AN ABSTRACT OF THE THESIS OF

Jake Bertalotto for the degree of Honors Baccalaureate of Science in Accountancy and Finance presented on May 29, 2014. Title: Buying Wins: An analysis of Salary and Performance in the National Basketball Association.

Abstract approved: ____

Raymond Brooks

This study examines the relationships between player salaries and performance in the National Basketball Association, by analyzing team salaries and statistics for the five seasons between 2008 and 2013. We find that the teams are able to achieve more wins by outspending their competitors, even if that means incurring a tax bill for salary paid in excess of the luxury tax level. We also find that statistics which lead to a greater number of possessions or opportunities for the team have the highest correlation with team wins. Furthermore, we analyze the statistics that are most important at each of the five player positions. Finally, we determine that focusing on 1, 3, or 5 highly paid players relates positively to wins.

Key words: National Basketball Association, statistics, team payroll, salary diversification.

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Buying Wins:

An analysis of Salary and Performance in the National Basketball Association

by

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A PROJECT

submitted to

Oregon State University

University Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Accountancy and Finance (Honors Scholar)

Presented May 29, 2014

Commencement June 2014

Honors Baccalaureate of Science in Accountancy and Finance project of Jake Bertalotto presented on May 29, 2014.

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

Jake Bertalotto, Author

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1. INTRODUCTION

Athletes in the NBA are, on average, the highest paid athletes in the four major professional sports leagues in the United States. A study released by the NBA in 2011 found that NBA players make an average of $5.15 million per year, higher than players in Major League Baseball ($3.3 million), the National Hockey League ($2.4 million), and the National Football League ($1.9 million). Evaluating the value of individual players is a difficult process that has attracted widespread media and academic attention. Since NBA players are, on average, the highest-paid athletes in sports, it is worthwhile to analyze several issues related to salary and team performance. This paper analyzes salary and performance from a team and individual player perspective.

In depth statistical analysis in sports has become increasingly popular. The 2011 film *Moneyball,* based on Michael Lewis's 2003 book of the same name, drew attention to the performance of Major League Baseball's Oakland Athletics during the 2002 season. During that year, General Manager Billy Beane was able to assemble a team with the third lowest payroll (approximately $41 million) and produce 103 regular season wins, tied for best in the MLB. The New York Yankees, who also finished with 103 regular season wins, spent approximately $125 million on their roster to achieve the same regular-season win total. This example indicates that it is possible for low-budget teams to compete with their high-budget counterparts by finding undervalued players who can produce wins. However, while the story of the 2002 Athletics has garnered attention, we expect that in general, teams with larger payrolls win more games.

For the purposes of this study, we turn our attention to the National Basketball Association. The Collective Bargaining Agreement (CBA), a contract between the NBA and its players, governs the salary and payroll environment of the league. The CBA establishes minimum and maximum player salaries, a team salary cap, and outlines the tax structure for teams who exceed the salary cap – among many other functions. In order to understand the current environment of player and team salaries in the NBA, an introduction to the basic principles of the CBA is necessary for this study. The most recent iteration of the CBA came into effect in 2011 and extends through the 2020-2021 season, so the basic principles used for this study are likely to hold in the short term.

Many academic papers have constructed models to statistically measure a basketball player's production. Zak, Huang, and Siegfried (1979) were pioneers in this area, as they were able to develop a model that predicted the potential output of NBA based on relationships between wins and a variety of statistics. They found that team output is most responsive to field goal percentage, free throw percentage, and rebounding. Hofler and Payne (1997) used a similar approach to develop a model that gauges whether teams live up to their potential by comparing actual wins to "frontier" wins, the maximum wins they could have achieved based on their team statistics. For the 1992-1993 season, they found that teams operated at efficiency levels ranging from 61.7% (Dallas Mavericks) to 98.5% (Denver Nuggets). Berri (1999) also developed a model linking player statistics to team wins. His model produces a per-minute production estimate for a given player, which can be multiplied by minutes played to determine total wins contributed to a team by any particular player.

Researchers have also been interested in determining the positional effects of statistics on team wins. Page, Fellingham, and Reese (2007) analyzed the statistics across the standard five basketball positions. One of their key findings were that the effect of assists was most positive for small forwards, and the turnover effect was most negative for small forwards as well. This suggests that having a small forward that can pass well and protect the basketball is important. They also found that defensive rebounds are only significant for the guard positions. This doesn't suggest that centers should disregard rebounding, but it shows that rebounding should be emphasized for guards. They conclude that assists, steals, turnovers, and field goal percentage are the most significant statistics that are representative of a well-rounded basketball player. We are interested in exploring similar analyses in our data set.

Another interesting application of this type of research is effects of salary focus or diversification. Hausman and Leonard (1997) find that superstars in the NBA are important for generating revenue for the league through television contracts and ticket sales. Among their findings were that during the 1991-1992 Michael Jordan was worth \$53.2 million to teams in the NBA other than his own Chicago Bulls. This breaks down to approximately \$2 million per team, which equates to approximately \$3.4 million per team in today's dollars (CPI). While it's hard to challenge that today's superstars such as LeBron James, Kobe Bryant, and Kevin Durant are huge generators of league revenue, do their large salaries help their team performance? Berri and Jewell (2007) find that wage inequality and team performance are not related, suggesting that teams who allocate a large percentage of their salary to one player do not earn less wins due to having more lesser-paid players on their roster. In our study, we attempt to determine if there is a benefit to a focused or diversified team roster.

This study offers four main contributions. First, the results provide evidence that NBA teams are able to ”buy” wins by spending more in player salaries. Secondly, we find that several statistics are positively correlated to team wins. Third, we find that each player position has certain statistics that are correlated to the salaries players receive. Lastly, we provide evidence that increasing the salary paid to a team's Top 1, Top 3, or Top 5 players can have a positive effect on team wins.

The remainder of this paper is organized as follows: In the next section, we provide a background of the NBA Collective Bargaining Agreement. Section 3 describes the methodology used by this study. In Section 4, we examine the results of each of the questions presented. We conclude in Section 5.

2. BACKGROUND OF THE NBA COLLECTIVE BARGENING AGREEMENT

For this study, it is important to discuss the nature of the NBA Collective Bargaining Agreement (CBA). The CBA is an agreement made between the NBA and the National Basketball Players Association (NBPA). The current CBA became effective with the 2011-12 season, and runs through the 2020-2021 season, with each side of the contract having an early termination option after the 2016-2017 season. The CBA contains all of the agreed-upon rules regarding player salaries and contracts.

An important purpose of the CBA is to divide the NBA's total Basketball Related Income ("BRI") between the NBA and its owners, and the players. From the perspective of the NBA and team owners, there should be a limit on the percentage of BRI that is given to players to a specific percentage that constitutes a ceiling. The percentages are used because the BRI levels tend to rise year after year. From the perspective of the NBPA, they want to maximize the percentage of BRI they receive, in order to raise player income levels or at least keep them at the same percentages. The percentage revenue distribution was one primary topic debated during the most recent negotiation of the CBA. In the previous CBA that became effective for the 2005-2006 season, team owners retained approximately 43% of BRI, while the remainder went to players. In the current CBA, that percentage increased to 49-51%, with an equal amount of BRI going to the players. This debate led to a 161-day "lockout" that shortened the 2011-2012 regular season from 82 to 66 games.

Under the CBA, all teams are subject to a Salary Cap and Minimum Team Salary for each season. The "Salary Cap" places a limit on the total salaries each team can pay its players during the season, subject to exceptions. For the 2012-2013 seasons, the salary cap is $58.044 million. The CBA also specifies a minimum team salary, which is 85 percent of the salary cap. In 2012-2013 the minimum team salary was $49.337 million.

Many teams exceed this agreed-upon salary cap figure. In order to keep team salaries relatively equitable, the NBA has implemented a luxury tax for teams who exceed an agreed-upon "Tax Level". This was also a hotly debated topic in the most recent CBA negations. The NBA wanted to implement a hard salary cap that could not be exceeded in order to increase competition among teams. The players favored the current "soft" salary cap format, which allows teams to overspend the salary cap and pay the luxury tax. This soft cap leads to disparity between team payrolls, and generally leads to higher player salaries.

As a result, the luxury tax structure in the NBA is changing. For the 2012-2013 season, the Tax Level was $70.307 million. Any team paying its players more than this amount paid a $1-for-$1 luxury tax. However, beginning with the 2013-2014 season, the NBA will implement an incremental structure that will further punish teams who outspend the tax level by higher amounts. In this new system, teams with incremental salary between $0 and $4.99M above the Tax Level, must pay a tax of $1.50-for-$1. This tax increases for each $5 million increase in team salary in excess of the tax level. A team outspending the

Tax Level by $5M to $9.99M will pay a tax of $1.75-for-$1. Teams who overpay in the range of $10M to $14.99M will pay a $2.50-for-$1 tax. A team exceeding the Tax Level by $15M to $19.99M must pay a tax of $3.25-for-$1. Beginning in 2014-2015, if a team is a taxpayer in four of the last five seasons (called a "repeater"), their tax increases further by $1 at each increment. This new structure strongly discourages teams from outspending other teams in the league.

Based on this structure, seven teams had to pay a luxury tax in the 2012-2013 season: the Lakers, Heat, Nets, Knicks, Bulls, Celtics, and Warriors. Let's further examine the tax status of the Miami Heat. Their total team salary was $83.43 million in 2012-2013. That amount exceeds the tax level of $70.307 by $13.125 million. Because the new tax rate structure had not kicked in, their amount of overspending equaled their tax bill of $13.125 million. However, had the Heat maintained this salary level into the 2013-2014 season, when the incremental rate structure was imposed, they would face a much higher bill. Their salary level places them in the CBA-assigned marginal tax bracket of $2.50-for-$1. Therefore, the Heat would face a luxury tax bill of $24 million if they were to maintain their salary levels into the 2013-2014 season. Furthermore, if the Heat continue to be taxed until the "repeater" clause kicks in in 2014-2015, their rate would increase by a dollar to their $3.50-for-$1 for some of their tax bill, resulting in a total tax burden of $37.2 million.

The above example shows that teams such as the Heat cannot afford to dramatically outspend the Tax Level under the 2011 CBA. Doing so will drastically cut into team revenue. As one rival NBA general manager said of the Heat, who have three superstars on their roster: "They're going to have to break up their team" (Thomsen). Therefore, this tax structure is going to change the way NBA owners and general mangers construct their rosters. They will have to be more diligent about assessing talent and wealthy teams can no longer outspend their competitors without being penalized with a heavy tax bill.

3. METHODOLOGY

In order to evaluate the relationship between player salaries and performance, a large amount of data must be collected. For the purposes of this study, we looked back at the five most recently complete NBA seasons. The first year of data collected was for the 2008-2009 season, running through the 2012-2013 season. There were thirty NBA teams in each of the five seasons, providing 150 total team observations. There are 759 unique players represented in the data set, and 2,607 total player observations.

NBA player and team statistics were collected from ESPN's website. NBA salary data is disclosed as players sign contracts, and is organized and maintained on several web databases. For this study, we obtained player salary information from Jeff Kramer's data set at Storyteller Contracts, a reputable provider of historical and current NBA salary data. This data was collected for every player on each team, for each of the five seasons in the data set.

In addition to statistics and salary data, several other variables were collected. We obtained the years experience for each player, in case testing of player salary in relation to years in the league was conducted. Playoff finish for each team was calculated, in order to evaluate the performance of teams that advance to the playoffs versus teams that do not. Players who were traded throughout a season were noted, and the amount of games played for each team was recorded.

An important variable in the study is "player position". Each player is assigned to one of five positions. This variable becomes important when we analyze the effects of salary and statistical differences between players who play different positions. The five basketball positions used in the study are as follows: point guard, shooting guard, small forward, power forward, and center. Point guards, for example, are generally shorter and quicker than their teammates, and are the primary ball handler of the team. They are naturally expected to have a high number of assists, due to their ability to distribute the ball to their teammates. Alternatively, centers are generally taller than their teammates, and would be expected to collect more rebounds than their teammates.

Our study attempts to answer the following questions. First, does team salary impact team wins? If a team's wins and payroll are positively correlated, we would expect teams who spend more on players to win more games.

Secondly, which team statistics have the highest correlation to wins? If a team is looking to win additional games by focusing on a particular statistic, we would expect certain statics to lead to more wins than others.

Third, what statistics are players at each of the five positions being paid for? We expect that each position will have different statistics that are correlated to player salary. For example, we would expect assists to be significant to a point guard's pay, and rebounds to be important for determining a center's salary.

Fourth, does a diversified or focused roster lead to more wins? We find that some teams focus a high percentage of their payroll on one player, and produce a superstar. Is this more effective than teams that spread wealth more evenly throughout the team? We would expect teams who have a diversified approach to be more successful.

4. RESULTS

Wins on Salary. We are interested in determining if NBA team wins are related to total team salary. If this were the case, teams who spend more money in payroll would win more games. The results for this analysis over each of the last five seasons, as well as the period as a whole are shown in Table 1. We find that for each season, the coefficient on payroll is positive. This indicates that expected wins increase as team payroll increases.

Table 1
Wins on Team Salary – Year by Year Results

This table shows results of the year-by-year regressions of wins on team salary.

Season	Intercept	Coefficient on Payroll	p-value
2012-2013	6.002	0.501	0.005
2011-2012	15.069	0.370	0.023
2010-2011	-0.954	0.618	0.008
2009-2010	-15.014	0.798	0.001
2008-2009	-13.836	0.766	0.006
Total, All Years	2.731	0.548	0.000

Now that year-by-year formulas have been established, we can further examine a specific year. When analyzing the salaries and win totals for the 2012-2013 season, we find that the intercept estimate for this regression is 6.002, and the coefficient on payroll is 0.501. Again, this suggests that there is a positive correlation between team payroll and team wins. To determine how a team performed in the given year relative to this regression, we multiply their salary in millions of dollars by the coefficient on payroll, and add the intercept. Using the Golden State Warriors as an example, we use the following formula:

$$Intercept + (Salary \times Coefficient\ on\ Payroll) = Expected\ Wins$$

$$6.002 + (70.5 \times .501) = 41.3$$

These results show that the 2012-2013 Golden State Warriors were expected to win approximately 41 games based on the amount of salary they paid to their players. However, they actually won 47 games in the regular season, outperforming the league standard by 5.7 wins. Table 2 documents these results for each of the 30 teams in the NBA for the 2012-2013 season.

While the overall relationship between salary and wins is positive, teams overachieve and underachieve each year relative to this benchmark. In Table 2, each team's expected and actual wins for 2013 are shown. For example, the Lakers spent $113.5 million for 45 wins, when they were expected to win approximately 63 games based on their payroll. Conversely, the Thunder spent $68.3 million and won 60 games, when their payroll suggested an expected win total of only 40 games. These two examples represent the two of the most extreme cases.

Based on the regression run for the five year span from 2008-2013, we can project team win total for a season outside the sample. Since team salary and actual wins for the 2013-2014 regular season were available at the time of publication of this study, we tested our regression results using this season's data. Table 3 shows the results of this test, using the intercept estimate of 2.731 and coefficient on payroll of 0.548.

Table 2
Wins on Team Salary – 2012-2013 Season

This table shows team-by-team projected wins based on team salary. Projected wins is shown, along with each team's over/under performance compared to their projected win total.

Team	Salary ($M)	Actual Wins	Projected Wins	Over/ Under
Oklahoma City	68.3	60	**40.2**	19.8
Miami	83.4	66	**47.8**	18.2
Denver	70.3	57	**41.2**	15.8
LA Clippers	70.4	56	**41.3**	14.7
Memphis	73.7	56	**42.9**	13.1
San Antonio	79.9	58	**46.0**	12.0
Houston	56.5	45	**34.3**	10.7
Indianapolis	66.7	49	**39.4**	9.6
New York	81.4	54	**46.8**	7.2
Golden State	70.5	47	**41.3**	5.7
Dallas	60.7	41	**36.4**	4.6
Atlanta	71.1	44	**41.6**	2.4
Chicago	75.1	45	**43.6**	1.4
Brooklyn	83.2	49	**47.7**	1.3
Milwaukee	61.7	38	**36.9**	1.1
Utah	76.1	43	**44.1**	-1.1
Portland	58.4	33	**35.3**	-2.3
Philadelphia	65.2	34	**38.7**	-4.7
Sacramento	53.6	28	**32.9**	-4.9
Toronto	67.2	34	**39.7**	-5.7
Minnesota	61.8	31	**37.0**	-6.0
Washington	60.9	29	**36.5**	-7.5
Phoenix	53.2	25	**32.7**	-7.7
Cleveland	55.3	24	**33.7**	-9.7
New Orleans	63.8	27	**38.0**	-11.0
Boston	92.5	41	**52.3**	-11.3
Detroit	74.1	29	**43.1**	-14.1
Charlotte	58.2	21	**35.2**	-14.2
LA Lakers	113.5	45	**62.9**	-17.9
Orlando	67.1	20	**39.6**	-19.6

Table 3
Wins on Team Salary – 2013-2014 Season

This table shows team-by-team projected wins based on team salary. Projected wins is shown, along with each team's over/under performance compared to their projected win total. This regression takes the results from our five-year model and projects them onto the payrolls of the teams in the 2013-2014 season.

Team	**Salary ($M)**	**Actual Wins**	**Projected Wins**	**Over/ Under**
Oklahoma City	70.5	59.0	**41.4**	17.6
Portland	62.7	54.0	**37.1**	16.9
Indiana	67.4	56.0	**39.7**	16.3
Houston	63.8	54.0	**37.7**	16.3
San Antonio	74.7	59.0	**43.7**	15.3
LA Clippers	72.5	57.0	**42.4**	14.6
Phoenix	65.0	48.0	**38.4**	9.6
Dallas	67.3	49.0	**39.6**	9.4
Golden State	71.4	51.0	**41.9**	9.1
Miami	81.5	54.0	**47.4**	6.6
Toronto	71.6	48.0	**41.9**	6.1
Charlotte	62.7	43.0	**37.1**	5.9
Chicago	73.5	48.0	**43.0**	5.0
Washington	70.3	44.0	**41.3**	2.7
Atlanta	59.6	38.0	**35.4**	2.6
Memphis	81.6	50.0	**47.5**	2.5
Minnesota	68.4	40.0	**40.2**	-0.2
New Orleans	64.3	34.0	**38.0**	-4.0
Cleveland	64.7	33.0	**38.2**	-5.2
Denver	71.7	36.0	**42.0**	-6.0
Detroit	61.9	29.0	**36.7**	-7.7
Sacramento	62.8	28.0	**37.2**	-9.2
Utah	58.8	25.0	**35.0**	-10.0
Orland	55.4	23.0	**33.1**	-10.1
Philadelphia	54.6	19.0	**32.7**	-13.7
Brooklyn	103.7	44.0	**59.6**	-15.6
New York	91.0	37.0	**52.6**	-15.6
Milwaukee	56.1	15.0	**33.5**	-18.5
LA Lakers	91.9	27.0	**53.1**	-26.1
Boston	92.5	25.0	**53.4**	-28.4

These results indicate that it is difficult to predict a team's wins based on their total salary alone. However, the relationship holds that teams who pay more money for their players win more games. This relationship is shown in each of the five seasons between 2008 and 2013, and during the entire period as a whole. In the context of the current CBA environment, this result indicates that teams who are able to spend above the Tax Level should do so in order to generate wins, even though they will incur a luxury tax payment.

Wins on Team Statistics. We now look at how wins are affected by team statistics. In order to do this, we regress wins on nine variables. Six variables are per-game measures and three are efficiency measures. Per-game measures include: points, rebounds, assists, blocks, turnovers, and steals. Efficiency measures include 3-point field goal percentage, 2-point field goal percentage, and assist-to-turnover ratio. Table 4 provides a summary of the statistics used in this dataset.

Table 4
Summary Statistics of Team Data

This table reports summary statistics of each of the team-specific statistical variables used in the sample. The sample includes all 30 teams in the National Basketball Association over a five-year period beginning with the 2008-2009 season and ending with the 2012-2013 season. The mean, median, standard deviation, and number of data points are provided.

	Mean	Median	Std Dev	N
Points per game	98.869	98.400	4.302	150
Rebounds per game	41.744	41.700	1.650	150
Assists per game	21.366	21.200	1.558	150
Blocks per game	4.951	4.880	0.759	150
Turnovers per game	14.208	14.200	1.019	150
Steals per game	7.459	7.385	0.836	150
3pt field goal percentage	0.356	0.357	0.020	150
2pt field goal percentage	0.485	0.484	0.019	150
Assist to Turnover ratio	1.513	1.500	0.162	150

In order to test the validity of the data, we first compare the statistics of teams who make the playoffs versus teams who do not. Based on the statistics shows in Table 4, we would expect playoff-caliber teams to record higher statistical values for all categories except turnovers per game. The data in Table 5 confirms this assertion. The data shows that playoff teams scored more points, collected more rebounds, had more assists, more blocks, fewer turnovers, and more steals than teams that did not make the playoffs.

Table 5
Preliminary team measures based on playoff berth

This table provides a comparison of statistical attributes of teams who qualified for the playoffs versus teams that failed to make the playoffs throughout the sample. In every season, sixteen teams qualified for the playoffs, while fourteen did not. Therefore, there were eighty teams that made the playoffs over the course of five years, and seventy that did not. Entries in the table represent the average statistic pooled by teams for each of the conditions. T-statistics and p-values are provided in the final column.

	Made Playoffs	Missed Playoffs	p-value
Points per game	99.824	97.777	2.98 (0.004)
Rebounds per game	42.205	41.217	3.89 (0.000)
Assists per game	21.628	21.067	2.23 (0.028)
Blocks per game	5.108	4.771	2.77 (0.000)
Turnovers per game	13.935	14.520	-3.65 (0.000)
Steals per game	7.626	7.268	2.71 (0.008)

We now are interesting in constructing a model to calculate team wins based on team statistics. Using a two-way fixed effects model, we run regressions using the aforementioned nine statistical attributes. Coefficients for eight models produced using these statistics are presented in Table 6. We can use these models to determine which statistics have the highest correlation to team wins.

Table 6
Regressing Wins on Team Statistics

This table shows eight different models for regressing wins on team statistics. The variables used in this regression are described in Table 1. The regressions below were conducted using a two-way fixed effects model.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Points per	0.927	1.285	1.483	0.990	1.276	1.391		
game	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
Rebounds per	3.213			3.287	2.351		3.255	
game	(0.000)			(0.000)	(0.001)		(0.000)	
Assists per	0.278		-0.097		-0.099			
game	(0.707)		(0.903)		(.903)			
Blocks per	0.891	2.047				1.928	1.693	
game	(0.467)	(0.138)				(0.137)	(0.218)	
Turnovers per	-4.226		-3.564	-4.235		-3.539		
game	(0.000)		(0.000)	(0.000)		(0.000)		
Steals per	2.993	1.191		3.048			4.011	
game	(0.010)	(0.3501)		(0.008)			(0.002)	
3pt Field Goal								175.265
percentage								(0.000)
2pt Field Goal								326.274
percentage								(0.000)
Assist to								15.187
Turnover ratio								(0.009)
R^2	0.738	0.635	0.671	0.737	0.660	0.677	0.643	0.759

To determine the effects of increasing these team statistics, we consider the eff team focusing on increasing one statistic, with all others held equal. For this analysis, continue to use Model 1 of the regressions shown in Table 5. We begin by looking at p per game. The mean points per game for NBA teams in this sample is 98.869. If a part team were to increase their scoring by one standard deviation, or 4.32 points per game projected wins per season would increase by 4.00. We now calculate these effects for t remaining statistics in the model.

If a team were to increase their rebounds per game by one standard deviation, t would win an estimated 5.30 additional games per season. Increasing assists per game standard deviation would produce 0.43 additional wins. A one standard deviation posi change in blocks per game would produce an estimated 0.76 wins per season. Since tu are negatively correlated to wins, we subtract one standard deviation from the mean. T suggests that teams who reduce their turnovers by one standard deviation would win 4 additional games per season. Finally, we find that if a team increases their steals by on standard deviation, their wins increase by 2.50 wins per season. These results are desc in Table 7.

Table 7
Effect on Team Wins – Per Game Statistics

This table shows the team statistics with the highest effect on team wins.

	Coefficient	Mean	Mean x Coeff.	[Mean + Standard Deviation] x Coeff.	E
Rebounds per game	3.213	41.744	134.123	139.425	
Turnovers per game	-4.226	14.208	-60.043	-55.737	
Points per game	0.927	98.869	91.652	95.640	
Steals per game	2.993	7.459	22.325	24.827	
Blocks per game	0.891	4.951	4.411	5.088	
Assists per game	0.278	21.366	5.940	6.373	

Based on this analysis, the data suggests that increases in some statistics contribute more to team wins than others. Increasing rebounds has the highest effect, at 5.30 wins per year. Reducing turnovers has the second highest effect, producing 4.32 additional wins per year. Increasing scoring is the third most effect method for increasing wins using this model, producing 4.00 additional wins per season.

Salary on Player Statistics by Position. We are interested in determining what per-game statistics are most important in determining a player's salary depending on their position. We categorized players based on the five standard NBA positions: point guard, shooting guard, small forward, power forward, and center. We used observations from every team in the dataset, excluding players who were traded mid-season. This allowed for a total of 1,905 player observations, with over 350 results for each position. The results from this analysis are shown in Table 9.

Table 9
Salary on Player Statistics by Position

This table presents regression results of player salary on per game statistics. The five statistics, as abbreviated below, are as follows: points per game (PPG), rebounds per game (RPG), turnovers per game (TPG), blocks per game (BPG), and assists per game (APG). P-values are reported for each coefficient. We consider a result significant if it's p-value is less than 0.050.

	N	R-Square	PPG	RPG	TPG	BPG	APG
Point guard	351	0.6271	0.204 (0.000)	0.063 (0.765)	-1.056 (0.002)	1.347 (0.220)	0.850 (0.000)
Shooting guard	381	0.6103	0.442 (0.000)	-0.256 (0.289)	-0.226 (0.704)	-0.346 (0.725)	0.464 (0.524)
Small forward	390	0.6489	0.162 (0.004)	0.039 (0.800)	0.726 (0.160)	0.570 (0.328)	0.799 (0.000)
Power forward	429	0.6589	0.475 (0.000)	-0.267 (0.009)	0.336 (0.556)	0.674 (0.057)	1.059 (0.320)
Center	354	0.6219	0.343 (0.000)	0.233 (0.037)	-0.252 (0.612)	1.135 (0.004)	0.182 (0.522)

We consider results to be significant if the reported p-value is less than 0.005. Using this approach, we find that points per game are significant for every position. Rebounds per game are only significant for power forwards and centers. Turnovers per game are significant for point guards. Blocks per game are only significant for centers. Lastly, assists per game are significant for players at the point guard and small forward positions. We now discuss each statistic in more detail.

Points per game is positive and significant at each of the five position. The coefficients are largest in magnitude for players at the shooting guard and power forward positions. This suggests that players at the shooting guard and power forward positions are expected to be leading scorers on the team. However, the results show that points per game is important across all positions, and all players earn more in salary for more point scoring.

Rebounds per game are most positive and significant for centers. This statistic is also significant for power forwards, although the relationship is negative. This initially suggests that power forwards who rebound more are paid less. To investigate this result, we performed some further testing and found that when separating offensive and defensive rebounds for power forwards, it is the offensive rebounds that are negatively related to lower salary. This could suggest that a power forward who gets more offensive rebounds isn't as efficient or isn't scoring as many points.

Two of the statistics are tied to only one position. Turnovers per game is most negative and significant for point guards, suggesting that it is most important for them to handle the ball well. In other words, a large amount of turnovers would be detrimental to a point guard's salary, as they are expected to run the offense and be the primary ballhandler of the team. Similarly, blocks per game are positive and significant for centers. This indicates that centers are expected to be strong defenders who alter their opponent's shots.

Assists per game both is positive and significant for point guards and shooting guards. This indicates that it is important for both positions to distribute the ball well in order to make the offense function.

Salary Diversification. In addition to the effect of wins on team statistics, we are also interested in the effects of wins on salary diversification. In the business world, we generally think of diversification as a positive attribute. In a portfolio of stocks, diversification is associated with reducing the overall risk of the portfolio. Focusing the portfolio on a small number of stocks could expose the portfolio to excess risk. Is the same idea present in the NBA on team rosters? If this logic were to hold, we would expect teams who spread their salaries evenly over their rosters to outperform teams who focus on paying a premium for "superstars". In this section, we will see if the "superstar" effect holds.

In order to test this theory, we employ the Herfindahl Index method. This method is normally used to measure the size of firms in relation to an industry, and provides an indicator for the amount of competition between them. Here, we use the players on each roster to represent firms, and each team to represent an industry. The major benefit to using this technique is that more weight is given to larger firms (or in our case, salaries), which allows us to examine the amount of focus or diversification a team has in their salary distribution. We will test to see the effects of focusing salary on the Top 1, Top 3, or Top 5 players on a team. Summary statistics for this analysis are shown in in Table 7.

Table 9
Summary Statistics for Wins on Salary Focus / Diversification

This table reports summary statistics for the variables used to predict wins based on salary focus and diversification. The Herfindahl Index method is used.

	Mean	Median	Std Dev	N
$Salary_{H-index}$	0.135	0.1325024	0.0254896	150
$Salary_{Top\ 1}$	0.229	0.2289018	0.0477816	150
$Salary_{Top\ 3}$	0.540	0.5373607	0.0831696	150
$Salary_{Top\ 5}$	0.721	0.7274900	0.0744942	150
$Minutes_{H-index}$	0.073	0.0719385	0.0104615	150
$Minutes_{Top\ 1}$	0.106	0.1062581	0.0150334	150
$Minutes_{Top\ 3}$	0.301	0.2983302	0.0413561	150
$Minutes_{Top\ 5}$	0.470	0.4683319	0.0604006	150

A strong example of this focusing on the Top 3 players is the Miami Heat, who received widespread media attention when they signed the "Big Three" to their roster before the 2011-2012 season – Chris Bosh, Dwayne Wade, and LeBron James. Bosh and Wade each received a salary of $14,500,000 during the season, and Bosh received $14,200,000. Therefore, the trio received $43,200,000 of the team's total $65,258,647 payroll. This amount accounted for 66 percent of the Miami Heat's payroll that season. The remaining $22,058,647, or 34 percent of the payroll, was distributed between the remaining 13 players on the team payroll. After James, Bosh, and Wade, only three players made more than $2,000,000 in salary. This provides an example of teams focusing their payroll on their Top 3 players.

Alternatively, some teams distribute their payroll more evenly among their players. In the same 2011-2012 season that the Heat signed the "Big Three", the Charlotte Bobcats took a different approach to structuring their salaries. Their highest paid player, Boris Diaw, received a salary of $9,000,000, and the top five highest played players accounted for 65 percent of the team payroll, a similar percentage the salary occupied by the Heat's "Big Three". Interestingly, the Bobcats paid ten players more than $2,000,000, while the Heat only paid six players over that amount. The Bobcats model suggests more equity in team pay across the Top 5 players, and therefore more diversification.

We are interested in determining if teams with diversified rosters outperform teams with focused rosters. We established a null hypothesis that concentration is irrelevant to team performance, and that there is no difference between focusing or diversifying team salary. We then have two competing alternative hypotheses: a focused strategy that produces a superstar leads to more wins, and that a well-rounded team with five well-paid players leads to more wins. In this model, we ran a test on the diversification of both salaries and minutes. We determined a intercept and mean for each variable, as shown in Table 8.

Table 10
Wins on Salary Focus / Diversification

This table reports team wins as a result of their salary focus and diversification. We would expect that teams with a high amount of salary focused on one, two, or three players to have fewer wins than teams who do a better job of spreading wealth throughout their roster.

	Intercept	Coefficient	R-square
$Salary_{H-index}$	12.721	196.634	0.149
	(0.018)	(0.000)	
$Salary_{Top\ 1}$	25.988	58.379	0.046
	(0.000)	(0.008)	
$Salary_{Top\ 3}$	3.643	66.193	0.179
	(0.567)	(0.000)	
$Salary_{Top\ 5}$	-16.865	77.987	0.200
	(0.072)	(0.000)	
$Minutes_{H-index}$	-0.397	545.909	0.193
	(.0953)	(0.000)	
$Minutes_{Top\ 1}$	-4.730	415.712	0.232
	(0.479)	(0.000)	
$Minutes_{Top\ 3}$	-7.492	155.841	0.246
	(0.272)	(0.000)	
$Minutes_{Top\ 5}$	-10.681	106.581	0.246
	(0.144)	(0.000)	

Next, we added one standard deviation to the mean, and studied the change between the two values when multiplied by the coefficient. These results are shown in Table 11.

Table 11
Effect of Wins on Salary Focus / Diversification

This table reports summary statistics for the variables used to predict wins based on salary focus and diversification. The Herfindahl Index method is used.

	Coefficient	Mean	Mean x Coeff.	[Mean + Standard Deviation] x Coeff.	Effect on Wins
$Salary_{H-index}$	196.634	0.135	26.546	31.558	5.012
$Salary_{Top\ 1}$	58.379	0.229	13.369	16.158	2.789
$Salary_{Top\ 3}$	66.193	0.540	35.744	41.249	5.505
$Salary_{Top\ 5}$	77.987	0.721	56.229	62.038	5.810
$Minutes_{H-index}$	545.909	0.073	39.851	45.562	5.711
$Minutes_{Top\ 1}$	415.712	0.106	44.065	50.315	6.250
$Minutes_{Top\ 3}$	155.841	0.301	46.908	53.353	6.445
$Minutes_{Top\ 5}$	106.581	0.470	50.093	56.531	6.438

The results for salary indicates that we have found some support for both hypotheses. There is a positive and significant effect for increasing focus on the Top 1, Top 3, and Top 5 players on a particular team's roster. There is a larger impact for increasing the Top 5 salaries, but further testing is needed to determine the significance of this result. Results for the same test on player minutes are also shown. Here, the results are also positive and significant for increasing minutes of the Top 1, Top 3, and Top 5 players.

These results lead us to infer that more risk is added to a team roster by focusing on a small number of players due to injuries. If a team has a large percentage of their payroll devoted to their superstar and that player misses time due to injuries, it will result in a major impact on wins. For example, when we applied our Wins on Team Salary model from Table 1 to the 2013-2014 season, we saw that the LA Lakers underachieved by 26 games despite having the third-highest payroll in the NBA at $91.9 million. Kobe Bryant received $30.5 million of the team payroll, but only played in six of the team's 82 games due to injury. As a result, the Lakers finished with the sixth-worst record in the NBA and missed the playoffs for just the second time in Kobe Bryant's seventeen-year NBA career. The results of our study seem to show that by diversifying a team's Top 5 players, the franchise can reduce the risk of a below-average year if a superstar on the team misses time due to injury.

5. CONCLUSIONS

Our data includes the five seasons leading up to the luxury tax rate increases in the 2011 CBA. Therefore, as of the 2012-2013 NBA season, we find that:

First, we find that team wins and salary are positively correlated, suggesting that teams can buy wins by outspending other teams in the league. For our five year sample, we found a intercept of 2.731 and a coefficient on team payroll (in millions) of 0.548. Second, we found that a number of statistics are positively related to increasing team wins, all else held equal. The statistics with the largest effect include: increasing rebounds per game, reducing turnovers per game, and increasing points per game. Third, we see that players at each of the five basketball positions are compensated based on a different set of statistics that are most significant to each position on the team. Lastly, we found that focusing salary on 1, 3, or 5 highly paid players relates positively to wins, with a higher magnitude effect for focusing on the Top 3 or Top 5 players.

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