cousins tore his Achilles in 2018, the year he was a free agent) will not be included. Factoring out free agents coming off injuries is the best way to create an all-else-equal field for all the free agents, the best way to isolate the impact of all the variables. Another note is that the values REV (revenue) and the salary are adjusted to eliminate skewed results. A skew is present in the salaries because the superstar players tend to earn the majority of the money. Similarly, revenue is skewed because large market teams tend to receive the most revenue since they have more potential people to broadcast to. To eliminate the skews in the model, take the natural log of the salaries and the revenues.

Econometric Investigation:

Here is the descriptive statistics table for the 2018 and 2019 NBA free agents:

	Adjusted Salary	FG%	FT%	3PT%	REB	AST	STL	BLK	TOV	POS	SG	DEC	Adjusted Revenue
Count	106	106	106	106	106	106	106	106	106	106	106	106	106
Mean	15.90294249	0.472235849	0.775679245	0.317018868	4.943396226	2.645283019	0.833018868	0.514150943	1.469811321	0.575471698	0.773584906	0.603773585	19.52359036
SD	0.849162509	0.06322425	0.084191228	0.111882164	2.351413713	1.851286918	0.376632118	0.408816801	0.705916468	0.496619299	0.420498998	0.491436093	0.211339151
Min	14.22934124	0.367	0.543	0	1.2	0.5	0.2	0	0.4	0	0	0	19.22715661
Max	17.4562234	0.652	0.919	0.455	13.1	9.1	2	2.2	4.2	1	1	1	19.97248954

Below are the regression statistics for the model:

Regression Statistics	
Multiple R	0.725199535
R Square	0.525914366
Adjusted R Square	0.464742026
Standard Error	0.621258558
Observations	106

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	14.91274499	6.00522962	2.483293053	0.01480894	2.987549119	26.83794087	2.987549119	26.83794087
FG%	1.38380015	1.544936105	0.89570057	0.372725243	-1.684136771	4.451737071	-1.684136771	4.451737071
3P%	1.768793909	0.782916053	2.25923827	0.026204267	0.214077791	3.323510028	0.214077791	3.323510028
FT%	2.297610474	0.869078125	2.64373295	0.009623842	0.571793557	4.02342739	0.571793557	4.02342739
REB	0.09423966	0.043556578	2.163614873	0.033056808	0.007744928	0.180734393	0.007744928	0.180734393
AST	0.086577585	0.071082976	1.217979185	0.22631298	-0.054579118	0.227734288	-0.054579118	0.227734288
STL	0.618838462	0.202191094	3.060661332	0.002886509	0.217327021	1.020349903	0.217327021	1.020349903
BLK	0.173880573	0.21347439	0.814526617	0.417424196	-0.250037259	0.597798404	-0.250037259	0.597798404
TOV	0.129734013	0.148876237	0.871421896	0.385767874	-0.165904689	0.425372714	-0.165904689	0.425372714
Position	0.071771094	0.264572754	0.271271673	0.786783314	-0.453617961	0.597160148	-0.453617961	0.597160148
Shooting Guards	0.031951973	0.232095954	0.137667084	0.890801157	-0.428944592	0.492848539	-0.428944592	0.492848539
Decision	-0.348145679	0.131673166	-2.644013878	0.009616428	-0.609622492	-0.086668867	-0.609622492	-0.086668867
Adjusted Revenue	-0.171716708	0.302946876	-0.566821188	0.57220119	-0.773309165	0.429875748	-0.773309165	0.429875748

The model has an R squared of approximately 0.53, which means that the model explains approximately 53% of the variation in a free agent's salary. The regression model does support the main hypothesis that three-point and free throw shooting are significant factors that increase a player's salary. The model displays a positive coefficient for both variables, meaning the player makes money. Since the p-value for both is less than any of the confidence intervals (1%, 5%, or 10%), it means that the variables are significant. The decision variable is correct as it is in line with the details of the NBA's CBA. The most notable insignificant variables are the position and shooting guard dummy variables. The reason for this is that these variables being insignificant proves the hypothesis that guards, more specifically shooting guards make more money. The model shows that the position coefficient says that a player makes more money if they are listed as a forward. It also shows that all the other positions that are not shooting guards make more money, hence both disproving the hypothesis. Although the regression model had many

insignificant variables, it proved the main hypothesis that the three-point and free throw shots are significant factors that determine a player's salary. According to the results, below is what the average free agent NBA player should make calculated by using the mean values for each variable in the model. With the skew from the salary and team revenue eliminated, the answer the model produces, raise e to that output to see the actual average salary:

$$Predicted\ Salary_{Average} = 14.9127449 + 1.38380015\ (0.472) + 1.768793909\ (0.317) + 2.297601474\ (0.776) + 0.09423966\ (4.94) + 0.086577585\ (2.65) + 0.618838462\ (0.83) + 0.173880573\ (0.51) + 0.129734013\ (1.47) + 0.071771094\ (0.58) + 0.031951973\ (0.77) - 0.348145679\ (0.60) - 0.171716708\ (19.52359036)$$

$$Predicted\ Salary_{Average} = 15.09235970 \rightarrow e^{15.09235970}$$

$$\boldsymbol{Predicted\ Salary_{Average} = \$3,585,325}$$

According to the model, the average free agent NBA player should make around $3,585,325.

Conclusion:

Overall, the model did support the main hypothesis that three-point and free throw shots are significant factors in determining a free agent NBA player's salary. However, it was not very accurate in determining a player's salary. More dummy variables can be included to improve the model. Some can represent the accolades a player has won like MVP, Defensive Player of the Year, All-Star, and All-NBA team selection. The NBA CBA supports the fact that players make more money if they win an award from the previous season. The other dummy variable to include is the player who won a championship the year they became a free agent. Although not analyzed, the combination of variables used can also be changed since there are most likely signs of correlation and collinearity between the current variables.

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