

2016

Player Performance and Team Revenues: NBA Player Salary Analysis

Tyler Stanek
Claremont McKenna College

Recommended Citation

Stanek, Tyler, "Player Performance and Team Revenues: NBA Player Salary Analysis" (2016). *CMC Senior Theses*. Paper 1257.
http://scholarship.claremont.edu/cmc_theses/1257

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**Player Performance and Team Revenues:
NBA Player Salary Analysis**

SUBMITTED TO

PROFESSOR JILL HARRIS

AND

PROFESSOR JOSHUA ROSETT

AND

DEAN PETER UVIN

BY

TYLER MATTHEW STANEK

FOR

SENIOR THESIS

FALL 2015

NOVEMBER 30, 2015

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Abstract

The National Basketball Association (NBA) generated well over \$4 billion in revenues during the 2014-15 season. I analyze the value of a win to a team in terms of revenue and examine the potential underpayment or overpayment of players and superstars throughout the league relative to their marginal revenue product (MRP). My findings suggest that players are overpaid, especially superstars. However, it is important to consider the fixed-revenue streams a team receives before assuming a player is simply overpaid compared to his MRP. In congruence with previous literature, I find that veterans are overpaid at the expense of younger players' lower salaries. I also look at the drivers of a player's salary and find that general managers tend to overpay for points relative to other statistics.

I. Introduction

The National Basketball Association (“NBA”) first introduced a salary cap, or ceiling, on the amount of money franchises are allowed to allocate towards forming their roster, during the 1946-47 season. However, this limitation was short lived as it was abolished after one season. In 1970, the first collective bargaining agreement (“CBA”) was established in order to set the minimum and maximum player salaries, rules for trades, and procedures for the NBA draft. The CBA is “a legal contract between the league and the players association that sets up the rules by which the league operates”¹. Despite this progressive action, a salary cap was not reinstated until the 1984-85 season, whereby each team had a \$3.6 million payroll to spend on their entire roster. Before the enforcement of a salary cap, teams had the ability to spend an unlimited amount to form their roster, which created a disadvantage to those teams that did not have as much capital or were not as willing to spend money on the most talented players. The league implemented a salary cap in order to create parity and ensure competitive balance throughout the NBA.

The purpose of this study is to determine whether NBA players are appropriately paid relative to their contributions on the court. I will analyze two separate approaches to valuing a player’s performance and determine if their salaries ultimately are overcompensating or undercompensating them relative to the amount of revenue they are earning for their respective team. The first approach is John Hollinger’s Estimated Wins Added (EWA) statistic, which approximates how many points a player adds to his team

¹ Coon, Larry. "2011 Collective Bargaining Agreement." NBA Salary Cap FAQ. N.p., n.d. Web. 22 Nov. 2015.

above that of a replacement player. This ultimately determines the number of wins that player adds to his team throughout the season. The second approach I will analyze is David Berri's Wins Produced (WP) statistic, which looks at a player's offensive and defensive statistics relative to his teammates and the rest of the league. Berri's Wins Produced metric also crunches all of these statistics down to one number that represents the number of wins a player contributes to his team during the season. Next, I will compare the on-court contributions and salaries of superstars. I will then analyze if age plays a role in the under or overcompensation of players throughout the league. Finally, I am going to explore the drivers behind a player's salary and determine if team managers have a propensity towards spending more on scoring players.

The paper is organized as follows. Section I will discuss the history of the NBA salary cap, the history of the CBA, and analyze Hollinger's and Berri's methods that evaluate a player's on-court contributions. Section II consists of a literature review that explores topics relating to the NBA salary cap, wage equality and disparity, and paying employees in correspondence with their marginal revenue product (MRP). Section III is highlighted by four models that explain the relationship between team revenues and team wins, the drivers of a player's salary, the relationship between Hollinger's EWA and player salary, and the relationship between Berri's WP and salary. In Section IV, I will describe the data and variables used in these models. In section V, I will provide the results of these regressions and give possible explanations for my results. Section VI will include a summary and conclusion, along with additional research that can enhance this study.

History of the NBA Salary Cap & CBA

Since the 1984-85 season, the NBA has increased the salary cap from \$3.6 million up to \$63.065 million this past season (2014-15). The NBA determines the salary cap each year as a percentage of league revenues, or Basketball Related Income (BRI), from the prior season. “BRI consists of revenues received by the teams, the league and their related entities in agreed upon percentages, most notably broadcasting fees, ticket sales, merchandise, luxury box sales, naming right agreements and in-stadium revenues such as concessions and advertising”². Additionally, the NBA enforces a soft salary cap, which means that teams are able to make exceptions in order to sign players even though they will eclipse that season’s salary cap by doing so. The league’s salary cap is set by allocating 49-51% of $((\text{Projected BRI} - \text{Projected Benefits for players}) / 30 \text{ teams})$ ³. As of 2011, the CBA required teams to spend at least 75% of the salary cap in order to maintain balance among the league. With the introduction of a salary cap, along with the addition of free agency, NBA teams constantly strive to find the most efficient way to assemble a successful team. The NBA has created two types of free agents in order to give teams a chance to sign new players, while also allowing teams the opportunity to retain a player to stay competitive. An unrestricted free agent is able to sign with any team without any exceptions, while a restricted free agent can sign with another team as long as his original team does not match the other team’s offered contract. This has led to the potential for more trades, more player contracts, and more pressure on team managers

² Wong, Glenn M and Deubert, Chris, National Basketball Association General Managers: An Analysis of the Responsibilities, Qualifications and Characteristics (December 4, 2010). Villanova Sports and Entertainment Law Journal, Vol. 18, 2011. Page 7.

³ Wong, Glenn M and Deubert, Chris. Page 7.

to not only determine which players to sign and cut, but how much these players deserve to be paid.

Leading up to the 2011-12 NBA season, there was turmoil throughout the league. There was a variety of disagreements, but the main issue involved the distribution of BRI amongst the players and owners. A compromise could not be made in a timely matter, ultimately leading to a lockout. Finally, a new CBA was ratified on December 11th, 2011, effectively shortening the 2011-12 season from 82 to 66 regular season games. Moving forward, it is important that the players and owners are in agreement of what is in the best interest of the league in accordance with the CBA. This will enable the league to focus on strategies that increase the amount of BRI that is spread amongst the players and owners, rather than suffer from the economic consequences of a lockout. The most effective CBA across sports have been those that do more than merely satisfy the wants and needs of the respective parties. In order to compete in the entertainment industry, the CBA must be flexible so that it can accommodate both the players and the owners, and as a result, enable the NBA to generate more revenue by attracting a large fan base.⁴

Although it is vital for the league to concentrate their efforts on creating NBA revenues and not solely focus on the distribution of revenues, it is worthwhile to look deeper into the effects of the new CBA on the players and the owners. The reformation of the 2005 CBA into the new 2011 CBA brought optimism for both parties after negotiating for five months during the lockout. However, the new CBA seems to heavily favor the owners over the players. As referenced above, the players currently receive

⁴ Wyman, Alexander C.K., *Collective Bargaining and the Best Interests of Basketball* (2012). 12 Va. Sports & Ent. L.J. 171, 2012. Page 173.

roughly 50% of the league's BRI. However, this percentage decreased from a 57% allocation to the players under the previous CBA. According to BRI projections, each player will be losing approximately \$610,000 due to this drop in revenue distribution.⁵ The exact reasoning behind this change in revenue allocation is still unclear, but there has been speculation into the owners suppressing their profits and giving the appearance of being in greater need of an increased revenue share than the players.

Despite the difficulties and shortcomings of the CBA, it is essential for the NBA to operate. The CBA allows the NBA to avoid antitrust liability under the protection of the non-statutory labor exemption. Alexander Wyman (2012) explains, “[the CBA] provides the league with a regulatory framework that creates an effective arbitration system to enforce rules and adjudicate disputes, governs conduct supervision of players and owners, and enables scheduling and rule uniformity”⁶. Another benefit of the 2011 CBA is the harsh penalty the league enforces on teams that exceed the luxury tax threshold, which is set at 61% of a team's portion of BRI. Under the 2005 CBA, teams were charged a dollar for every additional dollar they spent on salary that exceeded the luxury tax threshold. The 2011 CBA cracks down even harder on these teams, as they are now required to pay an incremental tax that increases with every \$5 million above the tax threshold (\$1.50, \$1.75, \$2.50, \$3.25, etc.). Furthermore, the league tacks on an additional dollar to each of these progressive levels if the team is a repeat offender. A repeat offender is a team that exceeds the luxury tax threshold at least four out of the last five seasons⁷. These strict luxury taxes effectively create more competitive balance in the

⁵ Wyman, Alexander C.K. Page 185.

⁶ Wyman, Alexander C.K. Page 174.

⁷ Wyman, Alexander C.K. Page 187.

NBA. The higher spending teams are forced to either cough up a significant amount of money paying luxury taxes or decrease their salary expenditures. Both of these actions would give small-market teams a better chance of competing with the large-market teams, as these additional luxury taxes that large-market teams pay are redistributed among small-market teams that do not pay luxury taxes. Additionally, if large-market teams decide it is not worth spending millions in luxury taxes to sign a big name player, this shrinks the talent margin between small and large-market teams.

Although the players seemed to have received the shorter end of the stick in regards to the 2011 CBA, it is important to recognize that the league still enforces a soft cap rather than a hard cap. The soft cap enables NBA teams to utilize exceptions to the salary cap that ultimately allows some teams to spend upwards of \$80 million on player salaries. Additionally, the 2011 CBA increased the salary cap floor during the first two years from 75% to 85%, and bumped the cap floor up to 90% in the years thereafter⁸. This effectively requires teams to spend more of their allocated salary cap on their players, putting more money in the players' pockets.

Hollinger's Estimated Wins Added

John Hollinger, the Vice President of Basketball Operations for the Memphis Grizzlies and ex-ESPN (Entertainment and Sports Programming Network) analyst, created a Player Efficiency Rating (PER) that combines all of a player's contributions and crunches them down to one number. Hollinger mainly focuses on a player's offensive

⁸ Wyman, Alexander C.K. Page 189.

statistics in order to calculate their PER. His methodology was extremely innovative, as he attempted to take a ‘Moneyball’⁹ approach and apply it to the sport of basketball. However, he received harsh criticism for his PER metric, as a bench player who only played 15 minutes in a game could end up with the same PER as a starter who played 30 minutes and performed similarly to the bench player relative to the amount of time they were on the court. PER is intended to measure a player’s per-minute quality of play, although this scenario displays PER’s inability to detect the value a player adds to his team by the amount of time he is in the game. In order to solve this issue, he created a Value Added (VA) metric, which accounts for the number of minutes a player is on the court. Therefore, he effectively enhanced his PER statistic, as VA now not only measured the quality of a player’s contributions, but also the quantity of his contributions. This makes sense, as two players that are equally efficient are indifferent, but if Player A is on the court more than Player B, then Player A is more valuable to his team. Additionally, a bench player that comes in at the end of the game during a blowout can put up some impressive statistics in a small amount of time against an opponent’s less talented bench players, effectively boosting his PER. These numbers are inflated by a lack of skill this player is going against relative to the competition he would be facing if he was in against the opponents’ starters. Furthermore, the player in this example does not consistently put up these statistics throughout the game, as he is only in the game for a limited amount of time, effectively showing the importance of the VA statistic relative to PER. As Hollinger explains, “the idea behind Value Added is to take the difference between a

⁹ An approach first implemented by Oakland Athletics’ GM Billy Beane, in which he exploited inefficiencies in the player market and turned a low revenue team with a below average payroll into a legitimate contender through unique statistical analysis.

given player's performance and that of a 'replacement level' talent and multiply that difference by the number of minutes that player played. The result shows, theoretically, how many points the player added to his team's bottom line on the season"¹⁰.

$$\text{Value Added} = ((\text{Minutes} * (\text{PER} - \text{Position Replacement Level})) / 67^{\text{11}})$$

A replacement level player is defined as a player that can be easily acquired, such as a D-League player, someone on a minimum contract, or the last player on a team's roster. The replacement levels for each position group within the NBA are as follows according to Hollinger:

Power Forward (PF): 11.5

Small Forward (SF): 10.5

Point Guard (PG): 11.0

Shooting Guard (SG): 10.5

Center (C): 10.6

John Hollinger decided to further improve his measure of a player's contributions by developing the Estimated Wins Added (EWA) statistic. This calculates how important a player is to their respective team in terms of wins contributed. To put this into perspective, the Golden State Warriors won 67 regular season games during the 2014-15

¹⁰ Hollinger, John. "Hollinger's PER Diem." ESPN.com. N.p., 25 Mar. 2009. Web. 22 Nov. 2015.

¹¹ A point of PER over the course of 2,000 minutes is worth about 30 points to a team, meaning that one point of PER over one minute is worth 1/67th of a point).

season and ultimately won the NBA Finals, while Stephen Curry's EWA was 22.2. Without Stephen Curry, the Warriors would have theoretically won about 45 games, leaving them in a 3-way tie for the 8th seed (the final spot) in the Western Conference playoffs. If the tiebreaker did not go their way, one could argue that Stephen Curry was the difference between an NBA title and making the playoffs according to Hollinger's Estimated Wins Added metric.

$$EWA = (VA / 30^{12})$$

Berri's Wins Produced

David Berri is a sports economist who co-authored *The Wages of Wins*, in which he, Martin Schmidt, and Stacey Brook analyzed the four major North American sports using econometrics. As they analyzed player performance in the NBA, they determined that "offensive efficiency (points scored per offensive possession) and defensive efficiency (points given up per defensive possession) are good for modeling a team's winning percentage"¹³. David Berri created the Wins Produced model by determining the connection between wins and a player's efficiency measures. Berri used the following six step approach to calculate a player's Wins Produced¹⁴:

¹² It takes about 30 points over the course of an 82-game season to add another win.

¹³ Berri, David, Martin Schmidt, and Stacey Brook. "How to Calculate Wins Produced." *The Wages of Wins Journal*. N.p., n.d. Web. 22 Nov. 2015.

¹⁴ Refer to *The Wages of Wins Journal* for the math behind this model. <http://wagesofwins.com/how-to-calculate-wins-produced/>

- 1) The first step is to compute a player's production (PROD) and their production per 48 minutes¹⁵ (P48). In order to calculate a player's production, take that player's statistics throughout the season and insert them in front of the appropriate coefficient in his model. The P48 calculation determines a player's production per game.
- 2) The second step is to adjust for the player's teammates' defensive rebounding productivity. Berri interprets a defensive rebound as being taken away from a teammate rather than from an opponent, which means that a player that records more defensive rebounds will see a decrease in their P48, while a player that records fewer defensive rebounds will see an increase in their P48.
- 3) The third step is to adjust for assists. As Berri claims, a player will increase his value if he has more assists. Each assist results in more points for the player's teammates and their team as a whole.
- 4) The fourth step is to incorporate team defense and calculate adjusted P48. A player with a stronger team defense will give up fewer points to his opponents and his adjusted P48 will increase as a result.
- 5) The fifth step is to adjust for position played. Centers and power forwards have the highest average adjusted P48, while small forwards and guards have the lowest.
- 6) The sixth and final step is to calculate WP48¹⁶ and Wins Produced.

¹⁵ The number of regulation minutes in an NBA game.

¹⁶ WP48 = Wins Produced per 48 minutes (per game). The average team will win 0.500 games. Since a team employs five players per 48 minutes, the average player must produce per 48 minutes 0.100 wins. Because teams do play overtime games once in a while, the actual average production of wins per 48 minutes is 0.099

Although both Hollinger's and Berri's approaches offer appealing perspectives on the valuation of a player's contributions, they each have their own assumptions that open the door for questioning. Both of these metrics take a player's statistics and boil them down into one number, which is a result of stylized approaches that partially involves personal opinion. Hollinger's EWA statistic is heavily dependent on a player's offensive performance and has received criticism for not placing more weight on a player's defensive contributions. On the other hand, Berri's WP metric accounts for offensive and defensive production. However, Berri's model that estimates the value of each offensive and defensive statistic does not explain the entirety of a player's production or value to his team. Both of these metrics can provide valuable insight when calculating a player's contributions in terms of wins, as these are some of the first approaches to do so. Conversely, it is important to recognize that these wins estimates are not a tell-all statistic that describes the entirety of a player's contributions.

After analyzing the assumptions and methodologies behind these two statistics, we will now move into the literature that offers some perspective on relevant topics within the NBA and labor markets. The previous literature and studies that will be discussed in the next section will display how these two approaches can be applied to measure the magnitude of some of the current issues in the NBA.

II. Literature Review

Richard Sheehan said it best when describing the nature of the four major North American professional team sports: the National Basketball Association (NBA), National

Football League (NFL), Major League Baseball (MLB), and National Hockey League (NHL). “All four leagues on average have been and remain very profitable. The average return to major league professional franchises has been greater than the average return on stocks. Second, profits are not evenly distributed. In each league, some franchises barely break even or lose money. Third, owners have different motives for buying and owning a professional sports franchise. Some are in it primarily for the money while others are in it primarily for wins or ego or civic pride. And fourth, not all franchises are competently managed”¹⁷. This paper will mainly focus on the NBA, but will often draw comparisons to the other major professional sports. Although some managers allocate most, if not all, of their efforts towards winning a championship versus turning over a large profit, all managers are cognizant of their profits irrespective of the sport in which they are involved. And for those managers that prefer money over glory, they are certainly paying attention to their team’s drivers of revenues and costs.

One of the biggest tradeoffs managers face is the balance between spending more on players to increase revenues or to spend less on players to cut costs. This answer will vary from team to team, but players have a powerful effect on team revenues. As previously mentioned, the main factors that affect revenue are gate receipts, broadcasting rights, licensing income, and other stadium revenues such as luxury boxes, concession stands, and stadium naming rights¹⁸. Unlike the NFL and MLB, the NBA does not share gate revenues. This places more pressure on a manager to field a team that attracts more fans through signing exciting players and building a team that brings in more wins.

¹⁷ Sheehan, Richard G. *Keeping Score: The Economics of Big-time Sports*. South Bend, IN: Diamond Communications, 1996. Print.

¹⁸ Leeds, Michael, and Peter Von Allmen. *The Economics of Sports*. Boston: Addison-Wesley, 2002. Print. Page 362.

Before the days of broadcasting rights and television contracts, a manager solely depended on ticket sales to generate a team's revenue. However, television contracts have proven to be a significant source of revenues for all four major sports. In 2014, the NBA signed a nine-year, \$24 billion media-rights deal with ESPN and Turner Sports¹⁹. This deal will not go into effect until the 2016-17 NBA season, but speaks volumes about how important the media has become in increasing sports' popularity and revenues.

Additionally, Krautmann (2007) found that teams are able to take some pressure off of bringing in large attendances by selling tickets in the inelastic range of demand. MLB ticket prices are discounted by as much as 56% due to a team's ability to compensate for this loss of not selling the tickets at an elastic price by generating other sources of revenue, such as concession revenues²⁰.

Another potential source of revenue that is not mentioned above is the phenomenon known as star power. Star power is essentially a superstar externality, in which a player increases a game's attendance as a result of his talent, popularity, stardom, or any other reason that attracts more fans than average to watch him play. Hausman and Leonard (1997) claimed that Michael Jordan's star power generated \$53 million in revenue for other teams and approximately half of the league's paraphernalia sales were tied to Michael Jordan and the Bulls during the 1991-92 season²¹. Berri and Schmidt (2006) support this idea, as they provide evidence that star power exists through an

¹⁹ Draper, Kevin. "What The NBA's Insane New TV Deal Means For The League And For You." Deadspin. N.p., 6 Oct. 2014. Web. 22 Nov. 2015.

²⁰ Krautmann, Anthony C., and David J. Berri. "Can We Find It at the Concessions? Understanding Price Elasticity in Professional Sports." *Journal of Sports Economics* 8.2 (2007). Web. Page 190.

²¹ Hausman, Jerry A., and Gregory K. Leonard. "Superstars in the National Basketball Association: Economic Value and Policy." *Journal of Labor Economics* 15.4 (1997): 586-624. Web.

examination of television ratings and a team's road attendance²². It is important to note that this superstar externality provides a benefit for the other teams in the league, while it contributes minimal revenue for the team that the superstar is on. However, Berri, Schmidt, and Brook (2004) conducted another study that analyzed the relationship between team attendance and both a team's employment of superstars and team performance. They found star power to be statistically significant, but their results suggest that consumer demand is not driven by star power. Rather, it is determined by on-court performance and a team's ability to generate wins²³. Another finding of this study is the lack of competitive balance in professional basketball.

The main purpose behind enforcing a salary cap in the NBA is to create competitive balance and hinder player mobility within the league. Competitive balance creates parity among the league, while limiting player mobility allows small-market teams to keep players large-market teams sought after. This also has revenue implications, as a league with "competitive imbalance reduces the level of uncertainty of outcome and effectively reduces the level of consumer demand"²⁴. A lack of competitive balance decreases the demand for tickets to sporting events. A study conducted by John Vrooman (2000) researched the competitive balance of the NBA, NFL, and MLB. Vrooman determined that the "imposition of a salary cap and the cost-sharing collusion of the NBA lead to the least competitive balance of the three leagues"²⁵. He concluded

²² Berri, David J., and Martin B. Schmidt. "On the Road With the National Basketball Association's Superstar Externality." *Journal of Sports Economics* 7.4 (2006): 347-58. Web.

²³ Berri, David J., Martin B. Schmidt, and Stacey L. Brook. "Stars at the Gate: The Impact of Star Power on NBA Gate Revenues." *Journal of Sports Economics* J Sports Econ 5.1 (2004): 33-50. Web.

²⁴ Berri, David J., Martin B. Schmidt, and Stacey L. Brook. Page 33.

²⁵ Vrooman, John. "The Economics of American Sports Leagues." *Scottish J Political Economy* Scottish Journal of Political Economy 47.4 (2000). Web. Page 394.

that there was an increase in player exploitation and a decrease in the competitive balance throughout the league as a result of the salary cap.

A significant number of studies have been performed to analyze the effects of wage inequality on a company's performance. Within a business setting, Lazear (1989) concluded that pay compression is efficient when considering harmony among workers, while pay dispersion results in disharmony²⁶. In conjunction with some of his other work, Lazear determined "when pay is distributed relatively evenly among employees, cooperation increases and firm efficiency improves"²⁷. However, it is often difficult for an employer to justify equivalent salaries when some employees have a low marginal revenue product compared to highly motivated employees. These more efficient workers should be compensated with a higher salary rather than equal pay. DeBrock, Hendricks, and Koenker (2004) analyzed the effects of salary compensation and the performance in the MLB. They discovered that teams with greater salary dispersion did not perform as well on the field as teams with a flatter dispersion of salary²⁸. In other terms, teams that are majorly composed of average players who are paid a lower salary, combined with a few superstars that have a high salary will have a significant difference in compensation, and as a result, will not be as successful.

Leeds and Kowalewski (1999) analyzed the effects of the 1993 NFL CBA on salary compensation. They proved that the 1993 CBA placed a bias on whether or not a

²⁶ Lazear, Edward P. "Pay Equality and Industrial Politics". *Journal of Political Economy* 97.3 (1989). Web. Page 579.

²⁷ Borghesi, Richard. "Allocation of Scarce Resources: Insight from the NFL Salary Cap. *Journal of Economics and Business* (2007). Web.

²⁸ DeBrock, Lawrence, Wallace Hendricks, and Roger Koenker. "Pay and Performance: The Impact of Salary Distribution on Firm-Level Outcomes in Baseball." *Journal of Sports Economics*, Aug. 2004. Web. 22 Nov. 2015.

player was a starter, ultimately creating a significant increase in wage inequality in the league. They found that the superstars and veterans were paid disproportionately at the expense of the rookies and marginal players²⁹. These findings in the NFL are consistent with the NBA during the late 1990s as a result of the 1995 CBA. The 1995 CBA eradicated the institution of restricted free agency and increased the salary cap by 45 percent. In response to these changes in league policy, teams freed up a great deal of cap space by signing a significant portion of their roster to minimum contracts, while allocating the rest of their available salary payroll towards acquiring a few superstars. Banaian and Gallagher determined that the distribution of salaries in the NBA became increasingly unequal after the implementation of the 1995 CBA. The magnitude of the wage disparity is depicted by the fact that the top ten players in the NBA earned 15% of the league's payroll during the 1997-98 season³⁰. David Berri and Todd Jewell (2004) studied this massive increase in wage disparity and evaluated its effect on team performance. They discovered that salary dispersion is not a statistically significant determinant of team wins. The two factors they did find to have an impact on wins are the quality of coaching and the quality of players. Berri and Jewell also found that payroll was not able to explain much of the variation in team wins³¹. This shows how difficult it is for managers to predict the production they will get out of a player when determining their salary.

²⁹ Leeds, Michael A., and Sandra Kowalewski. "Winner Take All in the NFL: The Effect of the Salary Cap and Free Agency on the Compensation of Skill Position Players." *Journal of Sports Economics* 2.3 (2001). Web. Page 244.

³⁰ Fizek, John. *Handbook of Sports Economics Research*. Armonk, NY: M.E. Sharpe, 2006. Print. Page 43.

³¹ Berri, David J., and R. Todd Jewell. "Wage Inequality and Firm Performance: Professional Basketball's Natural Experiment." *Atlantic Economic Journal* 32.2 (2004): 130-39. Web.

Rosen (1981) explains the reasoning behind such vast differences in salary amongst the relatively small gaps in skills. The income distribution is stretched out in its right-hand tail compared to the distribution of talent³², effectively paying NBA superstars inordinate amounts relative to extremely talented players that are vastly underpaid in comparison. This phenomenon can be seen from the player contract disparity of the 2014-15 NBA draft, as the first overall pick was projected to earn a first year salary of \$4,152,900, while the last pick of the first round could be signed for as low as \$824,200 in his first year³³. This leads to a potential three-year contract difference of \$11,539,400³⁴ between the 1st and 30th pick of an NBA draft.

In order to measure where the NBA wage disparity was trending during the 1990s, Hill and Groothuis (2001) performed an analysis of the wage breakdown among players from the 1993-94 season to the 1999-2000 season. The growth of the mean salary in the NBA from the 1993-94 season to the 1997-98 season was approximately 78.5%, whereas the median salary rose by only 31.3%³⁵. Additionally, the Gini coefficient spiked from 0.41 in the 1993-94 season to 0.52 in the 1997-98 season, signaling an increase in unequal pay throughout the league³⁶. Wage disparity was still clearly alive and rampant in the NBA. This was one of the main factors that led to the renegotiation of the 1995 CBA, which partially corrected for the skewness of the NBA's salary distribution. For the 1999-2000 season, the Lorenz curve analysis created by Hill and

³² Rosen, Sherwin. "The Economics of Superstars." *The American Economic Review*, Dec. 1981. Web. Page 846.

³³ "2014-2015 NBA Rookie Scale." RealGM.com, n.d. Web. 22 Nov. 2015.

³⁴ "2014-2015 NBA Rookie Scale." $(\$4,952,200 + \$4,798,900 + \$5,005,500) - (\$911,400 + \$952,400 + \$993,400) = \$11,539,400$.

³⁵ Hill, J. Richard, and Peter A. Groothuis. "The New NBA Collective Bargaining Agreement, the Median Voter Model, and a Robin Hood Rent Redistribution." *Journal of Sports Economics*, May 2001. Web. 22 Nov. 2015. Page 140.

³⁶ Hill, J. Richard, and Peter A. Groothuis. Page 142.

Groothuis suggests that wage dispersion fell among the first three quintiles, as the players in the lower 60% of the wage distribution increased their percentage of income earned, while those in the top 40% of the wage distribution decreased their percentage of income³⁷. Players with more than two years of experience that signed a contract after 1999 received an average salary of \$1,935,633, while players that signed a contract before 1999 with at least two years of experience averaged a salary of \$4,284,542. This points towards a more equal salary distribution among experienced players and rookies in the NBA.

The work of Gerald Scully (1974) first shed light on the idea of analyzing the relationship between a labor's marginal revenue product (MRP) and their wage in the sports industry. Scully conducted the inaugural study on baseball players by evaluating the correlation between team wins and team revenue to determine marginal revenue, and then estimated the value of individual players' contributions to team wins³⁸. As a final step, he compared players' MRP to their respective salaries. He concluded that players were severely underpaid in comparison to their MRP and suffered from monopsony power due to the nonexistence of a free agency market. Scott, Long, and Somppi (1985) also analyzed the concept of paying an athlete in proportion to their marginal revenue product. In accordance with Scully, they found that restrictions placed on MLB players' ability to work out an optimal contract resulted in an underpayment relative to their MRP.

³⁷ Hill, J. Richard, and Peter A. Groothuis. Page 142.

³⁸ Berri, David J., Michael A. Leeds, and Peter Von Allmen. "Salary Determination in the Presence of Fixed Revenues." *International Journal of Sport Finance*, 2015. Web. 22 Nov. 2015. Page 6.

Consequently, Scott, Long, and Somppi concluded that NBA athletes were able to sign contracts equal to their MRP when they were given “unlimited freedom to negotiate”³⁹.

Previous literature on the NBA has highlighted the problem of wage disparity among NBA player salaries. Additionally, there has been extensive research on the effects wage inequality has on a team’s performance. Analysts have also looked into the various drivers of NBA revenues, including gate receipts, broadcasting rights, and the potential existence of star power. Furthermore, studies have shown that the existence of a salary cap leads to the exploitation and underpayment of NBA players. However, the vast majority of the general public views NBA players, and athletes in general, to be grossly overpaid. While NBA players tend to be paid quite handsomely relative to other occupations in the United States, it remains in question whether they are paid proportionately to their marginal revenue product for their team’s revenue. The purpose of this study is to analyze the relationship between a player’s marginal revenue product, or on-court contributions, relative to their salary. I want to determine whether players are overpaid or underpaid, or if they are actually paid in correspondence with their MRP. I will measure a player’s MRP by determining the number of wins they contribute to their respective teams in monetary terms of wins. More specifically, I will analyze two separate approaches as stated above, using John Hollinger’s Estimated Wins Added (EWA) metric and David Berri’s Wins Produced (WP) metric. After comparing players’ salaries and MRPs throughout the league, I will analyze if superstars and veterans tend to be overpaid or underpaid relative to the entire league. Next, I will evaluate the

³⁹ Scott, Frank A., Jr., James E. Long, and Ken Somppi. "Salary Vs. Marginal Revenue Product Under Monopsony and Competition: The Case of Professional Basketball." *Atlantic Economic Journal*, 1985. Web. 22 Nov. 2015. Page 58.

determinants of a player's salary. There has been speculation that general managers are more inclined to pay a player large sums of money if they score more points. As Hollinger's and especially Berri's metrics explain, more points do not necessarily mean efficiency, nor does it always lead to more contributed wins. Therefore, I will analyze if general managers tend to overpay for scoring versus other statistical categories. Finally, I will look into the predictive power of EWA and WP on player salary.

III. The Model

The first portion of this study is conducted in order to determine the MRP of a player's on-court performance. This application to the NBA is inspired by the work of Neale (1964) and the revenue sharing practices in the Women's National Basketball Association (WNBA). In the WNBA, players are employed and receive compensation from the league rather than earning a salary from their respective team. Under such conditions, Neale states that a player would then have the ability to receive a salary in proportion to their percentage of contributed league revenues, effectively eliminating the revenue problem that arises from star power⁴⁰. In line with this idea, I will attempt to derive the value of a player's contributions to team revenue in terms of wins added and determine if they are being over or undercompensated for their on-court performance.

The book *Wages of Wins* by David Berri, Martin Schmidt, and Stacey Brook sparked my interest in determining the value of a win. After doing more research and discovering their website, I found an article published by their director of analytics,

⁴⁰ Berri, David J., and Martin B. Schmidt. Page 354.

Arturo Galletti. In this article, *Explaining the NBA Cap and the Value of a Win*, Galletti describes his methodology in calculating the value of a win to an NBA general manager. His initial calculation was applied for the 2011-12 season, whereby he took 50% of BRI, which is the amount of league income that is allocated towards player salaries. Half of the BRI in 2011-12 was \$1.92 billion⁴¹. He then took the number of teams (30) and multiplied it by the number of games in the season per team (66 due to the 2011 lockout). Since there is only one winner per game, he divided this value by 2 to determine the number of total wins in the 2011-12 season⁴². Finally, he divided \$1.92 billion by 990 wins to come up with a value of \$1.94 million per win during the 2011-12 NBA season. However, two adjustments needed to be made. The first was to standardize the shortened season, as a typical NBA season consists of 82 games per team. The second tweak he made to his initial calculation was that it assumed a team was aiming to win half of its contests, resulting in a total of 41 wins and likely not qualifying for the NBA playoffs. Galletti moved forward with the assumption that NBA general managers are striving to win 52 regular season games in order to make the playoffs. After applying his methodology and projecting NBA revenues to increase at an average rate of 4 – 4.5% over the next four seasons, from the 2012-13 season to the 2015-16 season, he concluded that the value of an NBA win is \$1.47 million⁴³.

As I keep Galletti's work in mind throughout my paper, it is important to recognize that he is basing this value off of an expected return a general manager is paying for. In other words, a general manager aspiring to win 52 games will theoretically

⁴¹ Galletti, Arturo. "Explaining the NBA Cap and the Value of a Win." *The Wages of Wins Journal*, 9 July 2012. Web. 22 Nov. 2015.

⁴² (30 teams * 66 games per team) = 1,980 total games. (1,980 / 2) = 990 wins.

⁴³ Galletti, Arturo.

pay his players \$76.44 million before the season starts⁴⁴, hoping that his players will win 52 games, effectively making their collective contributions worth \$1.47 million per win. This approach is consistent with neoclassical economics, whereby labor markets are most efficient when employees are paid their marginal revenue product⁴⁵.

One assumption that Galletti makes is that the value of a win is consistent throughout the regular season. Another theory is that the value of a win is non-linear and its value fluctuates throughout the NBA season. In essence, a win that has playoff implications has a bigger impact on a team's revenue than a win does at the beginning of the season. That being said, I am going to move forward with Galletti's assumption that a win's value in terms of revenue is constant throughout the regular season in my model. The reasoning behind this is twofold. First, a team must win games at the beginning of the season in order to be in the position to make the playoffs at the end of the season, effectively making each win equally important. Second, the experts in this field, Berri, Leeds, and von Allmen, have never used a model that estimates the value of a win to change throughout an NBA regular season.

Additionally, Galletti assumes that a team's ultimate goal is to win 52 regular season games. Some teams may aspire to win more, while other teams may realize it is not realistic to win 52 games this season and are in a rebuilding year in order to have a stronger team in the following seasons.

Although it is nearly impossible to distinguish between these two motives, it is crucial to note that some managers are focused on winning games while others commit

⁴⁴ \$1.47 million * 52 wins = \$76.44 million.

⁴⁵ Berri, David J., Michael A. Leeds, and Peter Von Allmen. Page 5.

their efforts towards turning over higher profits. It is unclear whether a manager turns over a greater profit through saving money by only spending the required minimum on players, or if he is better off spending more to increase team revenues. However, the 2011 CBA implemented new policies that could have altered managers' spending strategies. The luxury tax penalties that came with the 2011 CBA have likely deterred managers from exceeding the luxury tax threshold since its implementation. This could have led to fewer general managers eclipsing the salary cap, resulting in fewer generous player contracts. To counteract this potential decline in large contracts, the salary cap increased by 27.4% from \$49,500,000 during the 2005-06 season to \$63,065,000 by the 2014-15 NBA season, with the luxury tax threshold increasing by 24.5% from \$61,700,000 to \$76,829,000 during the same time period⁴⁶.

This study spans 10 years from the 2005-06 NBA season to the 2014-15 season. However, the 2011-12 NBA season was excluded from this study as a result of the 2011 NBA lockout. After declining to extend the 2005 CBA option due to an estimated \$300 million in losses during the 2010-11 season⁴⁷, the NBA entered into a lockout spanning 161 days, from July 1st, 2011 to December 8th, 2011. The lockout shortened the NBA season by 16 games, effectively leading to fewer games that teams could win throughout the season. Since I am analyzing the effect a win has on team revenues, I felt the 2011-12 season could produce misleading results.

My approach is modeled after a variety of other studies that attempt to determine the value of an NBA win, but most closely resembles the work of David Berri, Michael

⁴⁶ "NBA Salary Cap History." RealGM.com, n.d. Web. 22 Nov. 2015.

⁴⁷ Coon, Larry.

Leeds, and Peter von Allmen⁴⁸. Keeping their framework in mind, I used a slightly different method. The OLS regression model that I use to evaluate the relationship between team revenues and the value of a win in U.S. dollars is defined as:

$$\ln\text{Rev}_{it} = \beta_0 + \beta_1 \text{Wins}_{it} + \beta_2 \text{LagWins}_{it} + \beta_3 \text{PlayerExp}_{it} + \beta_4 \text{MarketSize}_{it} + \mu_{it}, (1)$$

Within this model, $\ln\text{Rev}_{it}$ is the natural log of team i 's total revenue during season t . Wins_{it} measures the number of regular season wins for team i in season t , while LagWins (lagged wins) is the number of regular season wins for team i in season $t-1$. PlayerExp_{it} (player expense) measures the amount of money team i spends on their players during season t . MarketSize_{it} (market size) serves as a dummy variable, whereby it takes on the value of 1 for the 15 smallest NBA cities in terms of number of television homes and takes on a value of 0 for the 15 cities with the greatest number of television homes in the NBA.

As stated above, it is difficult to determine a general manager's objective function. Despite the fact that some managers are looking to maximize profits and my dependent variable is the natural log of revenue, my model is not attempting to measure how general managers try to maximize team revenues. Rather, my model assumes that general managers operate in order to win as many games as possible even if that means

⁴⁸ $\text{Revenue}_{it} = \beta_0 + \beta_1 \text{Wins}_{it} + \beta_2 \text{Wins}_{it-1} + \beta_3 \text{Population} + \beta_4 \text{StadiumCapacity}_i + \beta_5 \text{NewStadium}_i + \epsilon_{it}$. The Revenue term is the dependent variable representing total revenue for team i , with the following explanatory variables: Wins being the number of games team i won in year t , Wins_{it-1} illustrating lagged wins, or the number of wins team i won in year $t-1$, Population representing the number of people in team i 's market, StadiumCapacity which measures the number of fans team i 's stadium can hold, and NewStadium, which is a dummy variable for whether team i played in a stadium that was built in the past eight years.

they take a net profit loss. Effectively, I am estimating the revenue implications a win has on a team in order to determine if a player is being over or underpaid relative to their marginal revenue product.

I predict that the Wins and LagWins variables will have a positive relationship with increased team revenues. In order to determine a player's MRP using Hollinger's Estimated Wins Added statistic, I will multiply a player's EWA by the sum of the coefficients on Wins and LagWins. For Berri's Wins Produced metric, I will multiply a player's WP by the sum of the coefficients on Wins and LagWins. Using a similar approach that Berri, Leeds, and von Allmen utilized, I will discount lagged wins by a 5% discount rate to account for the time value of money⁴⁹. After separately applying Hollinger's and Berri's metrics to determine players' MRPs⁵⁰, I will then subtract each player's MRP by their salary to determine if they are being over or underpaid relative to their MRP⁵¹. I predict that, on average, players are underpaid relative to their MRP. I anticipate that players will suffer a greater underpayment relative to their MRP under Hollinger's EWA, as his statistic is biased towards players that shoot more, even when they shoot at inefficient rates. Furthermore, I expect that superstars will suffer from an ever greater underpayment compared to the average NBA player. I will use the same approach as above to test this hypothesis. My EWA superstar list for each season will consist of the top 30 players based off of EWA and salary, while my WP superstar list will be composed of the top 30 players based off of WP and salary, removing any

⁴⁹ Berri, David J., Michael A. Leeds, and Peter Von Allmen. Page 9.

⁵⁰ Player's EWA MRP = Player's EWA * value of win (in U.S. \$). Player's WP MRP = Player's WP * value of win (in U.S. \$).

⁵¹ $(\beta_1 + \beta_2/1.05) * (\text{EWA or WP}) = \text{MRP}$. Salary - MRP > 0 = overpayment, Salary - MRP < 0 = underpayment.

potential duplicates that are in both the top 30 of salary and top 30 of one of these metrics. I expect that veterans will be overpaid relative to the younger players in the league due to the rookie contract ceiling restrictions.

Additionally, I anticipate that PlayerExp will be positively correlated with team revenues, as teams that spend more on players tend to have higher quality players and attract more fans, ultimately increasing their revenues. Finally, I predict that the dummy variable, MarketSize, will have a negative relationship with team revenue. Cities with fewer television homes tend to have a smaller population and as a result, the NBA team in that respective city will suffer in terms of revenues from a smaller fan base.

For the second portion of my study, I will look at the determinants of a player's salary from the 2009-10 NBA season to the 2014-15 season⁵² using the following model:

$$\text{Salary}_{it} = \beta_0 + \beta_1 \text{PTS}_{it} + \beta_2 \text{BLK}_{it} + \beta_3 \text{STL}_{it} + \beta_4 \text{AST}_{it} + \beta_5 \text{ORB}_{it} + \beta_6 \text{DRB}_{it} + \beta_7 \text{eFG\%}_{it} + \beta_8 \text{TOV}_{it} + \beta_9 \text{Age}_{it} + \beta_{10} \text{GS}_{it} + \beta_{11} \text{MP}_{it} + \mu_{it}, (2)$$

The dependent variable in this model is Salary, which is player i's salary in season t. The explanatory variables are defined as follows, with all of the variables being measured for player i in season t: PTS stands for points scored, BLK is blocks, STL is steals, AST is assists, ORB is offensive rebounds, DRB is defensive rebounds, eFG% is effective field goal percentage, TOV is turnovers, Age is a player's age in years, GS is games started, and MP is minutes played⁵³.

⁵² Excluding the 2011-12 NBA season due to the lockout.

⁵³ Refer to Table 2 for more descriptive definitions of these variables.

When a player considers free agency, managers are constantly trying to calculate the optimal amount to pay that player in order to acquire them. However, there are almost always at least two parties competing for this player's services. Unless there is a reason the player's original team wants to release him, the original team is trying to offer that player an attractive contract in order to keep him from leaving their team. On the other hand, the other 29 general managers throughout the league are weighing the pros and cons of potentially acquiring this player. Regardless of which side of this scenario a manager is on, he must offer a contract that is more appealing than the other offer. However, game managers that pay in excess of a player's MRP will hurt their profit margin, while managers that pay below a player's MRP will likely lose that player's services to another team. Managers must analyze a player's on-court performance and project out potential contributions this player can make to their team in the future. I am going to model the various factors that contribute to a player's salary in order to determine the statistics that general managers value the most when deciding how much to pay a player when negotiating a contract. I am going to compare these results to Bellotti and Oliver's model, which determines the correlation coefficients between winning percentage and performance variables.

In order to measure whether general managers overpay for points relative to other player statistics, I am going to look at the elasticity of each explanatory variable. I will multiply the variable's coefficient by its standard deviation to determine how responsive each variable is as it moves away from their mean values. The larger the response, the more elastic the variable is, and the more general managers tend to pay for that statistic

relative to other player statistics. I predict that points scored will have the largest response out of all of the variables in my salary determinant model.

For my third and fourth model, I will analyze the effects EWA and WP have on player salaries from the 2009-2010 NBA season to the 2014-15 season⁵⁴.

$$\text{Salary}_{it} = \beta_0 + \beta_1 \text{EWA}_{it} + \mu_{it}, (3)$$

$$\text{Salary}_{it} = \beta_0 + \beta_1 \text{WP}_{it} + \mu_{it}, (4)$$

The purpose of these two models is to get a better understanding of how much of the variation in player salaries these two metrics can explain. I predict that EWA and WP will have a positive relationship with player salaries, as an increase in either of these explanatory variables is typically an indication of better player performance and as a result, a higher salary.

Selection of Variables

For my first model, I omit the attendance variable, as there was not a significant variance among fan attendance throughout the league in my sample. This can partially be attributed to the relatively small seating capacity of NBA teams compared to that of the NFL and MLB. Also, my market size variable is able to pick up some of the effects that attendance has on team revenues, as the number of television homes in a city is related to the size of that city's fan base and the number of people that are able to attend their

⁵⁴ Excluding the 2011-12 NBA season due to the lockout.

team's home games based on their proximity to the NBA arena. I chose to include a player expense variable because teams that invest more money in their players, particularly superstars, tend to bring in more revenues. I incorporated a lagged wins variable into my model because a team's success often is not immediately recognized. Part of this effect can be explained through non-ticket revenues such as revenue from luxury seats and other special seating⁵⁵. Luxury seats are usually purchased prior to the season and come in as a lump-sum of revenue. A team that performed poorly in the previous season will likely see a lower demand for luxury seats, whereas fans will be more inclined to purchase luxury seats for the upcoming season after a team performs well in the current year.

In my second model, I selected the majority of my explanatory variables based off separate, but similar studies performed by Bellotti and Oliver on the correlation coefficients between NBA winning percentages and team statistics⁵⁶. One of the reasons behind running this model was to determine if these same correlations occurred when analyzing these variables of player performance on player salary. More importantly, I created this model to see if points are overpaid for by general managers relative to other valuable statistics players accumulate that help generate wins. I chose to add an efficiency shooting percentage variable in place of a missed field goals variable to better gauge whether players were being compensated for scoring efficiently, or if their salary is more a function of how many points they are scoring regardless of the number of shots they take. I also removed personal fouls and missed free throws from my model, as these

⁵⁵ Leeds, Michael, and Peter Von Allmen. *The Economics of Sports*. Boston: Addison-Wesley, 2002. Print. Page 364.

⁵⁶ Berri, David J., Martin B. Schmidt, and Stacey L. Brook. *The Wages of Wins: Taking Measure of the Many Myths in*. Stanford, CA: Stanford Business, 2006. Print. See Table 19.

variables tend to not be significant indicators of a player's salary. I additionally wanted to analyze the effects age, number of games started, and minutes played have on a player's salary.

For my last two regressions, I chose to regress salary on the two metrics that measure a player's overall value in terms of wins; Hollinger's EWA and Berri's WP.

IV. Data

In my first data set on team revenues, I compiled 270 observations⁵⁷ over the course of the 2005-06 NBA season to the 2014-15 season⁵⁸. This data includes team revenues, logged team revenues, season wins, lagged season wins, player expenses, average fan attendance, and market size. I collected team revenue and expense data off of Forbes, while I gathered the attendance, wins, and market size data off of ESPN.com, landofbasketball.com, and nbahoopsonline.com, respectively. The EWA superstar data has 231 observations, consisting of the top 30 paid players and top 30 EWA performers per season from the 2009-10 season to 2014-15 NBA season. The WP superstar data was compiled using the same process, with a total of 254 observations.

My second data set contains 1,926 observations of every player's points scored, blocks, steals, assists, offensive and defensive rebounds, efficient field goal percentage, turnovers, age, games started, and minutes played from the 2009-10 season to the 2014-

⁵⁷ 270 observations = 30 teams * 9 NBA seasons.

⁵⁸ The 2011-12 NBA season was excluded from all three data sets due to the 2011 lockout.

15 season. I used ESPN.com to obtain my salary data. I was able to crosscheck my salary data with basketballreference.com, where I also gathered each individual's stats.

For my third and fourth model, I collected Hollinger's EWA statistic off of ESPN.com, while I obtained Berri's WP figures off of boxscoregeeks.com. Although I pulled my data from a variety of sources, they are well-known, reliable sources. These two models have 1,716 observations each.

The summary statistics of this data is located in Tables 4-9, with correlation tables located in Tables 10-13.

V. Results

Revenue Model and Valuing a Win

Table 14 displays the positive correlation between SeasonWins and team revenues, as well as the positive correlation between LagWins and team revenues. After taking the past ten-year team revenue average, I found the mean to be \$127,800,000 in team revenues. I then applied the SeasonWins coefficient to the lnRev variable. Its coefficient of .0016 means that for each additional regular season win, we can expect a team's revenues to increase by \$204,480⁵⁹. The LagWins coefficient of .0041 leads us to expect that a win will bring in an additional \$523,980⁶⁰ in the following year on average. Taking the 5% discount rate into account effectively values a lagged win at \$499,028⁶¹.

⁵⁹ \$204,480 = (\$127.8 million * .0016% * 100%).

⁶⁰ \$523,980 = (\$127.8 million * .0041% * 100%).

⁶¹ \$499,028 = (\$523,980 / 1.05).

After adding the values of SeasonWins and LagWins together, we find that one additional win will increase team revenues by \$703,508. SeasonWins was not found to be statistically significant at the 1, 5, or 10% level, but the LagWins variable is significant at the 1% level with a p-value less than 0.000.

The PlayerExp and MarketSize variables both reacted as I predicted, with a significant positive coefficient on PlayerExp and significant negative coefficient on MarketSize. On average, this model expects an additional \$1,000,000 spent on players will lead to an increase of \$1,329,120⁶² in team revenues. Meanwhile, when the dummy variable takes on a value of 1, whereby a team falls in the bottom half of the league in terms of number of television households in their city, we anticipate their team revenues to fall by an average of \$16,268,940⁶³.

Players' MRP vs. Salary (Hollinger's EWA Approach)

The summary statistics for Hollinger's EWA metric applied to my model's calculated value of a win added, as well as Galletti's value of a win in terms of team revenues can be found in Table 5. Based off of my model, players throughout the league are, on average, overpaid by \$2,546,746 relative to their contract⁶⁴. However, GallettiDiff⁶⁵ suggests the opposite, as (Hollinger's EWA * \$1.47M) – Player Salary = \$271,764 average underpayment relative to a player's marginal revenue product.

⁶² \$1,329,120 = (\$127.8 million * .0104% * 100%).

⁶³ -\$16,268,940 = (\$127.8 million * -.1273% * 100%).

⁶⁴ \$2,546,746 is average ModelDiff. ModelDiff = Player Salary – Player MRP under my model's value of a win. See Table 1 for more expansive definition of ModelDiff.

⁶⁵ -\$271,764 is average GallettiDiff. GallettiDiff = Player Salary – Player MRP under Galletti's value of win. See Table 1 for more expansive definition of GallettiDiff.

Applying Hollinger's EWA to my estimated value of a win elicited surprising results, as I was not anticipating players to be overpaid relative to their MRP, especially by such a large difference. However, we will compare these results to Berri's WP application before drawing any conclusions.

Players' MRP vs. Salary (Berri's WP Approach)

The summary statistics for Berri's WP metric can be found in Table 6. After applying Wins Produced to my model's value of a win, we find that players are overpaid by an average of \$2,221,592 relative to their MRP. However, Galletti's value shows an even more significant underpayment of NBA players compared to the EWA application, with the average player receiving \$671,691 less than their MRP. My initial prediction that players would suffer greater underpayment under Hollinger's EWA versus Berri's WP was incorrect. I was basing this assumption off of the nature of Hollinger's stat, as his metric tends to favor scoring. Under his model, a player that shoots at a better rate than 30% can boost his EWA by taking a higher volume of shots, which rewards inefficient shooting⁶⁶. However, I failed to recognize that EWA is much harsher in penalizing a player's poor performance, as the mean EWA from my sample is 3.67, while the mean WP is 3.77. Another statistic that points towards this conclusion is that the minimum EWA observed is -4.3, while the minimum WP observed is only -0.1 in my sample.

⁶⁶ "David Berri Educates Us on John Hollinger." 3sobcom. N.p., 18 Dec. 2012. Web. 23 Nov. 2015.

When utilizing Galletti's value of a win at \$1.47 million, it is not surprising to see that players are underpaid on average under both Hollinger's and Berri's respective wins added metrics. This value of a win seems to be realistic when considering that players are the reason teams bring in such large revenue figures. On the other hand, my model's indication that players are significantly overpaid was not expected. However, "North American sports all depend heavily on revenue from TV contracts that were signed long before many current players were in the league"⁶⁷. Revenues from TV contracts not only make up a significant portion of a team's revenue, but they come in as a lump-sum. This effectively eliminates the potential for a player to have an impact on an entire team's revenues. No matter how many points he scores, rebounds he collects, or how many wins he contributes to his team, his performance is not able to influence a major chunk of team revenues because they have already been fixed. As Berri, Leeds, and von Allmen explain, "a portion of the player's compensation reflects the impact of his efforts on variable revenue (his MRP)...the rest of his compensation results from his bargaining with the team"⁶⁸. In terms of my model, a player's contributions are worth his ModelProd, which is his estimated contributed wins to the team multiplied by my model's win value of \$703,508. For example, if a player is supposedly being overpaid by the WP's ModelDiff average of \$2,221,592, but deserves a salary of \$4,221,592, it is his job to bargain for this additional \$2,221,592 above his \$2,000,000 in on-court contributions because that represents his true value to his team. Although paying him \$4,221,592 would not be in direct congruence with his MRP, the fact that this player is in the league, along with the

⁶⁷ Berri, David J., Michael A. Leeds, and Peter Von Allmen. Page 6.

⁶⁸ Berri, David J., Michael A. Leeds, and Peter Von Allmen. Page 6.

rest of the NBA athletes, is the reason for these large TV revenues teams are earning.

Therefore, players need to be compensated for their on-court performance, as well as the fraction of TV contract revenues for which they are responsible.

Age vs ModelDiff

Figure 1 plots EWA ModelDiff against Age and Figure 2 plots WP ModelDiff against Age. These scatterplots suggest some interesting results, as there is clearly a positive relationship between age and ModelDiff⁶⁹. The estimated equation under EWA is $\text{ModelDiff} = -7,686,185 + 383,848 * \text{Age}$ (t score of 17.97), while the estimated equation under WP is $\text{ModelDiff} = -6,748,440 + 335,462 * \text{Age}$ (t score of 13.67). These results suggest that players are increasingly overpaid relative to their MRP as they get older in the NBA. This supports the work of Leeds and Kowalewski (1999), where they determined veterans were overpaid, while younger players suffered from lower wages. As stated earlier, Banaian and Gallagher found that the 1995 CBA led to an even greater wage disparity in the NBA compared to the already apparent difference seen in the early '90s. I will now analyze the MRP of superstars to determine if they are responsible for this overpayment in my model and underpayment under Galletti's value of a win.

Superstar MRP vs. Salary (Hollinger's Approach)

⁶⁹ Focused on results using ModelDiff, but this study found a similar positive relationship between Age and GallettiDiff.

After taking the top 30 most productive players in terms of EWA and top 30 paid players over the past five NBA seasons, excluding the 2011-12 season, I found that the average superstar is overpaid by \$5,234,035 when applying ModelDiff, which can be seen in Table 7. This is more than double the entire league average of \$2,546,746. This points towards superstars being overpaid. However, when we apply the GallettiDiff we find that superstars are actually underpaid by \$3,844,416 on average, which easily exceeds the GallettiDiff underpaid mean of \$271,764 when analyzing the entire league.

Superstar MRP vs. Salary (Berri's Approach)

As we see the results in Table 8, NBA superstars were overpaid by an average of \$6,240,523 under my model, but underpaid by \$669,372 according to Galletti's model. A possible explanation for the extremely large overpayment of superstars under my model is the potential for athletes to exercise shirking. Stiroh (2002) found that "performance improves in the year before a new contract is signed as workers increase their effort to convince employers of their high ability and earn more lucrative long-run contracts. Once the contract is signed, however, performance declines"⁷⁰. Even more importantly, he discovered that a team's performance is positively correlated with the number of players in their contract year, while it is negatively correlated with the number of players who recently signed large contracts.

⁷⁰ Stiroh, Kevin J. "Playing for Keeps: Pay and Performance in the NBA." SSRN Electronic Journal SSRN Journal (n.d.): n. pag. Web. 21 June 2002. Page 21.

Age vs. ModelDiff Superstars

Figure 3 displays EWA ModelDiff against Age of superstars, while Figure 4 plots WP ModelDiff against Age of superstars. The first graph has an estimated regression line of $\text{ModelDiff} = -28,100,000 + 1,201,628 * \text{Age}$, with a t score of 12.54. Meanwhile Figure 4 has an estimated regression line of $\text{ModelDiff} = -20,600,000 + 957,841 * \text{Age}$, with a t score of 8.39. These two regressions further support the issue of older players receiving higher salaries than younger players relative to their respective marginal revenue products, regardless of whether they are a superstar or average player in the NBA.

Salary Determinants

When comparing the regression results in Table 15 to the correlation coefficients in Table 19, defensive rebounds, assists, points, and blocked shots all have a positive relationship with a player's salary in my model, just as these variables have a positive correlation with winning percentage. The two variables that have a negative relationship in both models are turnovers and offensive rebounds. All of these results make intuitive sense, except for the negative coefficient on offensive rebounds. However, when a player grabs an offensive rebound, he is rebounding a missed shot. Missed shots are not a positive attribute to winning a game. Therefore, the more offensive rebounds a player collects, the fewer shots he and his team are making, which creates the negative relationship. The one variable that came up positively related in my model and negatively correlated in Bellotti and Oliver's model was steals. The more steals a player makes, the

more value he adds to his team, as he is taking away possessions from the opposing team. However, this coefficient suggests otherwise. A possible explanation for this result is that my data does not adjust for the position of each player, effectively diminishing the importance of steals relative to other statistics that are more prominent among centers and forwards such as blocks and rebounds.

As we focus solely on my salary determinants model, we see that this model describes 49% of the variation in player salaries. One key takeaway is the large coefficient on points, as each additional point a player scores results in their salary increasing by an average of \$7,762. Points, blocks, steals, assists, defensive rebounds, effective field goal percentage, age, games started, and minutes played are all significant at the 95% confidence level. The more minutes played by an athlete also decreases their salary. This is hard to contemplate, as the best players in the league tend to be on the court the most. However, general managers could view a player that has played an inordinate amount of minutes to be less valuable because he no longer has as “much left in the tank”. Furthermore, the more minutes a player is in on the court, the greater the chance he has of getting injured during the course of the season. Also, the negative coefficient on effective field goal shooting percentage, which takes into account the fact that 3-point field goals are worth 1 more point than a typical 2-point field goal, is a result worth looking further into. The higher shooting percentage a player has the more efficient and productive he is for his team. The fact that this model suggests otherwise leads to the investigation of how important points are when determining a player’s salary.

Do General Managers Overpay for Points?

To answer this question, I looked at the value of each variable's coefficient one standard deviation from its mean. Although the coefficient estimates in Table 15 are useful to interpret player salary determinants, Table 16 offers additional insight into the importance of each statistic when analyzing how much value a general manager places on each statistic compared to another. Upon initial interpretation of the coefficients, it seemed that age, games started, and blocks were the most important determinants of a player's salary with the three largest coefficients of 357,093, 35,279, and 16,126, respectively. However, this is just a point estimate of a unit increase in age, games started, and blocks. This does not speak to the relative occurrence of each statistic or variable and therefore is not an accurate representation of how valuable each statistic is when determining a player's salary. As we multiply each of these coefficients by their respective standard deviations, we get an idea of the elasticity of each of these variables. Effectively, we are measuring how frequently these statistics occur and how much it costs a manager to pay for a player's statistics at the league average versus one standard deviation above the average. These results tell a much different story, as points scored now has a salary response that is more than six times larger than block's salary response (3,464,409 versus 546,369).

When considering all of the statistics that overlap in my model and Bellotti and Oliver's model, we see that points have the largest salary response by a significant margin. Defensive rebounds (1,294,833), turnovers (-161,381), assists (848,680), offensive rebounds (-253,853), and steals (-331,950) all have a much smaller salary response. These results suggest that general managers do in fact have a tendency to pay more for points than other statistical categories.

Salary & Estimated Wins Added

This regression's purpose was to determine if there is a significant relationship between wins added and player salary. Table 17 shows that one additional win added increases a player's salary by an average of \$597,458. Additionally, this is statistically significant at the 1%, 5%, and 10% significance levels, with a t score of 29.41. Estimated Wins Added is able to explain 33.5% of the variation in player salary.

Salary & Wins Produced

Similar to the last model, this regression was performed to determine if there was a significant relationship between wins produced and player salary. Furthermore, its purpose was to determine which statistic explains more of the variation in player salary. Referring to Table 18, we see that one additional win produced increases a player's salary by \$608,607 on average. Wins Produced has a t score of 20.56, making it statistically significant at the 1%, 5%, and 10% significance levels. Additionally, this model is able to explain 19.7% of the variation in player salary. Comparing Estimated Wins Added and Wins Produced shows that EWA is more significant and is able to explain about 13.8% more of the variation in the dependent variable.

Although these statistics carry some value, we cannot conclude that one is simply better than the other based off of these two measures. More importantly, Hollinger's EWA and Berri's WP are rooted in theory and assumptions that can lead to major differences in wins added and wins produced from one player to the next.

Finally, these last two regressions show how much of the variation in player salary is left unexplained by these two metrics.

VI. Summary and Conclusion

The revenue model created in this study showed that players throughout the league are vastly overpaid when comparing their marginal revenue product to their salary. Superstars were overpaid by even more when applying the model's value of a win to both Hollinger's EWA and Berri's WP. The fixed nature of TV contract revenues is a major reason for this study's findings of overpayment of NBA athletes. However, Galletti's value of a win is able to partially account for these fixed revenue streams and therefore finds players to be underpaid on average relative to their marginal revenue product. Additionally, this study found that older players receive larger salaries relative to their marginal revenue product compared to younger players and their MRP. Furthermore, this study found that general managers do tend to pay players more for points scored versus other statistics. Finally, this study showed that John Hollinger's Estimated Wins Added statistic and David Berri's Wins Produced statistic are able to explain some of the variation in player salaries. However, neither of these statistics is capable of describing the entirety of player salaries.

“One cannot end the analysis when one has measured the value of player performance. Knowing the value of each player is only the starting point of analysis. The next step is determining why the player is productive or unproductive...ultimately this question can only be answered by additional scrutiny into the age and injury status of the

player, the construction of a team, and the roles the player plays on the floor”⁷¹. This model’s estimated value of a win in monetary terms and its application to EWA and WP provides insight into the value of a player’s contributions to team revenues. However, these numbers are not able to tell the entire story, as they do not account for clutch factors, making the extra pass, and other smart decisions players make that do not show up on a stat sheet, but contribute to their team’s success.

This study provides a look into the impact player performance has on team revenues and their salaries. Future research could explore the impact players have on TV contract and broadcasting revenues to enhance the estimation of a player’s marginal revenue product. Additionally, statistics that lead up to a player’s contract could improve this study’s determination of the factors that contribute to a player’s salary.

⁷¹ Berri, David J., Martin B. Schmidt, and Stacey L. Brook. *The Wages of Wins: Taking Measure of the Many Myths* in. Stanford, CA: Stanford Business, 2006. Print. Page 125.

Appendix

Table 1

Definitions of Revenue & MRP Variables

Variable	Definition
Rev	Amount of team revenues in U.S. dollars
lnRev	The natural log of team revenues in U.S. dollars
Wins	Number of wins an NBA team has during a single season
LagWins	Number of wins an NBA team had in their previous season
PlayerExp	Amount of money a team spends on player salaries, including benefits and bonuses
MarketSize	A dummy variable equal to one if the team's city is in the bottom half of the league for number of television homes, and zero if they are in the top half of the league
Salary	Value of a player's contract in U.S. dollars in a single season
EWA	Hollinger's Estimated Wins Added metric
WP	Berri's Wins Produced metric
ModelProd	Value of multiplying a player's EWA or WP by my model's estimated value of a win, which is \$703,508
ModelDiff	The difference of (Salary – ModelProd), with negative values resulting in underpayment relative to a player's MRP and vice versa
GallettiProd	Value of multiplying a player's EWA or WP by Galletti's estimated value of a win, which is \$1.47 million
GallettiDiff	The difference of (Salary – GallettiProd), with negative values resulting in underpayment of a player's MRP and vice versa

Table 2
Definitions of Salary Determinant Variables

Variable	Definition
PTS	Number of points a player scores in a single season
BLK	Number of blocks a player accumulates in a single season
STL	Number of steals a player accumulates in a single season
AST	Number of assists a player accumulates in a single season
ORB	Number of offensive rebounds a player accumulates in a single season
DRB	Number of defensive rebounds a player accumulates in a single season
eFG%	A player's effective field goal percentage in a single season, which adjusts for the fact that a 3-point field goal is worth one more point than a 2-point field goal
TOV	Number of turnovers a player commits in a single season
Age	A player's age in years during a season
GS	Number of games a player started in during a single season
MP	Number of minutes a player is on the court throughout a single season

Table 3
NBA Salary Cap by Year

Year	Salary Cap
2006	\$49.5 million
2007	\$53.1 million
2008	\$55.6 million
2009	\$58.7 million
2010	\$57.7 million
2011	\$58.0 million
2012	\$58.0 million
2013	\$58.0 million
2014	\$58.7 million
2015	\$63.1 million

Table 4
Team Revenue Model – Summary Statistics⁷²

Variable	Observations	Mean	Std. Dev.	Min	Max
Rev	270	127.80	37.08	73	295
lnRev	270	4.81	0.26	4.29	5.68
SeasonWins	270	40.99	12.69	12	67
LagWins	270	40.99	-12.60	12	67
PlayerExp	270	70.10	12.92	28	121
MarketSize	270	.50	0.50	0	1

⁷² This data set spans 10 years from the 2005-06 NBA season through the 2014-15 NBA season. The 2011-12 NBA season is excluded from this data set due to the lockout. Revenue and expense data was pulled from forbes.com, team wins from ESPN.com and landofbasketball.com, and team market size from nbahoopsonline.com.

Table 5
Hollinger Summary Statistics – Entire League⁷³

Variable	Observations	Mean	Std. Dev.	Min	Max
Salary	1,716	5,133,655	4,856,152	59,686	30,500,000
EWA	1,716	3.67	4.70	-4.3	30.5
ModelProd	1,716	2,586,909	3,311,289	-3,025,084	21,500,000
ModelDiff	1,716	2,546,746	3,990,398	-13,100,000	22,400,000
GallettiProd	1,716	5,405,420	6,919,034	-6,321,000	44,800,000
GallettiDiff	1,716	-271,764	5,704,449	-32,500,000	22,000,000

⁷³ This data set is compiled from the 2009-2010 NBA season through the 2014-15 NBA season, excluding the 2011-12 NBA season due to the lockout. I compiled the EWA statistics from ESPN.com and the salary figures from basketball-reference.com and ESPN.com.

Table 6
Berri Summary Statistics – Entire League⁷⁴

Variable	Observations	Mean	Std. Dev.	Min	Max
Salary	1,716	4,877,130	4,897,003	2692	30,500,000
WP	1,716	3.77	3.57	-0.1	21.3
ModelProd	1,716	2,655,538	2,517,741	-70,358	15,000,000
ModelDiff	1,716	2,221,592	4,399,071	-10,300,000	23,700,000
GallettiProd	1,716	5,548,822	5,260,892	-147,000	31,300,000
GallettiDiff	1,716	-671,691	5,360,973	-24,100,000	22,300,000

⁷⁴ This data set is compiled from the 2009-2010 NBA season through the 2014-15 NBA season, excluding the 2011-12 NBA season due to the lockout. I compiled the WP statistics from boxscoregeeks.com and the salary figures from basketball-reference.com and ESPN.com.

Table 7
Hollinger Summary Statistics - Superstars⁷⁵

Variable	Observations	Mean	Std. Dev.	Min	Max
Salary	231	13,600,000	5,513,296	884,293	30,500,000
EWA	231	11.84	5.79	-0.2	30.5
ModelProd	231	8,332,458	4,078,893	-140,701	21,500,000
ModelDiff	231	5,234,035	7,361,432	-13,100,000	22,400,000
GallettiProd	231	17,400,000	8,522,963	-294,000	44,800,000
GallettiDiff	231	-3,844,416	10,900,000	-32,500,000	22,000,000

⁷⁵ This data set is compiled from the 2009-10 NBA season through the 2014-15 NBA season, excluding the 2011-12 NBA season due to the lockout. The superstars were defined as the top 30 paid players and the top 30 players in terms of EWA for each season.

Table 8
Berri Summary Statistics - Superstars⁷⁶

Variable	Observations	Mean	Std. Dev.	Min	Max
Salary	254	12,600,000	6,064,152	473,604	30,500,000
WP	254	9.01	4.74	0	21.3
ModelProd	254	6,342,097	3,337,126	0	15,000,000
ModelDiff	254	6,240,523	7,909,812	-10,300,000	23,700,000
GallettiProd	254	13,300,000	6,973,020	0	31,300,000
GallettiDiff	254	-669,372	10,800,000	-24,100,000	22,300,000

⁷⁶ This data set is compiled from the 2009-10 NBA season through the 2014-15 NBA season, excluding the 2011-12 NBA season due to the lockout. The superstars were defined as the top 30 paid players and the top 30 players in terms of WP for each season.

Table 9
Salary Determinants Summary Statistics⁷⁷

Variable	Observations	Mean	Std. Dev.	Min	Max
Salary	1,926	4,762,359	4,788,809	2,692	30,500,000
PTS	1,926	623.15	446.28	2	2,593
BLK	1,926	30.38	33.88	0	242
STL	1,926	46.96	33.38	0	191
AST	1,926	135.81	137.90	0	892
ORB	1,926	68.05	63.33	0	440
DRB	1,926	194.76	139.45	0	829
eFG%	1,926	0.50	0.05	0.16	1
TOV	1,926	85.24	60.60	0	321
Age	1,926	26.70	4.16	19	40
GS	1,926	31.56	29.78	0	82
MP	1,926	1,498.50	801.83	5	3,239

⁷⁷ This data set spans from the 2009-2010 NBA season through the 2014-15 NBA season, excluding the 2011-12 NBA season due to the lockout. This data was compiled from ESPN.com and basketball-reference.com.

Table 10

Team Revenue Correlation Matrix⁷⁸

	InRev	SeasonWins	LagWins	PlayerExp	MarketSize
InRev	1.00				
SeasonWins	0.23 0.00	1.00			
LagWins	0.36 0.00	0.57 0.00	1.00		
PlayerExp	0.60 0.00	0.06 0.26	0.22 0.00	1.00	
MarketSize	-0.32 0.00	-0.01 0.82	0.00 0.98	-0.14 0.01	1.00

⁷⁸ This table displays the correlation and p-value significance between all of my independent variables used in my Team Revenue regression model and my dependent variable, the natural log of team revenue (InRev).

N = 270 observations

Table 11

Salary Determinants Correlation Matrix⁷⁹

	Salary	PTS	BLK	STL	AST	ORB	DRB	eFG%	TOV	Age	GS	MP
Salary	1.00											
PTS	0.56	1.00										
	0.00											
BLK	0.30	0.35	1.00									
	0.00	0.00										
STL	0.35	0.74	0.20	1.00								
	0.00	0.00	0.00									
AST	0.38	0.66	-0.01	0.73	1.00							
	0.00	0.00	0.69	0.00								
ORB	0.29	0.41	0.75	0.24	0.00	1.00						
	0.00	0.00	0.00	0.00	0.79							
DRB	0.50	0.70	0.69	0.51	0.31	0.81	1.00					
	0.00	0.00	0.00	0.00	0.00	0.00						
eFG_perc	0.07	0.09	0.20	0.00	-0.05	0.16	0.16	1.00				
	0.00	0.00	0.00	0.85	0.02	0.00	0.00					
TOV	0.50	0.88	0.31	0.78	0.82	0.36	0.63	0.00	1.00			
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84				
Age	0.29	-0.05	-0.07	-0.06	0.02	-0.10	-0.01	0.06	-0.07	1.00		
	0.00	0.02	0.00	0.01	0.31	0.00	0.74	0.00	0.00			
GS	0.50	0.76	0.43	0.66	0.56	0.48	0.71	0.10	0.72	0.00	1.00	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97		
MP	0.48	0.91	0.42	0.80	0.67	0.49	0.76	0.09	0.84	-0.02	0.83	1.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	

⁷⁹ This table displays the correlation and p-value significance between all of my independent variables used in my Player Salary regression model and my dependent variable, Salary.
N = 1,926 observations

Table 12

Salary on Estimated Wins Added Correlation Matrix⁸⁰

	Salary	WP
Salary	1.00	
EWA	0.57	1.00
	0.00	

⁸⁰ This table displays the correlation and p-value significance between Estimated Wins Added and Salary. N = 1,716 observations

Table 13

Salary on Wins Produced Correlation Matrix⁸¹

	Salary	WP
Salary	1.00	
WP	0.44	1.00
	0.00	

⁸¹ This table displays the correlation and p-value significance between Wins Produced and Salary.
N = 1,716 observations

Table 14

Team Revenue Model – Determinants of Revenue & Valuing a Win⁸²

$$R^2 = 0.4826$$

Variable	Coefficient	T-Score	P-Value
SeasonWins	0.0016	1.43	0.153
LagWins	0.0041***	3.59	0.000
PlayerExp	0.0104***	11.27	0.000
MarketSize	-0.1273***	-5.45	0.000
Constant	3.906971***	52.03	0.000

⁸² This table contains my results from my team revenue regression, spanning from the 2005-06 to the 2015-15 NBA season, excluding the 2011-12 NBA season due to the lockout. Coefficient Estimates are listed with their associated p-values. *, **, and *** note significance at the 10%, 5%, and 1% levels, respectively.

Table 15
Salary Model – Determinants of Player Salary⁸³

$R^2 = .4952$

Variable	Coefficient	T-Score	P-Value
PTS	7,762.86***	15.12	0.000
BLK	16,126.61***	4.40	0.000
STL	-9,944.58**	-2.24	0.025
AST	6,154.32***	4.63	0.000
ORB	-4,008.43	-1.54	0.124
DRB	9,285.29***	6.22	0.000
eFG%	-2,966,533**	-2.16	0.031
TOV	-2,663.06	-0.65	0.516
Age	357,093.60***	18.35	0.000
GS	35,279.51***	7.23	0.000
MP	-3,626.08***	-11.18	0.000
Constant	-5,975,919***	-7.00	0.000

⁸³ This table contains my results from my salary determinants regression, spanning from the 2009-10 NBA season to the 2014-15 NBA season, excluding the 2011-12 season due to the lockout. Coefficient Estimates are listed with their associated p-values. *, **, and *** note significance at the 10%, 5%, and 1% levels, respectively.

Table 16
Salary Determinants' Elasticity⁸⁴

Variable	Coefficient	Std. Dev.	Salary Response
PTS	7,762.86***	446.28	3,464,409.16
BLK	16,126.61***	33.88	546,369.55
STL	-9,944.58**	33.38	-331,950.08
AST	6,154.32***	137.90	848,680.73
ORB	-4,008.43	63.33	-253,853.87
DRB	9,285.29***	139.45	1,294,833.69
eFG%	-2,966,533**	0.05	-148,326.65
TOV	-2,663.06	60.60	-161,381.44
Age	357,093.60***	4.16	1,485,509.38
GS	35,279.51***	29.78	1,050,623.81
MP	-3,626.08***	801.83	-2,907,499.73

⁸⁴ This table is pulling salary determinant coefficients from Table 15 and salary determinant standard deviations from Table 9. *, **, and *** note significance at the 10%, 5%, and 1% levels, respectively. Salary response = (Coefficient * Std. Dev.)

Table 17

Salary Regression on Estimated Wins Added⁸⁵

$$R^2 = 0.3353$$

Variable	Coefficient	T-Score	P-Value
EWA	597,458.70***	29.41	0.000
Constant	2,936,706***	24.20	0.000

⁸⁵ This table contains my results from salary regression on EWA, spanning from the 2009-10 NBA season to the 2014-15 NBA season, excluding the 2011-12 season due to the lockout. Coefficient Estimates are listed with their associated p-values. *, **, and *** note significance at the 10%, 5%, and 1% levels, respectively.

Table 18

Salary Regression on Wins Produced⁸⁶

$$R^2 = 0.1978$$

Variable	Coefficient	T-Score	P-Value
WP	608,607.90***	20.56	0.000
Constant	2,579,813***	16.76	0.000

⁸⁶ This table contains my results from salary regression on EWA, spanning from the 2009-10 NBA season to the 2014-15 NBA season, excluding the 2011-12 season due to the lockout. Coefficient Estimates are listed with their associated p-values. *, **, and *** note significance at the 10%, 5%, and 1% levels, respectively.

Table 19

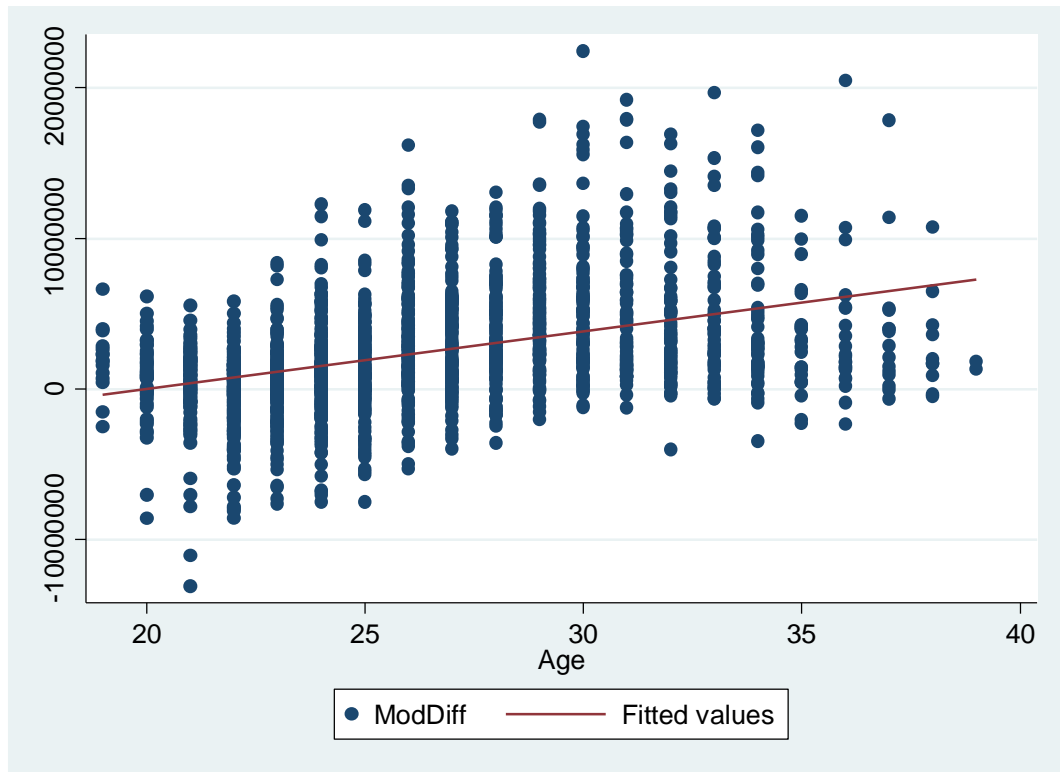
Bellotti and Oliver's Correlation Coefficients for Various NBA Statistics and Winning Percentage⁸⁷

Variable	Correlation Coefficient
Defensive Rebounds	0.48
Missed Field Goals	-0.44
Turnovers	-0.39
Assists	0.38
Points Scored	0.34
Personal Fouls	-0.28
Offensive Rebounds	-0.16
Blocked Shots	0.14
Steals	0.10
Missed Free Throws	0.01

⁸⁷ This table is pulled from *Wages of Wins* by Berri, David J., Martin B. Schmidt, and Stacey L. Brook. This specific model was conducted by Bellotti and Oliver on the correlation coefficients between NBA winning percentages and various team statistics.

Figure 1

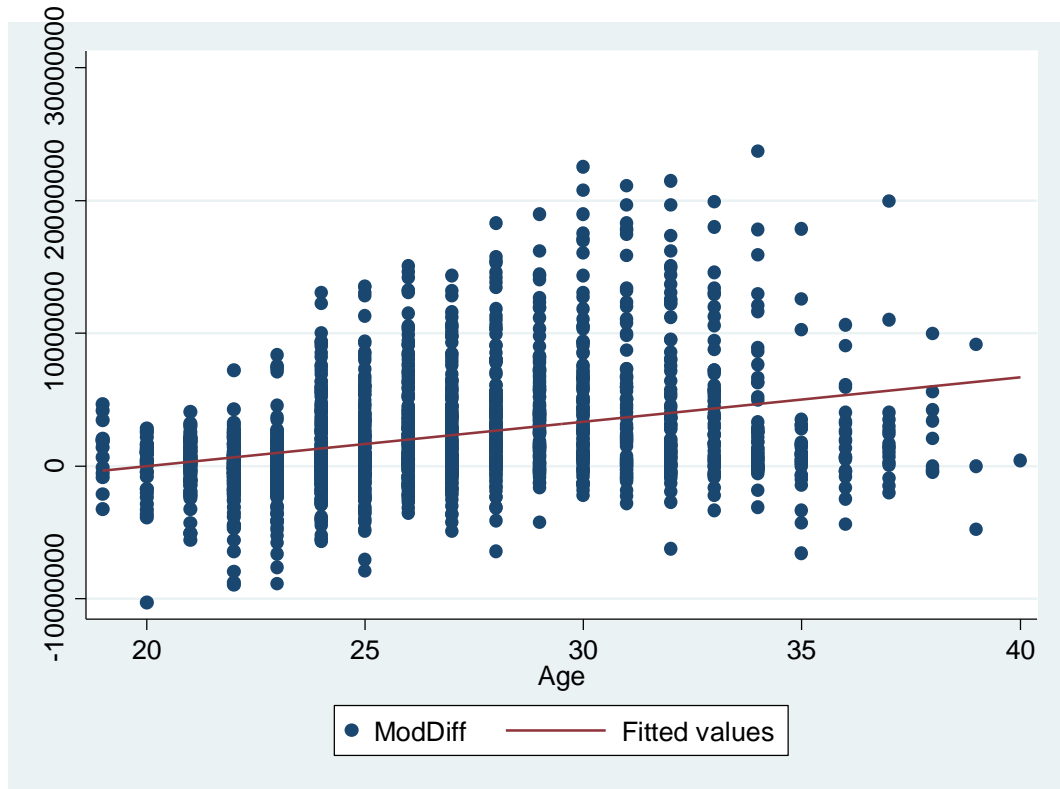
Hollinger's Age vs ModelDiff Scatterplot – Entire League⁸⁸



⁸⁸ Regression line : $\text{ModelDiff} = -7,686,185 + 383,848 * \text{Age}$
Age T score = 17.97

Figure 2

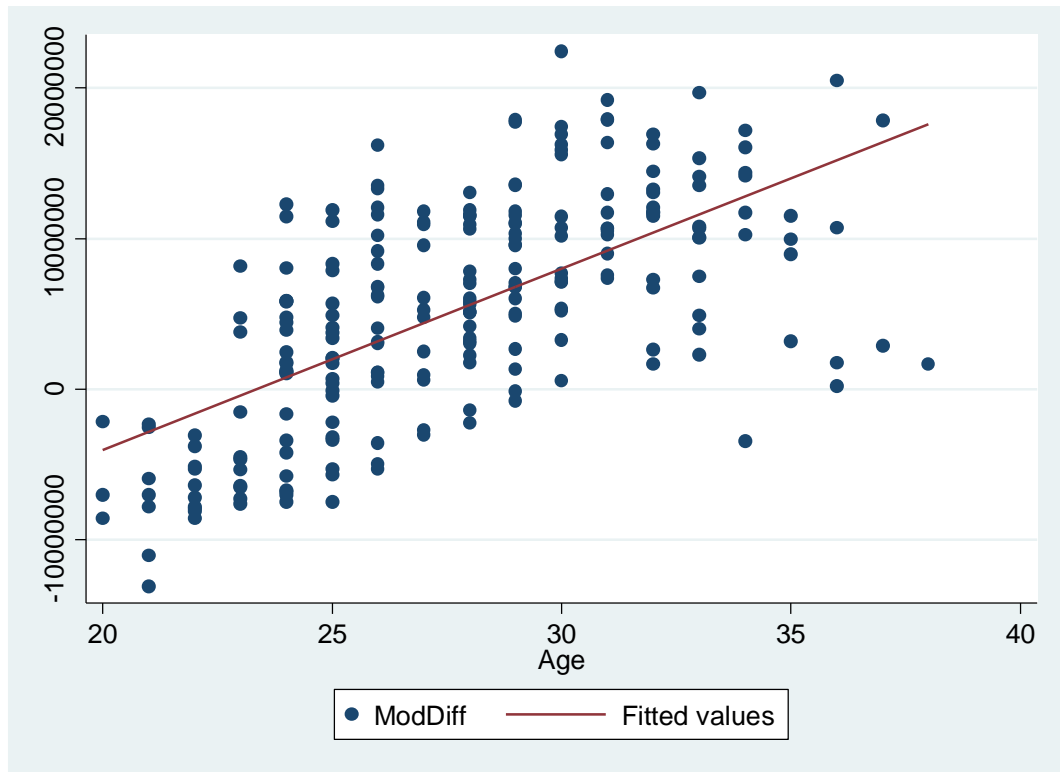
Berri's Age vs ModelDiff Scatterplot – Entire League⁸⁹



⁸⁹ Regression line: $\text{ModelDiff} = -6,748,440 + 335,462 \cdot \text{Age}$
Age T score = 13.67

Figure 3

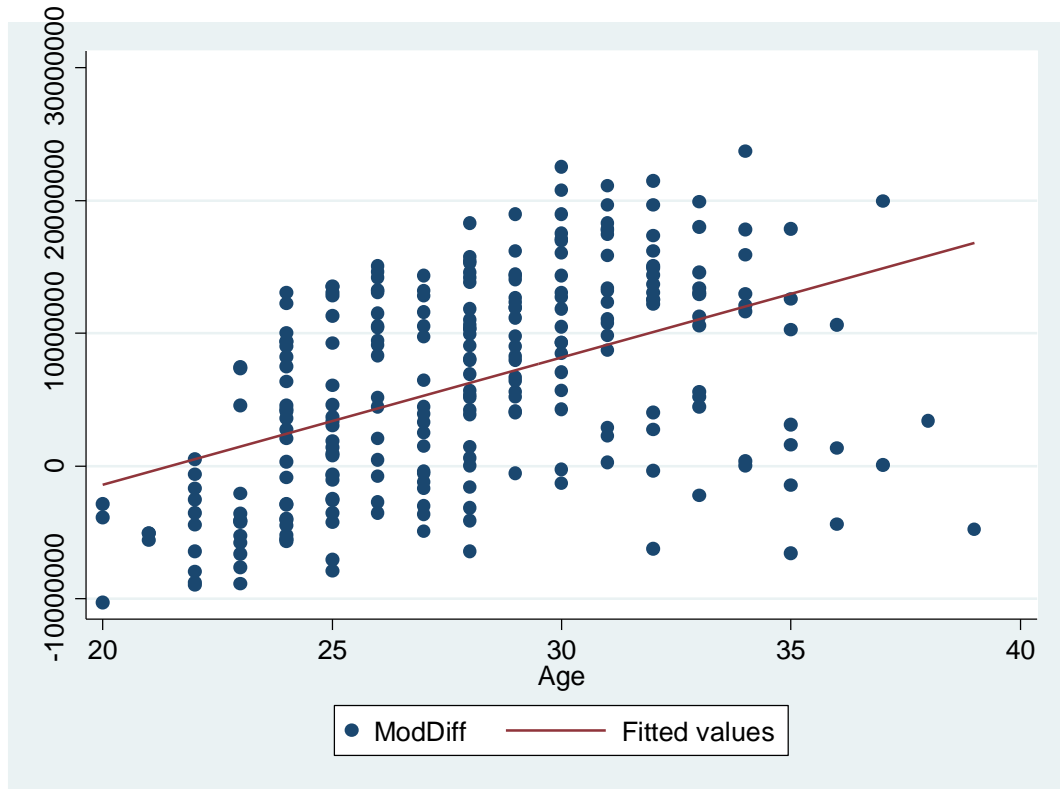
Hollinger's Age vs ModelDiff Scatterplot – Superstars⁹⁰



⁹⁰ Regression line: $\text{ModelDiff} = -28,100,000 + 1,201,628 * \text{Age}$
Age T score = 12.54

Figure 4

Berri's Age vs ModDiff Scatterplot – Superstars⁹¹



⁹¹ Regression line: $\text{ModelDiff} = -20,600,000 + 957,841 * \text{Age}$
Age T score = 8.39

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