Measuring How NBA Players Were Paid in the 2011-2012 Season Based on Previous Season Play

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Abstract

This paper looks to see the link between an NBA player's 2010-2011 season statistics and their 2011-2012 salary. I used basic box score statistic data for the 2010-2011 season. The results of the Ordinary Least Squares regression shows that two point shots made, free throws made, defensive rebounds, and assists all have a positive and significant correlation with salary. Personal fouls have a negative and significant relationship with salary, and offensive rebounds, steals, blocks, turnovers, three point shots missed, two point shots missed, and free throws missed did not play a significant factor in determining a player's 2010-2011 salary. The position a player plays relative to the point guard position was also found to have a significant relationship with player salary.

I Introduction

When it comes to sports, almost everyone seems to have an opinion, from who is contributing to their team, who the best player is, and who is over or under paid. With the sports world playing such a dominant role in today's society, the players of these games are under constant scrutiny. Take Chris Bosh of the Miami Heat as an example. Chris Bosh was constantly under fire for his lack of production towards the team, considering how much money he was paid. This scrutiny came from Bosh's lack of points scored for the team. However, without Chris Bosh's presence rebounding, would Miami have made three finals appearances and won two championships without him? While that is impossible to know, it is a question worth considering.

Basketball can essentially be broken down into a simple idea. The goal of the game is to score more than the opponent. Therefore, all possessions basically have one of two outcomes. The possession can either end in a score, which is a positive for the friendly team, or a turnover, which is a negative for the friendly team. In basketball, since a team can only score when it has possession of the ball, the team should look to maximize possessions, since that maximizes the team's possibilities to score, while trying to minimize the opposing team's possessions, since that minimizes the opposing team's chances to score.

However, it seems NBA teams focus on one part of that simplification over the rest. Teams are only concerned with outscoring the opposing team, since that is ultimately how a team wins the game. The second aspect of this basic breakdown of basketball as a game does not seem to have as much attention paid to it, the aspect of maximizing your own possessions and limiting your opponents. Players that score seemed to be paid a substantially larger amount than players that rebound or play defense. Similarly, players that cause the other team to gain extra

possessions, by missing a shot or losing possession of the ball, do not seem to be punished for allowing the opposing team extra opportunities to score. Even if a player scores a fairly high amount, NBA teams to not appear to distinguish between a player that scores a high amount efficiently, that is by making most of his shots, and a player that scores inefficiently, by missing a significant amount of his shots.

This paper sets out to determine which statistics NBA teams value when paying players. While scoring is a significant part of the game, there are other important statistics that help teams win. To test the impact each statistic has on a player's salary, I used an Ordinary Least Squares regression with player salary as the dependent variable**.**

The results showed two point shots made, free throws made, defensive rebounds, and assists all had a positive and significant impact on a player's salary. Personal fouls had a negative and significant impact on salary. Three point shots made, offensive rebounds, steals, blocks, turnovers, three point shots missed, two point shots missed, and free throws missed all were found not to have a significant impact on salary. Furthermore, shooting guards, small forwards, power forwards, and centers all made more at a statistically significant level than point guards.

This paper is divided into five different sections. The first section will provide an overview of the relevant literature would predict players are paid. The second section will describe the variables used in the research and where the data was collected from. The third explains the model used in the study. Section four provides an examination of the empirical results, while section five offers my conclusions from the study and where the model could be improved.

II Literature Review

Finding literature on this topic is not easy. As far this may be one of the first studies to look into the impact each statistic has on a player's next year salary. However, by looking at popular methods in determining what a player is worth, as well as what some of the greatest minds to ever coach the sport say about player performance, a clear enough picture can be painted as to what effect individual statistics should have on NBA salaries.

Mathletics, by Wayne L. Winston discusses the link between salary and the estimated wins a player produces. Winston uses a player point rating, which is the adjusted +/- rating a player has (Winston 203). A +/- rating for a player is simply the amount of points the player's team scores while that player is on the court, relative to the amount of points the other team scores. For example, if team A with player A scores ten points while player A is on the floor, and team B scores only seven points, then player A's +/- rating is positive three, since his team scored three more points than the other team while he was on the floor. Winston then adjusts this number for minutes played and play compared to a "replacement" player. (Winston 234). He then determines a win is worth $1,560,976 in 2006-07 season based on current total NBA salaries. From there, he multiplies the value of a win times the player's performance to determine how much that player is worth. (Winston 234).

There seem to be several problems with this approach. First, it is an oversimplification of the way basketball is played. Winston focuses solely on points as a measure of performance. He claims the adjusted +/- rating of a player is comprehensive, in that it takes into account the player's full performance (Winston 203). However, this is not the case. A player is still dependent on his teammate to play good defense and shoot the ball well. Second, the model does not take into account any other specific box score statistic other than points. Again, a player is

dependent on his team's performance to have a positive +/- rating. A player could hypothetically get every single rebound for the entire game, and still have a +/- rating of 0 to -4 if his teammates do not ever make a shot.[1] That does not mean the player did not contribute to the team. This does not seem to be an effective measure of player performance related to salary.

Sports Analytics by Benjamin C. Alamar discusses the reason why sports analytics exist. As the paper is focusing on future salaries based on past results, this book helps explain the importance of analyzing sports in terms of uncertainty and risk. There is a graph in the book detailing the more information a team has on a player, the less information a team has on a player, the more risk that player has for the team. (Alamar 51). This is why specific statistics should be kept on player's performance. By evaluating these statistics, teams are able to measure their risk. In this case, the more teams are able to know about a player's contribution to wins, the less the team risks overpaying the player. Five questions must also be applied to every sports analytics question, which will be answered in this paper. The questions are: What was the thought process that led to the analysis? What is the context of the results? How much uncertainty is in the analysis? How does the result inform the decision-making process? How can we further reduce the uncertainty? (Alamar 55) As the foundation for all questions related to sports, the questions will also focus the thought process behind this paper. Finally, the book lays the foundation for which box score statistics in the NBA are significant, and whether they positively or negatively impact wins. This is important, because players are bought to produce wins for a team. Therefore, the statistics that positively impact wins should also positively impact a player's salary. The positive contributors to wins are points, offensive rebounds,

[1] If the rebounder's team got the ball first and never lost possession, the opposing team would never score, meaning the rebounder would have a +/- of 0, since in this situation his team never scores either. If the rebounder's team did not get the ball first, the opposing team has the ability to score anywhere from 0 to 4 points assuming the rebounder grabs every single missed shot, which would lead to a maximum of a +/- rating for the rebounder.

defensive rebounds, assists, free throw attempts, free throws made, steals, and blocked shots (Alamar 69). In almost all of the literature, points are listed as the first significant contributor of wins. While this should be the case, as scoring more points than the other team leads to a win, this is also an indicator of why basketball scorers may be so heavily weighted over players that contribute in other ways. It is most important to score more points than the other team, so team executives want players that can score. However, interestingly, field goal attempts, which are required to score points, are listed as a negative attribute, along with personal fouls and turnovers (Alamar 69). This suggests that players that score a lot of points, but have a poor shooting percentage actually hurt their team. In my study, I focus on shots missed instead of attempts to eliminate multicoliniarity between shots made and shots attempted. Shots missed should have a negative impact similar to field goal attempts.

One of the more common, and recent statistics used to determine a player's contribution is the Wins Produced statistic, laid out in *Stumbling on Wins* by David J. Berri and Martin B. Schmidt. The wins produced statistic takes all of the box score statistics and equates a single number to place on player performance. Similar to *Sports Analytics*, points, offensive rebounds, defensive rebounds, and steals, blocks, and assists are all positive contributors to the estimated amount of wins a player contributes to his team (Berri and Schmidt 148). Field goal attempts, free three attempts, turnovers, and personal fouls are all listed as negatives (Berri and Schmidt 148). The Wins Produced statistic also accounts for the minutes a player is on the floor. My study excludes any indication of how much a player plays as the amount a player plays is not independent from the box score statistics a player posts. That is, a player that plays more often is more likely to have higher box score totals than a player who plays less often. Berri and Schmidt also go on to give an example of the 03-04 New York Knicks. The Knicks traded for several

high scoring players, but ended up only winning an average of 28 games (Berri and Schmidt 31). Berri and Schmidt conclude the NBA places too much emphasis on scoring. If this is the case, the total impact of three point shots made, two point shots made, and free throws made should be far greater on salary than other statistics.

Scorecasting by Tobias J. Moskowitz and L. Jon Wertheim explains why teams are so fascinated at obtaining "all-star" players. According to Moskowitz and Wetheim, a team that has three first team all-stars has a thirty nine percent chance of winning an NBA title. Also, a team with three first team all-stars has a seventy seven percent chance of making the finals in the first place (Moskowitz 170). This explains why teams are so eager to spend money on getting talented players. The Los Angeles Lakers brought in Dwight Howard, a player with a known history of coach killing and immaturity because if he and Kobe Bryant could have both performed at first team all-star level, the Lakers would have historically had a twenty five percent chance at winning an NBA title. However, Kobe and Howard were never able to mesh, and this signing has left the Lakers floundering at the bottom of the league after Howard left at the beginning of the 2013 season. However, in cases where teams were able to assemble a team that was cohesive, they have won championships. The signing of the Big 3 in both Boston and Miami led the Celtics and the Heat to two championships each to date. Clearly, high talented players are important to aspiring championship teams. However, it does not just need to be scorers that help a team to a championship.

III Data Description

This study uses box score statistics from NBA players across all thirty NBA teams during the 2010-2011 season and the player's salary from the 2011-2012 season. The dependent variable for this study is a player's 2011-2012 salary. The independent variables used in this

model are the two point field goals made (twopm), two point field goals missed (twopt_ms), three point field goals made (threepm), three point field goals missed (threept_ms), free throws made (ft), free throws missed (ft_ms), offensive rebounds (orb), defensive rebounds (drb), assists (ast), steals (stl), blocks (blk), turnovers (tov), and personal fouls (pf) while also controlling for the player's position. The data includes players that played with one team a whole season, or were traded before, on, or around December 21st, 2011 and played for no more than two teams. Players also had to have played for the 2010-2011 season. Players on rookie contracts were also eliminated from the data, as they have a fixed pay scale, meaning their earnings are independent of their previous season's statistics. If a player was traded in the 2010-2011 season, their totals playing for all teams were compiled into a single total for the season.

By looking at two point field goals made and two point field goals missed instead of total two point field goal percentage, I hope to be able to determine if NBA teams are weigh made field goals more than missed field goals. Using a single field goal percentage number would not show how teams value made shots relative to missed shots. Instead, it would show how teams value efficient scorers. By separating this statistic, it will be possible to determine how NBA teams value efficient scorers as well as seeing if missed field goals play a significant factor into a player's salary.

The breakdown of total points a player scores into two point field goals made and missed, three point field goals made and miss, and free throws made and missed is to account for the different value perimeter players are given over players that primarily score two point field goals, and to see if there is a difference. By breaking this one statistic down into three separate categories, it will be possible to determine how NBA teams value the way a player scores his points.

Similarly, the rebound statistic has been broken down into offensive rebounds and defensive rebounds. NBA teams are restricted to a twenty-four second shot clock, meaning the ball has to touch the rim they are attacking within twenty-four seconds of gaining possession of the ball. By acquiring an offensive rebound, a player is theoretically giving his team a few extra seconds on a new shot clock, since the shot clock is reset every time the ball touches the rim. Defensive rebounds gain a team a possession, but require the team to move the ball to the opposite end of the court, taking time off of the shot clock. Since these two statistics are separate in this study, it should show whether NBA teams value the few added seconds an offensive rebound gives over a defensive rebound.

Assists, steals, blocks, and turnovers are not possible to separate into two or more statistics, so they remain whole. An assist is when a player A passes to player B and player B scores as a result of that pass. A steal is when Player A takes the ball from an opposing player, Player B, resulting in an extra possession for player A's team. A block occurs when Player A stops the ball that Player B has shot, resulting in Player B missing the shot. A turnover is when a player loses possession of the ball causing the opposing team to acquire possession of the ball. Assists and turnovers will show how much a teammate helps his team on the offensive side of the ball. Assists help the team since it allowed a teammate to score, while a turnover hurts the team because it costs the team to lose an opportunity to score. Steals and blocks measure how much a player helps his team on the defensive end of the court. By stealing the ball, a player gives his team an extra possession, and thus an extra opportunity to score. A block prevents the other team from scoring, which helps the team have a higher score than their rival. In an ideal world, there would be a statistic for blocks that result in a friendly rebound (that is, a block by Player A that leads Player B, his teammate, to gain possession of the ball) and a block that results

in the opposing team maintaining possession of the ball. This would show whether NBA teams value blocks that end an opposing team's possession over a block that allows the opposing team to retain possession, or whether NBA teams value all blocked shots the same. However, I could not find this data.

Personal fouls are often theorized to cost teams points, and therefore costing them wins. By measuring the impact personal fouls have on a player's salary, this will show if NBA teams see personal fouls the same way. If a player is penalized for committing personal fouls by getting paid less, then that shows NBA teams also see personal fouls as a detriment to the team.

We also need to control for a player's position. A player that plays center may be valued more than a player that plays the point guard position. By controlling for the position a player plays, it will be possible to determine how NBA teams value some positions relative to another. In this study, the positions will be compared to the point guard position. The other four positions are shooting guard (pos_num_2), small forward (pos_num_3), power forward (pos_num_4), and center (pos_num_5).

An important statistic that seems to be missing is a measure of how much a player plays on the court. Minutes played, games played, games started, and games missed are all a measure of this. However, these variables are not independent of the other independent variables in the model. That is, a player that plays more minutes is more likely to have a higher stat total than a player who plays less minutes. By leaving out these measures, this model assumes teams pay players for production of the statistics mentioned above, and not based solely on a player's ability to play large amounts of time, or for a player's ability to be healthy.

IV Model and Methodology

This study is looking at the direct impact scoring has on a player's salary compared to a player's other box score statistics. Along with these statistics, the independent variables of position played, team played for, games started, games not started, and games missed should also have an impact on a player's salary.

The Ordinary Least Squares model used to estimate the impact these variables have on salary is:

Salary = ß0 + ß1 (threepm) + ß2 (twopm) + ß3 (ft) + ß4 (orb) + ß5 (drb) + ß6 (ast) + ß7 (stl) + ß8 (blk) + ß9 (tov) + ß10 (pf) + ß11 (threept_ms) + ß12 (twopt_ms) + ß13 (ft_ms) + ß14 (pos_num) + μ

I predict there is a positive, significant correlation between salary and three point shots made, two point shots made, free throws made, offensive rebounds, defensive rebounds, assists, steals, and blocks. Personal fouls and turnovers should have a negative and significant impact on salary, and I also hypothesize three point shots missed, two point shots missed, and free throws missed will not be significant in determining the salary for a player.

An Ordinary Least Squares regression was run with the dependent variable being the salary of an NBA player in the 2011-2012 season. Dummy variables for the position each player played were also created. The salary of shooting guards, small forwards, power forwards, and centers are compared to that of a point guard.

V. Empirical Results

The regression showed two point shots made, free throws made, defensive rebounds, and assists all had a positive and significant correlation with a player's salary the next year. Personal fouls had a negative significant relationship with a player's next year salary. Three point shots

made, offensive rebounds, steals, blocks, turnovers, three point shots missed, two point shots missed, and free throws missed did not have a significant impact on a player's next year salary. The results go against my hypothesis that three point shots made offensive rebounds, steals, and blocks would have a positive, significant relationship with salary, and that turnovers and missed shots would have a negative and significant impact on a player's next year salary.[2]

The results showed two point shots made had a significant impact on a player's salary the next year. These results were significant at the $\alpha = .05$ level. This is unsurprising, as NBA teams appear to pay players that score higher amounts than those that do not score. The same applies for free throws made, which were significant at the $\alpha = .05$ level as well. The surprising point statistic that did not play a significant role in a player's salary was three point shots made. This seems odd because a player is scoring points when he makes a three point shot, therefore it seems likely that the player would be rewarded for making that shot through an increase in salary.

Offensive rebounds were determined to not play a significant role in determining a player's salary. However, defensive rebounds were considered to have a $\alpha = .01$ significance level when predicting the impact they would have on salary. It is interesting to see that offensive rebounds and defensive rebounds would not both be positive and significant, since both grant the team an extra possession. Assists were determined to have a positive significant impact on players' salary at the $\alpha = .05$ significance level. Assists having a positive impact on players' salary is unsurprising, because an assist results in a score for the team. Therefore, the player should be awarded for helping his team score points.

Both variables concerning defense, steals and blocks, were found to have an insignificant impact on a player's salary. For blocks, this is less surprising, since a blocked shot does not

[2] A table with the full results can be found in the appendix.

guarantee a team an extra possession. However, a blocked shot does prevent a shot attempt from going in, so it would still seem NBA teams would want to reward a player that makes an opposing player's shot attempt chance of success be zero. Steals are the more surprising insignificant variable. Steals directly cause a team to have an extra possession which they can use to score. It is odd NBA teams do not seem to reward players for playing defense.

A player's personal fouls committed played a negative and significant (at the $\alpha = .05$ level) impact on the player's next year salary. Personal fouls are thought to let the other team score, so it seems reasonable that NBA teams would penalize players for fouling since it gives the other team a chance to score points. However, turnovers were found to have an insignificant impact on a player's salary. Turnovers allow the opposing team extra possessions, giving the other team more opportunities to score. It does not seem that NBA teams punish players for turning the ball over.

Three point missed shots, two point missed shots, and free throws missed were not found to have a significant impact on a player's salary. This implies that teams only care about the points a player scores, not how many attempts it takes a player to score them. While these results go against my hypothesis, they do seem to make sense. Kobe Bryant and Carmelo Anthony are both known to score high point totals, but they both take a high amount of shots to get there. However, these two are also two of the highest paid players in the league. It seems NBA teams do not punish players for missing shots, but simply reward them for making shots.

The OLS regression also found that shooting guards, small forwards, power forwards, and centers are all more likely to be paid more than point guards at a significant level. Shooting guards and power forwards were at the $\alpha = .05$ significance level. Small forwards were at the $\alpha = .10$ significance level, and centers were at the .01 significance level.

VI. Conclusion

The study looked at the impact a player's performance in the 2010-2011 season had on the player's 2011-2012 salary. The hypothesis for the study was three point shots made, two point shots made, free throws made, offensive rebounds, defensive rebounds, assists, steals, and blocks would all have a positive and significant impact on a player's salary, while turnovers, personal fouls, three point shots missed, two point shots missed, and free throws missed would have a negative and significant impact on a player's salary. However, the results showed three point shots made, offensive rebounds, steals, blocks, turnovers, three point shots missed, two point shots missed, and free throws missed did not play a significant role in determining a player's salary, though the other variables behaved as expected. This differences from the hypothesis may come from not taking a large enough sample in terms of time. By looking at only one year, it was not possible to get rid of time-fixed effects.

In the future, I would like to specify the model more. Though the results showed three point shots made did not play a significant role in a player's salary, it would still seem the player would be rewarded for those points. Perhaps by looking at points produced by the player's three point shot makes, that would give a better explanation of how three point made shots are treated.

Another modification I would like to make would be to put all statistics in terms of points. That is, see how many points an offensive rebound will generate on average. This would capture the simplification of the game, scoring more points than your opponents, better than just regressing offensive rebounds on salary. This might also give steals and blocks greater significance since it is putting the statistics in terms of points gained.

Finally, I would also like to look a multiple years. One potential problem my results face comes from the fact that it did not take into account whether the player was already under

contract at the beginning of the 2011-2012 season. Because players are usually given some sort of guaranteed money in their contracts, teams sometimes choose to keep high paid unproductive players rather than get rid of them. Teams also trade for high paid players whose contracts are expiring soon, in order to clear salary cap space. So in a way, some player's salary were guaranteed independent of their 2010-2011 season statistics. Another reason some player's may be paid higher than their statistics would warrant comes from the way they play, or the player's personality. A player that scores in a more exciting way than an average player would tend to draw more fans to the game. A player that is well liked in the community may lead to an increase in revenue through jersey sales. There was no way to control for this, but it still is a possible explanation why some players may be overpaid.

I would instead like to look at only new contracts generated over a time period. I would take the average amount the pay was to be played over the life of the contract, and run a regression on that amount based on the statistics laid out in this study. This would measure the direct impact a player's statistics over the average salary while also eliminating these salary cap problems. By doing the study over multiple years, it would also allow for the creating of dummy variables for teams. Since some teams had as few as four qualifying players for this study, it was not feasible to create a dummy variable for them.

Works Cited

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Appendix A

Table 1

Results of OLS Regression on 2011-2012 player salary data

Salary	Coefficient	Robust Std. Error	t	P>abs(t)
threepm	-5726.48	20144.31	-.28	.776
twopm	14720.18	6295.327	2.34**	.020
ft	10222.22	4018.73	2.54**	.012
orb	-8167.61	8076.29	-1.01	.313
drb	14692.57	4163	3.53***	.000
ast	8363.23	3534.797	2.37**	.019
stl	-9261.176	11448.24	-.81	.419
blk	12464.37	9518.479	1.31	.192
tov	4795.986	11858.34	.4	.686
pf	-15478.05	6080.805	-2.55**	.012
threept_ms	4117.902	13963.17	.29	.768
twopt_ms	-57077.553	5604.339	-1.02	.310
ft_ms	-9894.735	10678.79	-.93	.355
pos_num_2	1701401	730034.2	2.33**	.021
pos_num_3	1386232	751019.7	1.85*	.066
pos_num_4	1604547	750809.9	2.14**	.034
pos_num 5	3373617	866107.8	3.90***	.000

*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively.