The New Landscape of the NBA: The 2011 Collective Bargaining Agreement's Impact on Competitive Balance and Players' Salaries

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Abstract

The National Basketball Association (NBA) passed a new Collective Bargaining Agreement (CBA) in 2011 that introduced many changes to the structure of the league. The purpose of those changes was to improve competitive balance among the league, allowing smaller market teams to better compete with larger market teams. Many of the changes targeted the league's salary cap and teams' ability to pay players. This paper aims to determine whether competitive balance in the NBA improved under the 2011 CBA. The paper also determines which types of players' salaries were affected the most. The results showed that competitive balance did not improve under the 2011 CBA. However, the results showed that higher performing players were paid proportionally more money than lower performing players following 2011 CBA.

I. Introduction

Professional sports provide economists a unique opportunity to study labor economics and industrial organization. Sports yield a complete set of detailed and accurate data consisting of compensation and performance measures for every worker in the industry, as well as overall firm performance relative to their peers and past success. Labor economics study the relationship between workers and employers. Within sports labor markets, workers are the players and the employers are the teams. Sports are also prime examples of industrial organizations. The leagues owners (teams) employ players to produce competition and pay them according to their production. In addition, sport leagues periodically undergo drastic rule changes that affect the entire market structure for both players and teams, creating real life cases to test economic theory. The National Basketball Association (NBA) presents a distinctive opportunity for expanded research in labor economics given the recent rules changes implemented in the league's latest Collective Bargaining Agreement (CBA).

The CBA regulates the NBA's labor markets and is an agreement among the NBA Player's Association, the 30 NBA team owners, and the league commissioner that determines revenue sharing between the players and the league, as well as other basketball related business. The CBA defines teams' salary cap levels, minimum and maximum player salaries, trade rules, draft procedures, and free agency rules[1]. The first CBA was created in 1970 and is revised every three to six years. The CBA agreement was created to protect NBA players' rights during the impending merger between the American Basketball Association (ABA), a rival professional basketball league, and the NBA. The most recent CBA agreement was completed in 2011, and many new additions were introduced from the previous agreement.

[1] Many other NBA laws are defined in Collective Bargaining Agreement. Full details can be found on the league's official document at NBA.com.

The NBA operates under a soft salary cap. The salary cap acts as a budget constraint for the total amount of money teams can spend on players' contracts. The NBA's soft salary cap is different from the hard salary caps implemented by the National Football League (NFL). Under the hard salary cap, teams cannot spend above the cap under any circumstances. This differs from the NBA's soft salary cap, which, can be exceeded with certain exceptions and/or penalties[2]. The NBA's salary cap structure also differs from Major League Baseball (MLB), which does not have any salary cap restrictions. This allows baseball teams the ability to spend any amount of money to pay players. The new CBA based the salary cap at 44.74% of Basketball Related Income (BRI), down from the previous CBA, which set the salary cap at 51% of BRI[3]. Table 1 shows the salary cap from each season starting from 2011-2012 to 2014-2015. The salary cap was designed to promote competitive balance by distributing talent equally amongst the thirty teams. Therefore, higher-revenue generating teams would not be able to repeatedly sign the most talented players away from lower-revenue generating teams, and thus creating an uncompetitive league. If a team spent above the cap, at a certain threshold, a team must pay a "Luxury Tax" penalty to the league. The "Luxury Tax" will be discussed in further detail later.

Table 1. NBA Salary Cap

Season	Salary Cap
2011-2012	$58.044 million
2012-2013	$58.044 million
2013-2014	$58.679 million
2014-2015	$63.065 million

Free agency is the process where free agents (unemployed players without contracts) can negotiate with teams to reach a contract. The contract outlines the amount of years a player must play for the team

[2] Detailed description about the exceptions that allow teams to exceed the salary cap found in the Appendix.
[3] Full list of revenue included in BRI calculations found in the Appendix.

and the amount of money the team will pay the player over the life of the contract. Once a free agent signs a contract with a team, the team owns his basketball rights. The length of a contract can vary between a minimum of one year[4] and a maximum of five years. The maximum salary a team can pay a player is set at a certain percentage of the salary cap that increases with experience. In the 2013-2014 season, the maximum annual salary for a player with zero to six years of experience was 25% of the salary cap[5], or $13,701,250, while a player with over ten years of experience could make a maximum annual salary up to 35% of the salary cap, or $19,181,750. Table 2 breaks down the expected maximum salaries based on playing experience and season. Similarly, the minimum salary a team can pay players is a fixed salary that increases with experience. In the 2013-2014 season, the minimum annual salary for a player with two years of experience was $884,293, while a player with over ten years of experience was $1,399,507. Table 3 breaks down the minimum salary based on playing experience and season. However, if a player has been in the NBA for three or more seasons and plays under a one-year contract at the minimum salary, the league reimburses the team for any amount above the minimum salary level for a two-year veteran. In salary cap calculations, the player's cap hold is counted as only a two-year veteran's minimum salary. The purpose of the reimbursement is to prevent teams from being discouraged from signing older veterans because their minimum salaries are more expensive than younger veterans.

Table 2. Maximum Player Salaries

Years in NBA	Defined Maximum salary	2011-2012	2012-2013	2013-2014	2014-2015
0-6	25% of cap	$12,922,194	$13,668,750	$13,701,250	$14,746,000
7-9	30% of cap	$15,506,632	$16,402,500	$16,441,500	$17,695,200
10+	35% of cap	$18,091,071	$19,136,250	$19,181,750	$20,644,400

[4] One year is the minimum only if a contract is signed in the offseason. A player can sign a 10-day contract and/or a rest of the season contract, which is less than one year.
[5] 25% is not the exact percentage; the NBA's formula for calculating the percentage of salary uses a different base percentage for cap calculations.

Table 3. Minimum Player Salaries

Years in NBA	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
0	$473,604	$473,604	$490,180	$507,336	$525,093	$543,471	$562,493	$582,180	$602,557	$623,646
1	$762,195	$762,195	$788,872	$816,482	$845,059	$874,636	$905,249	$936,932	$969,725	$1,003,665
2	$854,389	$854,389	$884,293	$915,243	$947,276	$980,431	$1,014,746	$1,050,262	$1,087,021	$1,125,067
3	$885,120	$885,120	$916,099	$948,163	$981,348	$1,015,696	$1,051,245	$1,088,038	$1,126,120	$1,165,534
4	$915,852	$915,852	$947,907	$981,084	$1,015,421	$1,050,961	$1,139,123	$1,125,816	$1,165,220	$1,206,002
5	$992,680	$992,680	$1,027,424	$1,063,384	$1,100,602	$1,139,123	$1,178,992	$1,220,257	$1,262,966	$1,307,170
6	$1,069,509	$1,069,509	$1,106,942	$1,145,685	$1,185,784	$1,227,286	$1,270,241	$1,314,700	$1,360,714	$1,408,339
7	$1,146,337	$1,146,337	$1,186,459	$1,227,985	$1,270,964	$1,315,448	$1,361,489	$1,409,141	$1,458,461	$1,509,507
8	$1,223,166	$1,223,166	$1,265,977	$1,310,286	$1,356,146	$1,403,611	$1,452,738	$1,503,583	$1,556,209	$1,610,676
9	$1,229,255	$1,229,255	$1,272,279	$1,316,809	$1,362,897	$1,410,598	$1,459,969	$1,511,068	$1,563,956	$1,618,694
10+	$1,352,181	$1,352,181	$1,399,507	$1,448,490	$1,499,187	$1,551,659	$1,605,967	$1,662,176	$1,720,352	$1,780,564

The 2005 CBA expired on July 1st, 2011. The expiring CBA led to the 2011 NBA lockout, because the league needed to put a lockout in place until a new agreement between the NBA owners and the Players' association could be agreed upon. During the lockout, players were not allowed to play basketball for their NBA teams. Due to prolonged negotiations, the league canceled all games until December 25th, 2011 and reduced the 2011-2012 NBA season from 82 games to 66 games per team. The main cause of dispute between the players and the owners stemmed from determining the split of Basketball Related Income (BRI) among players and owners. Under the 2005 agreement, players were guaranteed 57% of BRI with owners only receiving 43% of BRI. Due to increased expenses and slowed revenue growth from the 2008 economic downturn, 22 of 30 team owners collectively lost $370 million during the 2009-2010 season. Owners initially proposed a reform that included a $45 million hard cap and salary rollbacks. Later, the owners proposed to reduce the players' share of BRI to 50%. The Player's association rejected the offer and responded with a counter offer of a 52% share of BRI. After lengthy negotiations, the Player's association and owners agreed upon terms for a new agreement on

December 8th, 2011, and the league ended the lockout. The BRI distribution issue was resolved with the players agreeing to reduce their share of BRI from 57% to 50%[6]. In return for taking a lower share of generated revenue, the league created supplemental benefits consisting of 1% of BRI for players in retirement and kept the soft salary cap structure, instead of imposing a hard salary cap.

One of the most significant changes in the recent CBA was the introduction of a more punitive "Luxury Tax". Under the previous CBA, teams would pay $1 in tax payments for every dollar they exceeded the tax threshold. In the new CBA, the "Luxury Tax" is progressive; with the tax rate increasing for every $5 million the team exceeds the tax line, as shown in Table 4. Also, teams that have paid the luxury tax in previous years must pay an even higher tax rate called the "Repeater Tax". The revenue gained from the tax paying teams gets redistributed to non-tax paying teams. The purpose of stricter tax penalties was to further increase the competitive balance between high and low revenue-generating teams by discouraging excess spending over the salary cap. Economic theory is consistent with the goal of the tax, as the demand of spending over the tax threshold will decrease if the penalty is more costly for firms.

Table 4. Luxury Tax under new CBA

Team Salary above Tax Level		**Non-Repeater**		**Repeater**	
Lower	**Upper**	**Tax Rate**	**Incremental Max**	**Tax Rate**	**Incremental Max**
$0	$4,999,999	$1.50	$ 7.5 Million	$2.50	$ 12.5 Million
$5,000,000	$9,999,999	$1.75	$ 8.75 Million	$2.75	$ 13.75 Million
$10,000,000	$14,999,999	$2.50	$ 12.5 Million	$3.50	$ 17.5 Million
$15,000,000	$19,999,999	$3.25	$ 16.25 Million	$4.25	$ 21.25 Million
$20,000,000	N/A	$3.75, and increasing $.50 for each additional $5 Million	N/A	$4.75, and increasing $.50 for each additional $5 Million	N/A

[6] 50% plus or minus 1% based on whether actual revenues exceeded or fell short of projected revenues.

Another important provision introduced in the 2011 CBA was the Amnesty Provision. The Amnesty Provision is a one-time opportunity for teams to release one player and remove his salary from counting against the team salary and "Luxury Tax" computations. The team must still pay the player the remaining guaranteed money outlined in the contract, but his salary does not count against the team's salary cap. Teams can only "amnesty" players that signed contracts before the 2011 CBA agreement became effective and may only use this provision once until the 2015-2016 season. To this date, twenty-one teams in the league have exercised the Amnesty Provision. Teams benefit from the provision because they can remove an exceedingly large contract from their team and reallocate the funds to other players.

The CBA is a topic of extreme interest among NBA teams and media. The changes instituted under the new CBA have affected the way teams allocate money to players to construct a competitive team. Zach Lowe (2014), Grantland reporter, noted that, "Teams are becoming very risk-averse about taking on [player contracts] above $5 million or so, even if the player in question has real value. The CBA plays a role in that, since the tax penalties are so onerous now." The consequences of the tax penalties also appear to have a negative impact on players' wages. Marc Cornstein, basketball agent, noted that the number of minimum wage players on shorter contracts would increase dramatically under the new CBA. Lowe (2014) also noted that "[shorter contracts] have huge implications for roster construction and competitive balance that the league is only beginning to understand". Understanding the implications of the recent CBA agreement is an extremely relevant and important topic for NBA teams and players. Under the 2011 CBA, competitive balance is expected to increase throughout the league due to the more punitive luxury tax penalties and players' contracts are expected to decrease in both total salary value and number of years.

My paper seeks to examine two issues regarding the recent changes of the CBA on the landscape of the NBA. My paper will evaluate the 2011 CBA's impact on (1) competitive balance between NBA teams, and (2) professional basketball players' salaries. My contribution to the study of sports labor economics is to further expand the discussion of competitive balance to incorporate the recent changes within the NBA and to analyze the residual effects of the policy on workers' wages.

Section II of this paper provides an overview of the previous literature conducted on my topic. Section III explores the topic of competitive balance. Section IV discusses the topic of players' salaries. Subsection A discusses the theoretical framework used in this paper to measure competitive balance and players' salaries. Subsection B presents the data of my research. Subsection C outlines the methodology employed and discusses of the results. Section V summarizes the paper and provides concluding thoughts.

II. Literature Review

Traditional studies in industrial organization seek to understand the behavior of firms within markets. Firms compete with one another to maximize profits. In the situations of oligopolies or monopolies, having significant market power allows firms to maximize their revenues by setting prices above marginal costs. In the situations of perfect competition, firms have equal market share and set prices to marginal costs.

However, professional sport organizations operate differently from traditional industrial organizations. Top teams require competition to maximize their profits. Rottenberg (1954) provided the first analysis of sports markets and noted that if top teams control too much of the market, lower teams would exit the industry. This would result in the top teams suffering. He noted that teams in competitive profit maximizing sports leagues would want to win, but only by a close margin in order to keep fans interested. As Neale (1964) illustrated in his analysis of sports markets, the competition for profit was not among the teams within the sports, but between different sports leagues and other types of consumer entertainment. Consumers of profession sports leagues are the fans, since their purchases of tickets and team related goods compose the main sources of revenues for teams. Neale (1964) stated that a decline in competition would lead to a fall in fan interest in the weaker teams first, followed by the stronger teams, until fan interest in the sport, itself, diminished. El-Hodiri and Quirk (1971) found that outcome predictability reduced game attendance, which demonstrates that fans take greater interest when the outcomes of games are uncertain. Therefore, maintaining a strong level competition between teams within a sport is vital to the league's financial stability.

There is an extensive amount of economic literature on the topic of competitive balance. Competitive balance measures the equality of the playing strengths among teams within a sports league (Owen, Ryan and Weatherston 2005). Fort and Maxcy (2003) distinguished the two types of competitive balance: the analysis of competitive balance (ACB) and uncertainty of outcome hypothesis (UOH). ACB tracks how competitive balance changes over time as a result of regulatory, institutional, and other systematic changes. Common measures employed by ACB focus on the change of teams' winning percentages over time. UOH studies how competitive balance affects fans' interest. Common measures employed by UOH focus on correlations between fan attendance and winning percentage. Both aspects are important to the discussion of competitive balance and each respective methodology should be distinguished from the other. Since the topic of this research paper focuses on the impacts from the 2011 CBA agreement on team performance, I will explore the appropriate methodologies that measure competitive balance for ACB.

A common debate amongst sports labor economists is whether systematic league changes affect competitive balance. Fort and Quirk (1995) argued that an enforceable salary cap can improve competitive balance in a given league[7]. Other economists argued that, based on the principles of the Coase theorem, systematic rule changes do not have an impact on competitive balance. Kahn (2000) studied the application of the Coase theorem in sports labor markets with regard to the introduction of free agency. The Coase theorem dictates that rule changes in free agency have no effect on real resource allocation, which suggests that the introduction of free agency should not affect player allocations among teams. However as Kahn (2000) noted, the Coase theorem was based on the assumptions of perfect information, zero transaction costs, and zero wealth effects (p. 87). The league imposed salary caps as "built-in" transaction costs, which made it difficult for teams with high payrolls to acquire more expensive players. Kahn (2000) compared the standard deviation winning percentage gaps between the top and bottom Major League Baseball teams under the reserve clause beginning with data from 1961 to free agency with data ending in 1983. He concluded that the creation of free agency did not have any impact on competitive balance (p.88). His findings were consistent with the Coase theorem, which demonstrate that rule changes were not associated with changes in competitive balance.

Among the four major American sports, profession basketball features the greatest competitive imbalance. Zimbalist (2002) examined competitive balance within the NBA using the standard deviations of winning percentages under the salary cap with data starting in 1980 until the late 1990s. The results showed that the NBA had the highest ratio of actual to idealized standard deviation among the four major sports leagues (Hockey, Football, Basketball, Baseball) and that the standard deviation of winning percentages increased over that time period. This proved Coase theorem to be invalid (p. 117). Zimbalist's methodology also included a regression between team revenue and winning percentage. The

[7] In their analysis of the NBA competitive balance, the theory actually failed and the disparity in winning percentages actually increased following the introduction of the cap. Their explanation for this result was that contracts had been grandfathered from under the old provision into the new one. Another factor is that the analysis included seasons unprecedentedly dominated by the Lakers, Celtics, and Bulls. Fort and Quick still come to a conclusion that enforceable salary caps were the only cross-subsidization method currently employed that helped financial viability while increasing competitive balance, and proved this result with more robust data in Major League Baseball.

results implied a positive relationship between payroll and performance; with higher-revenue teams generating higher win percentages (p.117). Zimbalist (2002) concluded that the NBA was on the high end of most statistical measures of imbalance compared to other professional sports (p.116).

Competitive balance has been measured in various ways within the existing economic literature. The most popular methodology measures the dispersion of teams' winning percentages over a period of time. This metric is a ratio actual standard deviation of winning percentages over the standard deviation of winning percentages in the "idealized" case. The "idealized" standard deviation is the standard deviation of winning percentages in a perfectly competitive league in which all teams have an equal chance of winning each game (Owen 2015). The formula for calculating "idealized" standard deviation is $ISD = 0.5/G^{0.5}$, where G is the number of games played in a season. A perfectly competitive league assumes a binomially distributed random variable with a success of 50% across independent trials (Owen 2015). A perfectly competitive balance league would have a ratio of one (actual standard deviation of winning percentages over the "idealized" standard deviation), meaning the actual case was equal to the "idealized" case. Fort and Quirk (1995), Kahn (2000), and Zimbalist (2002) used this methodology to measure competitive balance in professional sports leagues in their respective studies. This methodology is useful because it controls for season length and the number of teams. It also allows for a comparison over time and robustness to systematic league changes (Owen 2005).

Another popular methodology is the Concentration Ratio Index (CR). The CR index measures a team's market share of the league. Team market share is the number of wins by a given team over the total wins by all teams over the course of a season. Manasis, Avgerinou, Ntzoufras, and Reade (2011) explain that the CR index essentially measures the degree of domination by the top teams in a sports league. Manasis et al. (2011) provide a Normalized Concentration Ratio (NCR) that allows for comparison of competitive balance across different leagues within a sport. The CR index is useful for investigating competitive balance in leagues that are repeatedly dominated by a set of teams, such as professional soccer in Europe, but not for measuring competitive balance for all teams in a league.

Lee (2009)'s methodology differs from the other methodologies previously cited by introducing a regression equation that employs a lagged variable in his study of the NFL's 1993 CBA effects on competitive balance among the league's football teams. The 1993 CBA instituted a salary cap for the first time in NFL history. Lee (2009) developed a regression model measuring winning percentage within a given year against the winning percentage from the previous year. Lee (2009) stated the regression model focused exclusively on interseaonal balance and allowed for standard assessments (p. 82). The results of Lee's (2009) studies showed that the CBA's provisions on team's payroll had a positive impact on competitive balance within the NFL (p.86). My research objective is similar to the goal that Lee (2009) has achieved in analyzing the impact of the NFL's CBA on competitive balance. Due to the lack of observations of post-CBA seasons, my methodology adopts and modifies Lee's (2009) methodology, instead of using the popular method of measuring actual standard deviation of winning percentages to the "idealized" standard deviation of winning percentages. With Lee's (2009) regression, my methodology would have a sufficient number of observations. A further discussion on Lee's methodology is outlined in section III.

In addition to competitive balance, there have been many studies on labor economics that focus on the relationship between firms and workers, specifically wage determination. Economic theory dictates that firms should compensate workers based on their marginal revenue products (MRPs) or how much revenue the worker generates for the firm. Within profession sports, teams pay players based on many factors such as player performance, contribution to team wins, and the players' share of revenue generation.

There has been a considerable amount of economic literature exploring player compensation. Arcidiacono, Kinsler, and Price (2013) studied the impact of a player's impact on the team's success with compensation. The model studied basketball players' individual performance and their ability to improve the production of their teammates, called the spillover effect. The model measured players on overall effectiveness based on offensive production, spillover production, and defensive production. Arcidiacono et al. (2013) ranked players based on the per possession point differential a player would generate if he played for an average team and they played against an average opponent. The players' effective ranking was then compared to the Player Efficiency Rating (PER) and Adjusted Plus-Minus (APM) rankings. Arcidiacono et al. (2013) then analyzed the correlation between player compensation and performance. The results suggested that player compensation was more weighted towards offensive and defensive contributions, while no monetary gain existed for being a better spillover player. The results also showed that PER explained the greatest amount of variation in total earnings.

Hill and Groothius (2001) provided a detailed study that evaluated the NBA's salary distribution under the 1999 CBA. The most significant introduction in the 1999 CBA was the addition of the maximum salary, capping the amount teams could pay a single player. Hill and Groothius (2001) evaluated actual salary distributions amongst players before and after the CBA agreement. The results showed that salary dispersion among players improved after the CBA (p. 142). The results also showed that all players with salaries below the median wage gained the most from the agreement. Hill and Groothius (2001) attributed this change to the median voter model, with rent redistribution transferring from the rich (Superstars) to the poor (median voters) (p. 131). Hill and Groothius (2001) expanded their analysis by generating a Lorenz Curve measuring players' salaries in seasons before and after the 1999 CBA and calculating the Gini Coefficients. The analysis showed that wage dispersion rose in the seasons prior to the CBA reform, but fell in the following seasons, showing the CBA was effective in improving income equality amongst players.

Boothe (2013) used a Log-Linear model to analyze the factors that had the greatest impact on determining NBA players' salaries. Boothe (2013) identified attributes about an individual player that may have influenced their wage determination and regressed players' salaries on these variables. The explanatory variables included players' experience in the league, draft position, PER, team wins, player position, type of contract, number of all-star appearances, and player injuries. Boothe's (2013) results showed that PER had a greater impact on player salaries than team wins and the player's position also played a major determinant in salary, with centers earning the highest salary.

Li (2011) calculated a players' worth based on their Marginal Revenue Products. Li (2011) first determined the total team revenue generated over a course of the season. Li (2011) used an Estimated Win Model to determine how many regular and playoffs wins a player attributed to his team and applied this data to calculate individual's MRP. The estimation model predicted that for the 2008-2009 NBA season, Kobe Bryant's MRP was $23.5 million, while his actual salary was $21.26 million. This showed that Kobe Bryant was paid approximately close to his value to the team. In the same season, the estimation model predicted that Pau Gasol's MRP was $33.74 million, while his actual salary was $15.10 million, showing that Pau Gasol was underpaid according to the estimates. My methodology for analyzing players' salaries will adopt a similar Log-Level regression utilized by Boothe (2013). A further discussion about the Log-Level regression is described in section IV.

III. Competitive Balance

A. Theoretical Framework

The first part of this paper attempts to determine whether competitive balance increased in the seasons following the 2011 CBA. The theoretical framework used to test competitive balance is a variation of the lagged winning percentage model developed by Lee (2009) in his study of the NFL's CBA. The model that Lee used is as follows:

$$Win\ Percentage_{it} = a_{pre-1994}1_{pre-1994}Win\ Percentage_{it-1} + a_{post-1994}1_{post-1994}Win\ Percentage_{it-1}$$
$$+ b_{pre-1994}1_{pre-1994} + b_{post-1994}1_{post-1994} + \gamma X_{it} + U_{it}$$
$$U_{it} = pU_{it-1} + e_{it}$$

where *i and t* index the team and year and X is a set of controls. The theory behind the model is that competitive balance essentially measures turnover in team rankings between years. Over time, the best teams become less competitive while the worst teams improve; with a large number of seasons, every team is expected to finish first and last at least once (Lee 2009). This theory predicts that competitive balance is said to have increased if the impact of last year's winning percentage on the current year's performance is less. The baseline of perfect competitive balance would assume that the previous year's winning percentage did not have any impact on the current year's winning percentage, and therefore the coefficient of the lagged winning percentage would take on a value of 0 in a perfectly competitive league. Realistically, a league cannot achieve perfect competitiveness, but leagues can improve competitive disparity by instilling rules that equally distribute talent amongst all teams.

This model differs from the more popular measure of analyzing the dispersions of winning percentages because the regression exclusively measures interseasonal balance and allows for significance testing. In addition, the dispersion model is calculated on a yearly basis, so the unit of measurement is each season. Due to the CBA only being in effect since 2011, my post-CBA data would be limited to three observations, which would not be enough to draw a meaningful conclusion. Using a variation of the lagged winning percentage model would provide an ample amount of post-CBA data and avoid the problem presented with the alternative method. Since the model measures each team's winning percentage in a given year and there are thirty teams in the NBA with three seasons of data, I would have ninety post-CBA observations. For my methodology, I adopted Lee's (2009) regression, but slightly changed the regression to include a significance test.

My methodology considered including a *Team* set of controls, which would have consisted of factors that affect a team's on-court performance such as head coaching, player injuries, and mid-season trades or major free agent additions. However, my methodology does not include this set of controls due to difficulties quantifying these variables. It is hard to measure a coach's direct contribution to team performance or estimate how many games a team would have won had a player not been injured. Another reason why my methodology excludes this set of controls is that player movement and coaching impact are aspects of the NBA that may have been influenced by the new CBA and this analysis is trying to capture these changes in the results.

B. Data

The data needed for the study of competitive balance is the number of regular season wins and losses for all NBA teams from the 1999 to 2014 seasons. To calculate winning percentage for a season, the calculation would involve taking the number of wins divided by the total number of games played, or the sum of wins and losses. The 1999-2000 season is the first year in my data set because it represents the first full season following the 1999 CBA. The 1999 CBA established many modern day league policies such as maximum salaries, luxury tax, and mid-level exceptions. Data starting from 1999-2000, therefore, seem to be appropriate for comparing competitive balance in periods before and after the 2011 CBA.

The data set includes fifteen total seasons; twelve of which are pre-2011 CBA and three are post-2011 CBA. The 1999-2000 season through 2003-2004 season (5 years) had 29 teams in the league and the league grew to 30 teams in the subsequent years. There are a total of 445 observations of winning percentages; 355 observations for the period before the 2011 CBA and 90 observations for the period after the 2011 CBA. There were a total of 414 observations for lagged winning percentages. The data were calculated by omitting the first season for all thirty teams and the 2004-2005 season for the Charlotte Bobcats/Hornets (the first year the team came back into the league after a three year hiatus) because those years did not have any lagged observations. The winning percentage data were collected from the league's official website, www.nba.com. Figure 1 shows the correlations of a current year's winning percentage on the previous year's winning percentage. The correlations appear to spike after the 2011 CBA agreement and then gradually decrease in the subsequent seasons. The data needed for the controls *Organization* were collected from www.nba.com and the Metropolitan Statistical Area (MSA) data were collected from the www.census.gov/population/metro/.

Figure 1: Correlation of NBA Team Winning Percentage with Previous Year Winning Percentage

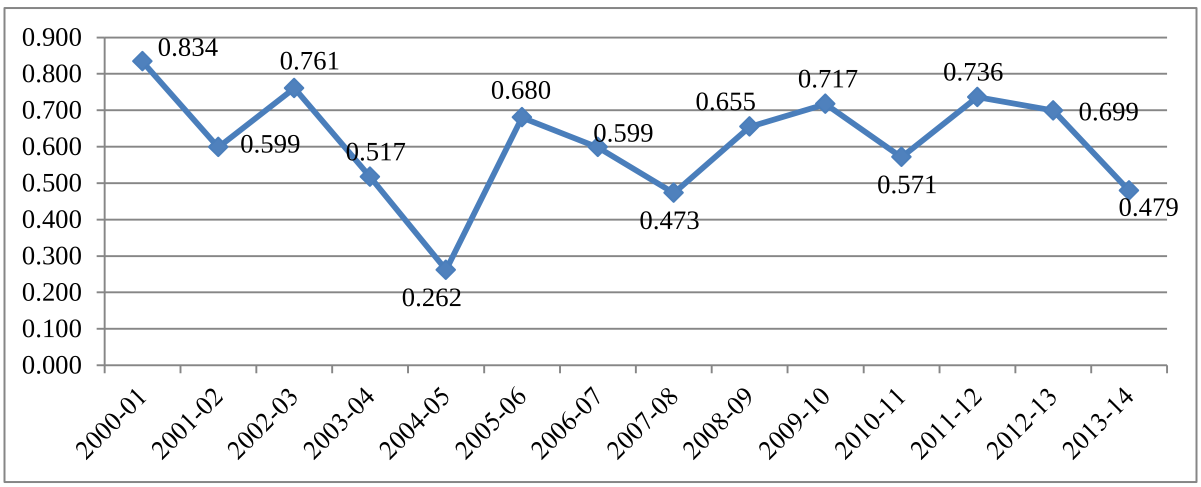

Table 5 outlines a general summary of the basic statistics for the winning percentages during the time period. The average winning percentage was 50.00% with a standard deviation of 15.09%. The highest winning percentage by a team during this time period was the Los Angeles Lakers during the 1999-2000 season winning 81.71% of their games and the lowest winning percentage was the Charlotte Bobcats during the 2011-2012 season winning 10.61% of their games.

Table 5: Descriptive Statistics for Competitive Balance

Variable	Observations	Mean	SD	Min	Max
Winning Percentage[8]	445	0.5	0.1509	0.1061	0.8171
Revenue (in $millions)	445	116.56	36.93	56	295
Years in Existence[9]	445	39.15	17.95	1	75
Years in Current Location[10]	445	32.29	15.18	1	68
Population	445	5032371	4555428	929195	19949502
Median Household income (in $)	445	40394.86	7789.34	25071	69127

A possible limitation to my data set is the missing data for the *Revenue* and *Per Capita Income* control variables. For *Revenue*, Forbes only published NBA revenues from the 2001-2002 season to the 2013-2014 season. This required calculating an exponential model for each individual NBA team based on the available data and then extrapolating the missing revenue values for the 1999-2000 and the 2000-2001 seasons[11]. For *Per Capita Income*, the Canadian census only published data for the city of Toronto from 2000 to 2007. Therefore, I had to use a similar exponential model to calculate the Per Capita Income for Toronto during the 1999-2000 and the seven seasons from 2007-2008 to 2013-2014 seasons. Since the values were in terms of CAD, the end of the year exchange rate from CAD into USD was used to convert the Per Capita Income to USD.

[8] The number of regular season games that each NBA team plays in a season is 82 games. During the 2011-2012 season, the number of regular season games was cut from 82 games to 66 games due to the NBA lockout.
[9] During the time period, the league added two expansion franchises. The Charlotte Bobcats' (now called the Charlotte Hornets) first year of existence was during the 2004-2005 season. The New Orleans Hornets' (now called the New Orleans Pelicans) first year of existence was in the 2002-2003 season.
[10] During the time period, five teams have changed locations (including the two Expansion franchise). The New Jersey Nets (now called Brooklyn Nets) relocated from New Jersey to Brooklyn at the start of the 2012-2013 season. The Seattle Supersonics (now called the Oklahoma City Thunder) relocated from Seattle to Oklahoma City at the start of the 2008-2009 season. The Vancouver Grizzlies (now called the Memphis Grizzlies) relocated from Vancouver to Memphis at the start of the 2001-2002 season.
[11] Each individual team's exponential model and the R^2 values are available in the Appendix.

C. Empirical Specification

The first part of my research measures team performance and examines whether competitive balance increased after the 2011 CBA agreement. The methodology I employed is a regression measuring teams' winning percentage in a given year on "lagged" winning percentage from the previous year and a set of controls. The regression is as follows:

$$WinPct_{it} = a + B_1 Win\ Pct_{it-1} + \ \gamma_1 D_1 WinPct_{it-1} + \lambda_1 Organization + \ e_{it}$$

where *i* and *t* index the team and the year. $WinPct_{it-1}$ is the lagged winning percentage of the previous year. D_1 is a dummy variable that takes on the value of 1 if *t* >2010 and a value of 0 if *t* ≤ 2010. $D_1 WinPct_{it-1}$ is the interaction term between the dummy variable and lagged winning percentage. *Organization* is a set of controls for factors that affect the organization including the number of years the organization has been in existence, years since its last relocation, team revenue, the population in the organization's city, and the per capita income in the organization's city.

The purpose of interacting the dummy variable and lagged winning percentage is to isolate the effects of the previous year's winning percentage on the current year's winning percentage for the period after the CBA compared to the period before the CBA was implemented. Based on Lee's (2009) theory, competitive balance is said to have increased if the previous season's winning percentage has a smaller impact on the current year's winning percentage. If the coefficient of the interaction term is negative, this means that the lagged winning percentage had a smaller impact on the current year's winning percentage for the period after the CBA implementation (2011 to 2014) than the period before the CBA implementation (1999 to 2010), implying competitive balance improved.

This methodology adds to the existing literature on competitive balance in various ways. First, my regression differs from Lee's (2009) model by using one dummy variable and an interaction term to test whether the CBA's impact was statistically significant. Second, Lee (2009) noted difficulties in obtaining data that would quantify the fan base of a team. He mentioned Team Revenues, Television Ratings, and Stadium Attendance as possible variables, but the difficulty of acquiring this private information for NFL teams prevented Lee (2009) from including them in his methodology. In my study, revenues for each NBA team were published by Forbes for the thirteen seasons from 2001-2002 to 2013-2014. My methodology included *Revenue* as an explanatory variable. Third, my methodology used a Fixed-Effects model to account for unobservable factors that may affect the winning percentage for each individual team in each season. Finally, my methodology adds to the existing literature by offering an additional way of measuring competitive balance in the NBA.

The nature of regressing current winning percentage with a lagged winning percentage may give arise to problems with autocorrelation. The Prais-Winston regression determines if autocorrelation is present and will correct for it. In my data set, the Prais-Winston regression yielded an autocorrelation parameter, or ρ, of 0.0588, indicating a small positive autocorrelation. The small positive autocorrelation is interpreted as the following: if random factors caused a high winning percentage, then the same random factors would affect winning percentage in future years. For example, if a team lost a high-performing player in the middle of a season due to injury and the team's winning percentage decreased in that given year, then that team could expect their winning percentage in future years to continue to decrease due to the loss of that player. An example is Derrick Rose, the Chicago Bulls' star player. He had a serious knee injury at the end of the 2011-2012 season that led him to miss the entire 2012-2013 season and most of the 2013-2014 season. The Chicago Bulls' winning percentage went from 75.76% in 2011-2012 to 54.88% in 2012-2013, and 58.52% in 2013-2014 seasons.

In addition to the OLS and Prais-Winston regressions, my methodology used a Fixed Effects model that regressed the lagged winning percentage for the paneled data by each team and season. Since the data set is paneled data, the purpose of the Fixed-Effects model was to control for any unobserved heterogeneity in the error terms that might have not been accounted for in the control variables. The Fixed Effects model yielded an F-test that all $u_i = 0$ of 1.34 and a p-value of .1174. While it is not significant at a 10% level, the p-value of .1174 still captures a lot of unobserved heterogeneity in the error terms. These results are still important and are worth using in analyzing the data because the Fixed Effects model has less overall random unknown errors than the OLS and Prais-Winston regressions.

The original OLS regression yielded a Durbin-Watson statistic of 1.810, and the Prais-Winston regression yielded a Durbin-Watson statistic of 1.857. A Durbin-Watson statistic ranges from 0 to 4, with a value of 0 meaning positive autocorrelation, a value of 2 meaning no autocorrelation, and a value of 4 meaning negative autocorrelation. The Durbin-Watson statistic for both the OLS and the Prais-Winston regression are very close in value, meaning that autocorrelation does not appear to be a major problem and the results are robust. Since the Durbin-Watson statistic is closer to 2 in the Prais Winston regression, the Prais-Winston results are used as the preferable regression analysis in studying competitive balance. However, the OLS, Prais-Winston, and Fixed-Effects regressions are all valid results to use and are added to the discussion of competitive balance.

Table 6 shows the results from the OLS, Prais-Winston, and Fixed-Effects regression. In the OLS, Prais-Winston, and Fixed-Effects regression, the constants, lagged winning percentage, and *Revenue* are significant at 1% level. The significance of *Revenue* makes economic sense, as teams with higher revenue tend to win more games than teams with lower revenue. These results are consistent with Zimbalist's (2002) result where revenue had a positive effect on winning percentage. *Per Capita Income* was significant at a 5% level in the Prais-Winston regression and at a 10% level in the OLS and Fixed-Effects regressions. City population was significant at a 10% level in the Prais-Winston regression. The other controls were not significant at the 10% level. While the controls varied in terms of significance

Table 6: Results from OLS, Prais-Winston, Fixed-Effects Regressions

	OLS	Prais-Winston AR	Fixed Effects
Coefficient			
Constant	0.222239***	0.242584***	0.4030496***
	(0.043259)	(0.0451344)	(0.1502129)
Win Pct_{it-1}	0.5455433***	0.5070799***	0.4327402***
	(0.0422656)	(0.0434504)	(0.0473835)
D_1Win Pct_{it-1}	-0.025862	-0.0260828	-0.0184876
	(0.0309641)	(0.0319895)	(0.0361887)
Revenue	0.0008844***	0.0009612***	0.0019417***
	(0.0002163)	(0.0002248)	(0.0004243)
Years in Existence	0.0003399	0.0003386	-0.0030578
	(0.0005509)	(0.0005808)	(0.0034102)
Years in Current Location	-0.0006875	-0.0006794	-0.0009542
	(0.0006675)	(0.0007013)	(0.0018488)
Population	-2.36E-09	-2.62E-09*	-4.04E-09
	(1.50E-09)	(1.58E-09)	(3.03E-08)
Per Capita Income	-1.85E-06*	-2.07E-06**	-4.25E-06*
	(9.68E-07)	(1.02E-06)	(2.38E-06)
Durbin-Watson Statistic	1.809751	1.856987	-
Autocorrelation parameter	-	0.0587482	-
Observations	414	414	414
Adjusted R^2	0.3996	0.3628	0.2773

Note: Standard Errors given in parenthesis

***p<.01 **p<.05 *p<.10

and coefficient signs, the magnitudes of all the controls were extremely low, suggesting the impact of these controls were nearly negligible in impacting the current year's winning percentage.

Based on the *Revenue* coefficient in the Prais-Winston regression, for each addition $1 million in team revenue, the team's current season's winning percentage is expected to increase by 0.000961. The lagged winning percentage coefficient in the Prais-Winston regression implies that for each additional increase of 1% of winning percentage in the previous year, a team can expect next year's winning percentage to increase by .507 of a percentage point.

The negative coefficients of *Population* and *Per Capita Income* in all three regressions were somewhat unexpected. My initial assumption was that a team's city population and wealth would have a positive effect on winning percentage. A possible explanation for the negative coefficient could be the effect of a very large city having consistently poor NBA teams. For example, the New York Knicks have been perennially a team with a losing record during the time period examined, despite having the highest population and per capita income of any city. This could skew the results to the point where population and per capita income show a negative effect on competitive balance. However, the magnitude of these coefficients are so low (-0.00000207 of a percentage point) that they are not economically significant despite being statistically significant.

The results were consistent across the OLS, Prais-Winston, and Fixed-Effects regressions. The magnitudes and signs of the coefficients were very similar to the coefficients in all three regressions. One difference in the coefficients was the sign of the *Years in Existence*, where the sign was negative in the Fixed-Effects model compared to the positive sign in the other two regressions. A negative coefficient would imply that for each additional year of existence, the current year's winning percentage is expected to decrease. Given the p-value of .370 and the low magnitude of the coefficient in the Fixed-Effects regression, this difference in sign is not statistically or economically significant for winning percentage.

The results showed a negative coefficient for the interaction variable in the OLS, Prais-Winston, and Fixed-Effects regressions. The p-value was .415 in the Prais-Winston regression and the coefficient was not statistically significant at the 10% level. In addition, the magnitude of the coefficient of the interaction term was extremely small; meaning that the CBA's effect on competitive balance is nearly negligible. The small magnitudes on the interaction term and the statistically insignificance were also consistent in the OLS and Fixed-Effects regressions. The negative coefficient indicates that the previous season's winning percentage had a weaker impact on the current year's winning percentage in the periods after the 2011 CBA, implying competitive balance has increased after the CBA. While there is evidence that the CBA may have contributed to an increase in competitive balance in the NBA, the results indicate that the CBA's impact on competitive balance was not statistically or economically significant.

The magnitudes of my coefficients were relatively similar to the results found in Lee's (2009) analysis of the NFL. The signs of our control variables, however, were the opposite in the areas of *Years in Current Location, Years in Existence,* and *Per Capita / Median Household Income*. Despite the differences, *Years in Existence,* and *Per Capita / Median Household Income, and Population* were not statistically or economically significant in his results. A possible explanation for this could be the different nature of the NFL compared to the NBA, where these factors may differ based on the sport and league history. Lee's (2009) interaction variable coefficients were statistically significant, while my results were not. A possible explanation for this could be the different changes implemented in the NFL's CBA compared to the NBA's, which may have had different levels of success or intended consequences for the league. Another explanation could be that Lee (2009) had 14 seasons of observations after the implementation of the 1993 NFL's CBA, while I only had 3 seasons of observations after the implementation of the 2011 NBA's CBA. The more seasons of observations may have allowed the changes from the 1993 CBA to fully come into effect, which might have increased competitive balance in the NFL, whereas the NBA's CBA may take more than 3 years to affect competitive balance. The 2011 CBA's impact on player allocation through free agency may not have had enough time to have its full impact on the NBA.

One possible explanation for these results could be that the implementation of the CBA was too recent for the intended effects on competitive balance to take place. The core players for most teams played in the subsequent seasons after the CBA were formed before the CBA went into effect. Another explanation is simply that the CBA did not impact competitive balance and that the many changes introduced failed to provide the improvement they were intended to create.

The results from the OLS, Prais-Winston, and Fixed-Effects regressions were consistent in showing that competitive balance did not improve in the NBA following the 2011 CBA. Despite having a negative coefficient on the interaction term, which would otherwise indicate an increase in competitive balance, the results were neither statistically or economically significant across all three regressions. Therefore, the results show that the 2011 CBA was not successful in improving competitive balance as of the 2014 season.

IV. Player Salaries

A. Theoretical Framework

The second part of this paper attempts to determine how player salaries changed under the new CBA. While the CBA directly decreased overall player income by reducing the players' share of BRI from 57% to 50%, there has been no current studies analyzing *which players* were affected the most by the change. One possible scenario is that all player salaries decreased evenly with the decline of BRI share. Another possible scenario is that a certain subset of players was affected more by the changes. For example, the league's superstars, or highest-performing players, may have had their salaries decrease proportionally more than average-performing players.

Understanding salary changes and distributions are not only important for players, but vital for teams as well. From a broad economic prospective, Akerlof and Yellen (1998) argued that wage equality enhances worker cooperation and improves firm performance. Borghesi (2008) applied this concept to team performance in the NFL. Borghesi (2008) found that teams with more equality in player wages tended to outperform teams with less equality. Hill and Groothius' (2001) showed that superstar salaries were most negatively impacted from the 1999 CBA, while the middle-lower class benefitted the most. Based on the distribution of players' salaries, they concluded that the 1999 CBA was effective in improving salary equality among the league.

The present theory for measuring salary equality is to perform a similar analysis as Hill and Groothius (2001) by comparing player salaries to periods before and after the 2011 CBA, followed by an analysis of salary disparity. The theory of player salary equality is inherently linked to the theory of competitive balance. If wage equality improves across the league, teams are expected to perform better, which would signal an increase in competitive balance. Since competitive balance has not improved after the 2011 CBA, salary equality among players is expected to decrease in the NBA after the 2011 CBA.

B. Data

The data needed to measure player salary changes consist of all contracts signed during the free agency periods from 2000 to 2014. The 2000 free agency period is an appropriate starting data point because it was the first full free agent period under the 1999 CBA. The 1999 CBA introduced many significant additions that have affected modern free agency, such as maximum salaries, luxury tax, and the mid-level exception. The league does not officially disclose contracts signed by players during free agency, but various websites compile information from media sources to list free agent contracts. This leads to a possible weakness with the data set; the salaries outlined in the contract may not be completely accurate due to the sparse nature of accumulating the contract data. The method I used to address this limitation and collect more accurate data was to identify the players who were free agents during a year and compare each player's salary cap hit for the team he signed with, which was available through separate online websites. This methodology produced the salary data for the first year of the player's contract.

The data needed from these contracts was the log of each player's next year salary and the year the contract was signed. The reason for looking at the player's next year's salary, as opposed the average salary over the life of the contract or the total salary amount, is that only the immediate year's salary counts toward a team's salary cap. Using a player's next year salary also controls for any complications that may arise due to "options" in contracts[12]. Furthermore, the source used to collect free agent contracts did not specify the length of contracts; therefore, the data were not available. The reason for using the log of a player's salary is to normalize the distribution of players' salaries.

My methodology also considered including the previous year's salary as an control variable for the next year's salary. However, most players that signed free agent contracts had expiring Rookie contracts where the salaries were fixed. If I included previous salary as a control variable, I would have had to eliminate contracts signed by players following their Rookie deals. In addition, the salary a player made in the past does not necessary dictate what a player may earn in the future. After considering these reasons, my methodology decided to exclude past salary as a control variable.

The primary explanatory variable used in the analysis is each player's Player Efficiency Rating, or PER[13]. PER is a widely-used advanced statistic that measures players' per-minute productivity. PER summarizes individual player's positive (field goals, free throws, 3-pointers, blocks, steals, assists, and

[12] An option is when the team or the player has the right, should they decide, to extend the year of the contract. The dollar amount for this year and the right of the option is agreed upon when the player first signs the contract.

[13] Player Efficiency Rating is an advanced statistic developed by John Hollinger that measures an individual's per-minute performance, while adjusting for pace. The league average PER is always 15.00. The formula for calculating PER can be found in the Appendix.

rebounds) and negative statistics (missed shots, turnovers, personal fouls) into one, encompassing statistic. The statistic weights each player's production by minutes played and the number of team possessions per game. One criticism about PER is that it primarily measures offensive performance and does not accurately represent a player's defensive contribution.

Three other widely used advanced metrics are Win-Share, Adjusted Plus-Minus, and Wins Above Replacement Average. Win-Share (WS) quantifies how many wins a player contributes to his team based on his weighted offensive and defensive statistics. For example, LeBron James had a WS of 19.3 during the 2012-2013 season, which implied that LeBron James was responsible for 19.3 victories for his team. Adjusted Plus-Minus (APM) measures the team's average point differential for each possession when a player is on the court. This statistic is adjusted by calculating a player's plus-minus when he is playing against five average opponents and playing with four average teammates. This statistic shows how effective a player's team is when he is playing. Wins Above Replacement Average (WARP) evaluates an individual player's performance in the context of a team made up four completely average teammates, and compares their performance to a team consisting of four average players and one replacement-level player[14]. WARP measures a player's performance in terms of their production compared to a replacement player.

The issue of determining whether a team-focused statistic, like Win-Share, as a more appropriate metric to use than PER to measure player performance was considered. However as Arcidiacono et al. (2013) and Boothe (2013) found in their respective studies, *PER* explains the greatest variation in determining players' salaries over other statistics, which indicates that a player's individual performance (PER) is valued more than his team contribution (Win-Share) in salary negotiation. Therefore, my

[14] A replacement player is the following: "the expected level of performance a major-league team can receive from one or more of the best available players who substitute for a suddenly unavailable starting player at the same position and who can be (or were) obtained with minimal expenditure of team resources." In the NBA, a replacement player is typically defined as a low-level rotational player.

methodology used PER instead of other performance metrics as the variable to describe a player's performance.

The data for identifying which players signed new contracts were collected from www.foxsports.com/nba/transactions/, which listed every transaction that occurred in the NBA for the seasons of interest. The data for these player salaries were collected from www.eskimo.com/~pbender/, which breaks down every teams' total salaries by player for the seasons of interest. The data needed for the explanatory variable, PER, were collected from www.basketball-reference.com. The data needed for the set of controls, *Other,* were also collected from www.basketball-reference.com.

There were 2306 new contracts signed in the between 2000 free agency and the 2014 free agency, with 681 new contracts signed after the 2011 CBA. Of these 2306 contracts, my data set uses 1590 contracts in my regression analysis. These contracts include players whose contracts expired and either signed a new contract with their existing team or a different team. Players that agreed to contract extensions with their existing team prior to the final year of their contract were excluded from the data. The contract extensions did not change the amount of money that player would earn in the immediate season but only changed their salaries in the subsequent seasons. The contracts considered for this study include contracts that were signed by players who played in the NBA in the previous season. These requirements exclude several types of contracts signed during this period: rookies signing their first NBA contracts, foreign players signing their first NBA contracts, injured players that missed the entire season before they signed a contract, players that came out of retirement to sign a contract, and players with previous NBA experience that spent a year playing in a foreign basketball league before signing a new NBA contract. My analysis aims to measure players that *continuously* played in the league and the CBA's effect on their salary. These subgroups of players took a hiatus in their NBA careers, making it difficult to analyze their previous season's impact on salary. Therefore, these players were excluded in my analysis, and this explained why the number of contracts used in the regression was lower than the total number of contracts signed.

Table 7 breaks down the 1824 contracts that had position data for players. Point Guards signed the most contracts during the time period with 398 contracts signed (21.82%) and Shooting Guards signed the least amount of contracts with 331 contracts signed (18.15%). One possible explanation for the high number of Point Guards is that Point Guards are typically the smallest players on the team. Therefore, the height requirement to play this position is lower than the other four positions, which could lead to a higher supply of people who can play Point Guard, possibly explaining why it was the most signed position. Another possible explanation for this result and a potential limitation to my data set is the fact that many players play more than one position in their career. For example, players who play the Shooting Guard position often have similar skillsets that allow them to also play Point Guard or Small Forward, and therefore, they may have been categorized under different positions. Also, players switch between positions during their career. For example, Allen Iverson was strictly a Point Guard early in his career, but transitioned to play Shooting Guard at the end of his career. In addition, the game has evolved over the course of the past ten years. In recent years, teams placed a lesser emphasis on having "traditional" Centers and Power Forwards and placed a greater emphasis on 3-point shooting and guard play. Many teams often implement a "small-ball" lineup with a traditional Small Forward playing the Power Forward spot in order to increase the team's ability to make 3-point shots. In dealing with this issue of playing multiple positions, my data set restricted labeling players under the position they played the majority of their games. The provided data made it too difficult to create a multiple position category; however, it would be interesting in future studies to see how players with the versatility to play multiple positions affect salaries.

Table 7: Player Position Statistics

Position	Observations	Percentage
Point Guard	398	21.82
Shooting Guard	331	18.15
Small Forward	338	18.53
Power Forward	394	21.6
Center	363	19.9

One limitation to my data set was the matching process. The data collection process involved matching data from three different sources. The matching process may have led to possible translation problems, which created missing values. The data set only yielded salary figures for 1,761 contracts and PER figures for 1,823 contracts. The combination and overlap between the missing figures led to a complete data set of 1590 observations. The characteristics of the missing PER data consisted of players that did not play in the NBA in the previous season before they signed their contracts. This mostly included fringe-NBA players that played in foreign leagues. A small number of the missing PER data were players that retired for a season but came back to play in the league. Another group of the missing PER data was players that were cut multiple times during the NBA season.

The characteristics of the missing salary data consisted of players that did not finish the season on a NBA team but signed a contract at the beginning of the season. These players were also fringe NBA players with low PERs and did not play many minutes. These players often sign temporary, non-guaranteed contracts (such as a 10-day contract), making them susceptible to being released by their NBA teams.

Table 8 outlines a general summary of basic statistics for the players signing contracts during the time period. The mean year of contracts signed was in 2007, in a range from 1999-2014. The mean salary signed was $2,675,159, with a minimum of $301,875 signed by 13 different players in 1999 (the minimum salary for the 1999-2000 season) and a maximum of $22,458,000 signed by Carmelo Anthony in 2014. The mean LogSalary was 14.31 with a minimum LogSalary of 12.62 signed by 11 different players in 1999 and a maximum LogSalary of 16.93 signed by Carmelo Anthony in 2014.

Table 8: Descriptive Statistics for Salary Data

Variable	Observations	Mean	SD	Min	Max
Year	2306	2007.08	4.64	1999	2014
Salary ($)	1761	2675159	3059050	301875	22458000
LogSalary	1761	14.31	0.96	12.62	16.93
Experience (Year)	2253	6.18	3.96	1	20
Age (Year)	1824	27.59	4.09	19	41
Height (inches)	2255	78.87	3.68	63	91
Weight (pounds)	2255	218.7	27.46	135	330
Player Efficiency Rating	1823	11.82	6.22	-90.6	88.3

A consideration to my data is that a player may choose to accept a lower salary, despite having a performance level that would imply a higher salary. The reasons that a player may choose to accept a lower nominal wage may be that he is willing to give up a higher salary to play for a team that perennially contends for a championship, or he has a personal history with that team which could lead to the player taking a lower salary to stay with a team (sometimes referred to as a “Hometown Discount”). A player may also collude with other players and agree to take lesser salaries to play together. This occurred during the free agency period of 2010 when LeBron James, Dwyane Wade, and Chris Bosh rejected higher salary offers and accepted less money to play together on the Miami Heat. Similar situations may affect the results of the regression by underestimating player’s salary based on their performance. However, accepting a lower salary may end up being a result of the new NBA landscape created by the restrictions on the salary cap by the 2011 CBA.

Another consideration about the data is the use of *PER* for measuring players' performance. The problem with using *PER* is that it could lead to a significant number of outliers. An example of this scenario is that a below-average player may only play 5 minutes of "garbage time"[15] during the season, and yet, he may have statistics that would yield him a high *PER*, when in fact his *PER* did not properly represent his actual season contribution. To account for the outliers, the regression uses robust standard errors to correct for heteroscedasticity.

C. Empirical Specification

The second part of my research measures how players' salaries changed after the 2011 CBA based on performance. The area being studied are new contracts signed by players during the free agency period in the years before and after the CBA agreement to isolate the effect of the CBA on salaries. The methodology I employed is a Log-Level regression equation measuring the log of players' salaries on player's Player Efficiency Rating (PER) with a dummy variable to isolate the effects of the CBA. The regression equation is as follows:

$$LogSalary_{it} = a_1 + a_2 D_1 \ + \ B_1 PER_{it-1} + \ B_2 D_1 PER_{it-1} + \lambda_1 Other_i + \ e_{it}$$

where *i* and *t* represent player and year of the contract. $LogSalary_{it}$ is the log transformation of the next year's salary for each signed contract. The distribution of the salaries is highly skewed to the right; using a log transformation instead of the nominal salary figure normalizes the distribution of player salaries[16].

[15] At the end of games where the score is so one-sided that one team is significantly ahead of the other with a very low probability of the other team coming back to win, both teams will typically take out their better players and play the reserve players.
[16] Histograms of distributions found in Appendix.

D_1 is a dummy variable that takes on the value of 1 if $t > 2010$ and 0 if $t \leq 2010$. a_2D_1 is the interaction variable of the dummy and the constant. PER_{it-1} is the PER for the player who signed the contract. The reason for using PER as a measure of player performance as opposed to other advanced statistics such as Adjusted Plus Minus or Win's Above Replacement Average is that PER explains the greatest amount of variation in player salary determined by Arcidiacono et al. (2013) and Boothe (2013). D_1PER_{it-1} is the interaction variable of the dummy variable and a player's PER. *Other* is a set of controls incorporating player specific factors that may affect player salary determination, such as player position, the age of the player, and years of experience. The coefficient of a_2 indicates the intercept of players' salaries after the 2011 CBA, and B_2 indicates the slope of the players' salaries over player performance after the 2011 CBA.

The purpose of interacting the dummy variable with the constant is to separate the intercept of players' salaries for the periods before and after the CBA. The purpose of interacting the dummy variable with PER is to analyze the impact of the CBA on players' salaries based on performance for the period after the 2011 CBA was implemented. The t-statistic of this second interaction determines whether the CBA had a statistically significant impact on players' salaries based on PER after the CBA was implemented.

This method adds to the existing literature on player salaries in a few ways. First, the inclusion of a dummy variable allows comparison of players' salaries for contracts signed before and after the 2011 CBA. Second, the explanatory variables on player performance solely focus on an individual player's ability, not their contribution to the team's success. Arcidiacono et al. (2013) and Boothe (2013) both showed that player's compensation is more directly tied to the individual player's performance, and not his impact on team success. Therefore, using a player-specific metric of performance like *PER* is preferable to a player contribution to team success metric like Win-Share. Finally, this model adds another methodology in determining player's salaries and a database of player contracts that may be used in future studies.

The salary regression is supplemented by a similar methodology employed by Hill and Groothius' (2001) by calculating Gini coefficients to study income equality. In this methodology, each NBA season generates a Lorenz Curve that separates the player's salaries into quintiles and the Gini coefficient is calculated. The Gini coefficient measures income equality: a higher number means greater salary disparity among a population. The Gini Coefficients ranges from 0 to 100, with 0 meaning perfect income equality and 100 meaning perfect income inequality. If the Gini coefficients in the seasons following the 2011 CBA are lower than the coefficients prior to the 2011 CBA, this would indicate a reduction in salary disparity amongst players. Table 9 provides the Gini Coefficients.

Table 9: Gini Coefficients for the NBA

Seasons	Gini Coefficient
1999-2000	58.68
2000-2001	53.10
2001-2002	53.03
2002-2003	54.59
2003-2004	54.01
2004-2005	52.86
2005-2006	52.80
2006-2007	55.42
2007-2008	53.25
2008-2009	52.39
2009-2010	52.54
2010-2011	53.67
2011-2012	53.65
2012-2013	54.29
2013-2014	58.40
2014-2015	57.07

The salary figures used to calculate the Gini Coefficients were the player's actual salaries and not their cap figures. The implications of using player's actual salaries as opposed to their cap figures are that players that sign pro-rated contracts (Players that signed in the middle of the season) were included in the calculation. Calculating every player's individual cap hit was not feasible given the data, and therefore, the players' actual salary number is used in the regression.

The Gini Coefficients for the seasons following the 2011 CBA appear to slightly increase relative to the Gini Coefficients for the seasons preceding the 2011 CBA. The average Gini Coefficient post-CBA was 55.85 compared to the average Gini Coefficient pre-CBA of 53.86. The slight increase in the Gini Coefficient indicates that salary equality decreases throughout the league after the agreement. This implies that disparities in salaries between higher and lower performing players increased. One interesting note is the high Gini Coefficient during the 1999-2000 season. One possible explanation for this high figure could be that the 1999-2000 season was after immediately the 1999 CBA, which implemented maximum salaries and salary cap exceptions. A pattern shows that wealth disparity increases immediately after Collective Bargaining Agreements that introduce changes to the salary cap. This would be consistent with the 1999 and 2011 CBA, but not the 2005 CBA. However, the 2005 CBA did not make major revisions to the salary cap, and therefore, explaining the lack of an increase in Gini Coefficient for the 2005-2006 season.

Table 10 outlines the results from the Log-Level regression for the salary data with robust standard errors to account for PER outliers. The constant of 13.31 represents the value of the log of the salary of a Point Guard holding every other variable equal to zero. The coefficients for Shooting Guards, Small Forwards, and Centers were not statistically significant, meaning that the salaries for these positions were not significantly different from Point Guards. Power Forwards were paid the least of any of

Table 10: Results from Log-Level Regression

	Log-Level
Coefficient	
Constant	13.31272***
	(1.052937)
D_1	-.702891***
	(.2182471)
PER_{it-1}	.0622607***
	(.0155291)
D_1PER_{it-1}	.0615012***
	(.0172966)
Height	0.0150798
	(.0138092)
Weight	.004549***
	(.0015063)
Age	-.0954518***
	(.0138499)
Experience	.1310253***
	(.0143613)
Center	-.1854287
	(.1510417)
Power Forward	-.2548433*
	(.1309849)
Small Forward	-.1116688
	(.1037396)
Shooting Guard	-0.0665743
	(.0763099)
Observations	1590
R^2	0.3223

Note: Standard Errors given in parenthesis
***p<.01 **p<.05 *p<.10

the five positions, with Power Forwards making 25.48% less than the other positions. The signs and magnitudes of every coefficient made economic sense. The *constant*, D_1, PER_{it-1}, D_1PER_{it-1}, *Weight*, *Age*, *Experience* variables were all significant at a 1% level. *Power Forward* was significant at a 10% level. The *Height* and *Weight* variables were highly correlated with a correlation of .8192. Therefore, the coefficient of *Weight* may have captured more impact on salary than *Height,* which could explain the lower significance level.

The dummy variable which took on a value of 1 if $t > 2010$ and 0 if $t \leq 2010$ had a coefficient of -70.29%, meaning that Point Guards salaries were 70.29% lower after the 2011 CBA . The negative coefficient makes sense as the terms of the 2011 CBA reduced players' share of BRI from 57% to 50%. However, the 70.29% reduction in player salaries is an unreasonably high number given the 7% reduction in BRI. In comparing the dummy variable coefficient in the Level-Level regression to the mean salary, the results indicate that players' salaries decreased by 16.28%, which makes more economic sense than -70.29%[17]. One possible explanation for the high coefficient of the dummy variable in the Log-Level regression could be that the number of players signing for the minimum salary drastically increased after the CBA. This explanation, nevertheless, does not appear plausible since the number of minimum contracts before the 2011 CBA was already considerably high. Another possible consideration could be that teams decided to spend a lower amount than the salary cap on their total team salary to preserve future salary cap space in a pursuit of "Superstar" players. The average team during the 2014-2015 season, however, spent 16% more than the salary cap, which suggests that this reasoning could not be the cause of the high coefficient of the dummy variable.

The PER_{it-1} variable had a coefficient of 6.23%. This means that for each additional PER, a player's salary is expected to increase by 6.23%. This coefficient made economic sense as higher performing players with higher PERs typically are paid more than lower performing players with lower PERs. This

[17] Level-Level regression results found in Appendix.

is also consistent with Boothe's (2013) regression where players with a higher PER were paid higher salaries.

The *Height*'s coefficient of 1.51% and *Weight's* coefficient of .45% both made economic sense as bigger players tend to get paid more than smaller players, since teams prefer to have oversized players instead of undersized players. *Age*'s coefficient of -9.55% makes economic sense as teams prefer to pay more money to players in their "Prime" (mid-to-late twenties) and less money to players past their "Prime" (mid-to-late thirties). *Experience*'s coefficient of 13.10% makes economic sense as teams tend to value players with experience more than inexperienced players. This coefficient is also consistent with the minimum salary established in the CBA, where the minimum salary for players with more experience is higher than the minimum salary for players with less experience.

The results of the Log-Level regression show that the coefficient of D_1PER_{it-1} was 6.15%. The interpretation of the coefficient is that for each additional increase in PER after the 2011 CBA, player's salaries are expected to increase by 6.15% as compared to an additional increase in PER before the 2011 CBA. This implies that the better performing players with higher PERs received proportionally higher salaries than lower performing players with lower PERs. These results were significant at the 1% level. This trend is consistent with the Gini Coefficient analysis, which showed that income equality slightly decreased following the 2011 CBA. The regression shows that higher performing players are receiving proportionally more money than lower performing players, which demonstrates an increase in wealth disparity among players.

One possible explanation for this result is that the 2011 CBA's introduction of the more punitive luxury tax laws led teams to reconstruct their basketball rosters around core players. In abiding by the salary cap restrictions, teams may have been more willing to pay a higher percentage of their salary cap to one or two "Superstars" and fill in the rest of their roster with lower performing players at lower salaries. This may have differed in the past where teams would field a balanced roster with medium to high performing players with more balanced salaries.

Table 11 shows the 20 most overpaid players according to the regression's residuals[18]. The most overpaid player based on the prior year's statistics was Nene Hilario, who signed a contract with the Denver Nuggets that paid him $8,000,000 in 2006-2007. However, Nene Hilario only played 1 game in the prior season due to injury, resulting in a high residual. A similar situation occurred for the second highest paid player, Gheorghe Muresan, who also only played one game in the prior season. However, Steve Francis played in 44 games the season prior to him signing his 2007 contract with the Houston Rockets. LeBron James had the highest expected LogSalary of 16.95 in 2014 and signed a LogSalary of 16.84 with the Cleveland Cavaliers. In an expanded analysis of the top 50 most overpaid players, the team with the highest number of overpaid players was the Denver Nuggets, who signed 5 of the top 50 most overpaid players. The San Antonio Spurs and the Houston Rockets each signed 4 of the top 50 most overpaid players. The New York Knicks, Washington Wizards, Chicago Bulls, and Orlando Magic each signed 3 of the top 50 most overpaid players. Although the San Antonio Spurs overpaid more players than the New York Knicks, the Spurs had a higher winning percentage than the Knicks over the time period. One explanation for this result is that the Spurs often overpaid rotational players who accounted for a relatively small percentage of the overall salary cap. The Knicks, however, tended to overpay above-average players with "Superstar" money, dedicating a large percent of the salary cap to these types of players. For example, one player the Spurs overpaid was Bruce Bowen who signed for $3,550,000 in 2002. While the Spurs overpaid this role player, $3,550,000 accounted for a small percentage of the overall salary cap. The Knicks signed Amar'e Stoudemire $16,486,611 in 2010, which represented a significant portion of the team's salary cap.

[18] Residuals may also capture other factors that affect salary, such as defensive contribution or intangible qualities, that PER does not measure.

Table 11: Top 20 Overpaid Players

Name	Year	Team	PER	Salary	Log Salary	Expected Log Salary	Residual
Nene Hilario	2006-2007	Denver Nuggets	-54.4	$ 8,000,000	15.89	10.43	5.46
Gheorghe Muresan	1999-2000	Brooklyn Nets	-90.6	$ 510,000	13.14	8.45	4.70
Steve Francis	2007-2008	New York Knicks	15.1	$ 15,070,000	16.53	14.62	1.91
Chandler Parsons	2014-2015	Dallas Mavericks	15.9	$ 14,700,000	16.50	14.60	1.90
Andres Nocioni	2007-2008	Chicago Bulls	15.6	$ 8,500,000	15.96	14.06	1.90
Antonio Davis	2001-2002	Toronto Raptors	16.5	$ 11,000,000	16.21	14.35	1.87
Michael Finley	2005-2006	San Antonio Spurs	14.3	$ 15,937,500	16.58	14.79	1.79
Dikembe Mutombo	2001-2002	Philadelphia 76ers	17.5	$ 14,315,790	16.48	14.69	1.78
Luis Scola	2010-2011	Houston Rockets	17.2	$ 7,775,378	15.87	14.09	1.78
Ben Wallace	2006-2007	Chicago Bulls	17.5	$ 16,000,000	16.59	14.88	1.71
Derek Anderson	2005-2006	Houston Rockets	11.7	$ 9,093,000	16.02	14.34	1.69
Vin Baker	1999-2000	Oklahoma City Thunder	12.5	$ 9,000,000	16.01	14.35	1.66
Fabricio Oberto	2007-2008	San Antonio Spurs	11.9	$ 3,600,000	15.10	13.45	1.64
Rudy Gay	2010-2011	Memphis Grizzlies	16.2	$ 13,603,750	16.43	14.79	1.63
Gilbert Arenas	2008-2009	Washington Wizards	18.2	$ 14,653,466	16.50	14.88	1.62
Allan Houston	2001-2002	New York Knicks	16.1	$ 12,750,000	16.36	14.75	1.61
Shawn Kemp	2002-2003	Orlando Magic	12.1	$ 12,621,028	16.35	14.74	1.61
Juwan Howard	2008-2009	Denver Nuggets	4.1	$ 7,375,500	15.81	14.22	1.60
Andre Miller	2003-2004	Denver Nuggets	15.2	$ 8,000,000	15.89	14.33	1.57

The coefficient of the interaction term in the Log-Level regression of player's salaries was statistically and economically significant. The implication of the results showed that higher performing players received proportionally higher salaries than lower performing players following the 2011 CBA. Therefore, these results were consistent with the Gini Coefficient analysis and income disparity grew under the 2011 CBA.

V. Conclusion

The 2011 CBA added many structural changes to the NBA's salary cap to increase competitive balance. As outlined earlier, many previous economists tackled the issue of measuring competitive balance with a change in league structure. My paper aimed to replicate these studies with the application of the NBA's most recent Collective Bargaining Agreement. The popular methodology of comparing actual standard deviation of winning percentages with the standard deviation of winning percentages in the "idealized" case to measure competitive balance would have been the preferred method. Given the lack of observations necessary to use this method, my methodology modified the lagged regression analysis Lee (2009) used in his study of the NFL's CBA on competitive balance. In the OLS, Prais-Winston, and Fixed-Effects regressions, the results showed that the 2011 CBA did not improve competitive balance.

The second part of my research focused on the CBA's residual effect on player salaries. My methodology regressed player salaries on Player Efficiency Rating (PER) and a set of controls for the period before and after the 2011 CBA. The Log-Level regression results showed that higher performing players received proportionally higher salaries than lower performing players following the 2011 CBA and income equality decreased.

Both the results from the competitive balance and player salaries are inherently linked with each other. One possible explanation for the results is that NBA teams may need more seasons to pass before the CBA's impact is in full effect. The CBA's impact already appears in the results for players' salaries, with teams altering the construction of their roster around one or two core "Superstars" and filling the rest of the roster with rotational players. The CBA's impact on winning percentages may not be immediate, such as the impact on player salaries, and could affect competitive balance in the future. Another explanation could be that the CBA actually did not improve competitive balance, but changed player salaries.

The 2011 CBA expires after the 2020-2021 season, but either side may opt out of the agreement after the 2016-2017 season. On October 6th, 2014, the NBA signed a \$2.66 billion per year television deal with ESPN and TNT that becomes effective at the start of the 2016-2017 season. Larry Coon (2014) predicts that the salary cap will dramatically increase in 2016 as a result of the infusion of revenue. This means that players who sign a contract in 2016 will see a sharp increase in salaries. The implications of the TV deal most likely will lead to both sides opting out of the current CBA after the 2017 season. In the next CBA, the league should aim to introduce changes that more effectively improve competitive balance and income equality than what was accomplished under the 2011 CBA.

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Appendix

1. Salary Cap Exceptions (found at www.cbafaq.com/salarycap.htm)

LARRY BIRD EXCEPTION -- This exception allows teams to exceed the cap in order to re-sign their own free agents, up to the player's maximum salary. Teams are said to have "Bird rights" to players who qualify. To qualify for this exception a player essentially must play for three seasons without clearing waivers or changing teams as a free agent, however there are nuances to this rule. This means a player can qualify by playing fewer than three consecutive one-year contracts, a single contract of at least three years, or any equivalent combination. It also means that when a player is traded, his Bird rights are traded with him, and his new team can use the Larry Bird exception to re-sign him. These contracts can be up to five years in length, with raises up to 7.5% of the salary in the first season of the contract. Players who qualify for this exception are called "Qualifying Veteran Free Agents" in the CBA, and this exception is formally a component of the Veteran Free Agent exception.

The 1983 CBA introduced the modern salary cap, and with it the provision allowing a team to exceed the cap to re-sign its own players. It is commonly believed that this exception acquired its common moniker because Larry Bird was the first such player to be re-signed. However, this is apocryphal, as Bird signed a seven-year contract in 1983 (before this provision took effect), and did not sign another until 1988.

EARLY BIRD EXCEPTION -- This is a weaker form of the Larry Bird exception. It also allows teams to exceed the cap to re-sign their own free agents, but with more limited contracts than the Larry Bird exception. To qualify for this exception the player must play for two seasons without clearing waivers or changing teams as a free agent. A team may use the Early Bird exception to re-sign its own free agent for up to 175% of his salary in the previous season[2] (not over the maximum salary, of course) or 104.5% of the average salary in the previous season, whichever is greater. Early Bird contracts must be at least two seasons in length, which prevents teams from using the Early Bird to sign a one-year contract, then signing the same player with the full Larry Bird exception the following season. Early Bird contracts can be up to four years in length, with raises up to 7.5% of the salary in the first season of the contract. Early Bird is also a component of the Veteran Free Agent exception, and qualifying players are called "Early Qualifying Veteran Free Agents" in the CBA.

If the player is a restricted free agent with two years of service and qualifies for the Early Bird exception, then the player's prior team may use the Early Bird exception to match an offer sheet he receives from another team. This is true even if the starting salary for the Early Bird exception is lower than the starting salary in the offer sheet, which is based on the Non-Taxpayer Mid-Level exception.

A team can renounce its Early Bird rights to a player, and instead re-sign him with the Non-Bird exception. They might do this in order to sign the player to a one-year contract, instead of the minimum two years required by the Early Bird exception.

NON-BIRD EXCEPTION -- This is also a component of the Veteran Free Agent exception. Its name is somewhat of a misnomer, since Non-Bird really is a form of Bird rights. Players who qualify for this exception are called "Non-Qualifying Veteran Free Agents" in the CBA. They are veteran free agents who are neither Qualifying Veteran Free Agents nor Early Qualifying Veteran Free Agents, and include the following:

- Players who finished the season with a given team, who have played no more than one season without clearing waivers or changing teams as a free agent.
- Players who were Early Bird free agents, but whose team renounced its right to use the Early Bird exception to re-sign the player.
- Players who were to be Larry Bird or Early Bird free agents, were playing on one-year contracts, and were traded mid-season.

This exception allows a team to re-sign its own free agent to a salary starting at up to 120% of his salary in the previous season[2] (not over the maximum salary, of course), 120% of the minimum salary, or the amount needed to tender a qualifying offer, whichever is greater. Raises are limited to 4.5% of the salary in the first year of the contract, and contracts are limited to four seasons when this exception is used.

A partial season counts as a full season for the tenure calculation related to Bird rights. If a team signs another team's free agent to a Rest-of-Season contract mid-way through the season, then at the end of that season the player is a non-Bird free agent.

NON-TAXPAYER MID-LEVEL EXCEPTION -- This exception is available only when a team is below the "apron" (i.e., not paying luxury tax, or less than $4 million above the tax line). This determination is made after the exception is used, so a team below the apron cannot use this exception if doing so takes it above the apron. It cannot be used by a team that has already used the Taxpayer Mid-Level Exception or the Room Mid-Level exception. It allows a team to sign any free agent to a contract with a starting salary up to the following amounts[3]:

Season	**First-year salary**
2011-12	$5.000 million
2012-13	$5.000 million
2013-14	$5.150 million
2014-15	$5.305 million
2015-16	$5.464 million
2016-17	$5.628 million
2017-18	$5.797 million
2018-19	$5.971 million
2019-20	$6.150 million

2020-21	$6.335 million

This exception may be split and given to multiple players. It may be used for contracts up to four years in length, with raises up to 4.5% of the salary in the first year of the contract. Signing a player to a multi-year contract does not affect a team's ability to use this exception every year -- for example, a team can use this exception to sign a player to a four-year contract, and use it again the following year to sign another player.

Again, this exception is only available to teams that are below the "apron," i.e., below the point $4 million above the tax line. Teams above the apron instead must use the smaller Taxpayer Mid-Level exception (see below). Further, any team that uses its Non-Taxpayer Mid-Level exception cannot go above the apron for the remainder of that season. In other words, once a team uses its Non-Taxpayer Mid-Level exception, it is hard-capped at the apron.

However, if a team uses its Non-Taxpayer Mid-Level exception but does not exceed the constraints of the Taxpayer Mid-Level exception (e.g., in 2011-12 they use the Non-Taxpayer Mid-Level exception to sign a player for $3 million or less), then the team is allowed to later exceed the apron (i.e., it is not hard-capped). If the team later exceeds the apron, then it is considered to have used the Taxpayer Mid-Level exception rather than the Non-Taxpayer Mid-Level exception. But the converse is not true -- if a team is above the apron and spends any of its Taxpayer Mid-Level exception, it cannot drop below the apron and spend the remaining money as part of its Non-Taxpayer Mid-Level exception. Finally, a team that was above the apron but did not spend any of its Taxpayer Mid-Level exception has full access to the Non-Taxpayer Mid-Level exception if it later drops below the apron.

A different team salary definition is used for determining whether a team is above or below the apron. In addition, this exception begins to pro-rate downward daily starting on January 10 each season and expires following the last day of the team's regular season.

TAXPAYER MID-LEVEL EXCEPTION -- This exception is available only when a team is above the "apron" (i.e., with a team salary $4 million or more above the tax line). This determination is made after the exception is used, so a team below the apron must use this exception rather than the Non-Taxpayer Mid-Level exception if doing so takes them above the apron. This exception cannot be used if the team has already used the Bi-Annual, Non-Taxpayer Mid-Level or the Room Mid-Level exception. Starting in 2013-14, it cannot be used if the team has received a player that season in a sign-and-trade transaction

This exception allows a team to sign any free agent to a contract with a starting salary up to the following amounts[3]:

Season	First-year salary
2011-12	$3.000 million
2012-13	$3.090 million
2013-14	$3.183 million

2014-15	$3.278 million
2015-16	$3.376 million
2016-17	$3.477 million
2017-18	$3.581 million
2018-19	$3.688 million
2019-20	$3.799 million
2020-21	$3.913 million

This exception may be split and given to multiple players. It may be used for contracts up to three years in length, with raises up to 4.5% of the salary in the first year of the contract. Signing a player to a multi-year contract does not affect a team's ability to use this exception every year -- for example, a team can use this exception to sign a player to a three-year contract, and use it again the following year to sign another player..

If the player is a restricted free agent with one or two years of service and receives an offer sheet from a new team, the player's prior team may use the Taxpayer Mid-Level exception to match the offer sheet, but only if the offer is within the constraints of the Taxpayer Mid-Level exception.

If a team uses its Non-Taxpayer Mid-Level exception but does not exceed the constraints of the Taxpayer Mid-Level exception (e.g., in 2011-12 they use the Non-Taxpayer Mid-Level exception to sign a player for $3 million or less) and the team later exceeds the apron, then the team is considered to have used the Taxpayer Mid-Level exception rather than the Non-Taxpayer Mid-Level exception. But the converse is not true -- if a team is above the apron and spends any of its Taxpayer Mid-Level exception, it cannot drop below the apron and spend the remaining money as part of its Non-Taxpayer Mid-Level exception. Finally, a team that was above the apron but did not spend any of its Taxpayer Mid-Level exception has full access to the Non-Taxpayer Mid-Level exception if it later drops below the apron.

A different team salary definition is used for determining whether a team is above or below the apron. In addition, this exception begins to pro-rate downward daily starting on January 10 each season, and expires following the last day of the team's regular season.

ROOM MID-LEVEL EXCEPTION -- This exception is available only to teams that drop far enough below the cap to use cap room, and lose their Bi-Annual, Non-Taxpayer Mid-Level and Taxpayer Mid-Level exceptions. This exception cannot be used if the team has already used the Bi-Annual, Non-Taxpayer Mid-Level or Taxpayer Mid-Level exceptions. This exception becomes available once the team salary drops far enough that the team loses its other exceptions, and expires following the last day of the regular season.

This exception allows a team to sign any free agent, starting at up to the following amounts:

Season	First-year salary
2011-12	$2.500 million
2012-13	$2.575 million
2013-14	$2.652 million
2014-15	$2.732 million
2015-16	$2.814 million
2016-17	$2.898 million
2017-18	$2.985 million
2018-19	$3.075 million
2019-20	$3.167 million
2020-21	$3.262 million

This exception may be split and given to multiple players. It may be used for contracts up to two years in length, with raises up to 4.5% of the salary in the first year of the contract. Signing a player to a multi-year contract does not affect a team's ability to use this exception every year -- for example, a team can use this exception to sign a player to a two-year contract, and use it again the following year to sign another player.

Once a team has used this exception, it can no longer use the Bi-Annual, Non-Taxpayer Mid-Level or Taxpayer Mid-Level exception.

BI-ANNUAL EXCEPTION -- This exception is available only to teams that are below the "apron" (i.e., not paying luxury tax, or less than $4 million above the tax line). This determination is made after the exception is used, so a team below the apron cannot use this exception if doing so takes them above the apron. It cannot be used if the team has already used the Taxpayer Mid-Level Exception or the Room Mid-Level exception. It allows a team to sign any free agent, starting at up to the following amounts:

Season	First-year salary
2011-12	$1.900 million
2012-13	$1.957 million
2013-14	$2.016 million
2014-15	$2.077 million
2015-16	$2.139 million

2016-17	$2.203 million
2017-18	$2.269 million
2018-19	$2.337 million
2019-20	$2.407 million
2020-21	$2.479 million

This exception may not be used two years in a row (and if this exception was used under the previous CBA in 2010-11, it may not be used in 2011-12). It may be split and given to more than one player, and can be used to sign players for up to two years, with raises limited to 4.5% of the salary in the first season of the contract.

A team that uses its Bi-Annual exception cannot go above the apron for the remainder of that season. In other words, once a team uses its Bi-Annual exception, it is hard-capped at the apron.

A different team salary definition is used for determining whether a team is above or below the apron. In addition, this exception begins to pro-rate downward daily starting on January 10 each season, and expires following the last day of the regular season.

ROOKIE EXCEPTION -- Teams may sign their first round draft picks to rookie "scale" contracts even if they will be over the cap as a result.

MINIMUM PLAYER SALARY EXCEPTION -- Teams can offer players minimum salary contracts even if they are over the cap. Contracts can be up to two years in length. For two-year contracts, the second season salary is the minimum salary for that season. The contract may not contain a bonus of any kind. This exception can also be used to acquire minimum salary players via trade. There is no limit to the number of players that can be signed or acquired using this exception.

This exception begins to reduce in value after the first day of the season. For example, if there are 170 days in the season, then this exception reduces in value by 1/170 of its initial value each day. So if a team signs a minimum salary player 90 days into the season, it can pay the player only 80/170 of the minimum salary.

DISABLED PLAYER EXCEPTION -- This exception allows a team which is over the cap to replace a disabled player who will be out for the remainder of that season (it can also be granted in the event of a player's death). This exception is granted by the league, based on an application from the team and a determination by an NBA-designated physician that the player is substantially more likely than not to be unable to play through the following June 15.

If this exception is granted, the team can acquire one player via free agent signing, trade or waiver claim, to replace the disabled player:

- The team may sign a free agent for one season only, for 50% of the disabled player's salary or the amount of the Non-Taxpayer Mid-Level exception, whichever is less.

- The team may trade for a player in the last season of his contract only (including any option years), who is making no more than 50% plus $100,000 of the disabled player's salary, or the amount of the Non-Taxpayer Mid-Level exception plus $100,000, whichever is less.
- The team may claim a player on waivers who is in the last season of his contract only (including any option years), who is making no more than 50% of the disabled player's salary, or the amount of the Non-Taxpayer Mid-Level exception, whichever is less.

Teams can apply for this exception from July 1 through January 15, and cannot apply after January 15. Once granted, the exception expires when a player is acquired, when the disabled player is traded or returns to the team, or on March 10 of that season, whichever comes first. This exception is granted on a season-by-season basis -- if the player will also be out the following season, the team needs to apply for this exception again the following season.

This exception can only be granted to the team for which the player was playing when his injury or illness was known, or reasonably should have become known. A team cannot trade for an injured player and subsequently apply for a Disabled Player exception for that player.

If a team's application for a disabled player exception is denied, the team must wait 90 days before submitting another request related to the same player, and then only for a new injury or aggravation of the same injury. Whether the application was approved or denied, the team can apply again (including for the same injury) the following season.

If the disabled player comes back sooner than expected he may be activated immediately, and the replacement player is not affected.

Don't confuse the Disabled Player exception with the salary cap relief teams sometimes receive after losing a player to a career-ending injury or death. The Disabled Player exception allows a team to acquire a replacement player. The salary cap relief removes a contract from the team's books.

REINSTATEMENT -- If a player was banned from the league for a drug-related offense and later reinstated, his prior team may re-sign him for up to his previous salary, or the average salary for the season in which he is reinstated, whichever is less.

2. Basket Related Income Calculations (found at www.cbafaq.com/salarycap.htm)

Basketball Related Income (BRI) essentially includes any income related to basketball operations received by the NBA, NBA Properties, NBA Media Ventures, or any other subsidiaries. It also includes income from businesses in which the league, a league entity or a team has an ownership stake of at least 50%. BRI includes:

- Regular season gate receipts, minus taxes and certain charges including those related to arena financing
- Broadcast rights
- Exhibition game proceeds
- Playoff gate receipts

- The value of all complimentary tickets, minus "excluded complimentary tickets" (1.6 million tickets in 2011-12, increasing by 50,000 each season thereafter)
- Novelty, program and concession sales (at the arena and in team-identified stores within proximity of an NBA arena)
- Parking
- Proceeds from team sponsorships
- Proceeds from team promotions
- Arena club revenues
- Proceeds from summer camps
- Proceeds from non-NBA basketball tournaments
- Proceeds from mascot and dance team appearances
- Proceeds from beverage sale rights
- 40% of proceeds from arena signage
- 40% of proceeds from luxury suites
- 50% of proceeds from arena naming rights
- 50% of the proceeds from team practice facility naming rights
- Proceeds from other premium seat licenses
- Proceeds received by NBA Properties, including international television, sponsorships, revenues from NBA Entertainment, the All-Star Game, and other NBA special events.

Some of the things specifically not included in BRI are proceeds from the grant of expansion teams, fines, all forms of revenue sharing, interest income, and the sale of assets.

3. Individual Teams Estimated Exponential Model for Revenue

Team	**Exponential Model**	**Model's R^2**
ATL	y=69.1906*1.03901^x	R^2 =.89931
BOS	y=81.6144*1.05217^x	R^2 = .913711
BRK	y=69.5434*1.0453^x	R^2 = .334404
CHI	y=103.753*1.04573^x	R^2 = .901149
CHO	y=58.3871*1.04918^x	R^2 = .836476
CLE	y=73.7961*1.05904^x	R^2 = .629403
DAL	y=102.861*1.03427^x	R^2 = .781748
DEN	y=70.0234*1.04396^x	R^2 = .876557
DET	y=107.404*1.02535^x	R^2 = .338987
GSW	y=53.7167*1.07788^x	R^2 = .970036
HOU	y=86.2082*1.05353^x	R^2 = .637772
IND	y=90.1288*1.01648^x	R^2 = .30645
LAC	y=61.2557*1.05278^x	R^2 = .925406
LAL	y=120.611*1.05363^x	R^2 = .82805
MEM	y=57.3442*1.0534^x	R^2 = .699605

MIA	y=77.9428*1.05799^x	R^2 = .859047
MIL	y=63.6339*1.03532^x	R^2 = .835292
MIN	y=83.2752*1.02007^x	R^2 = .494741
NOP	y=63.6682*1.04341^x	R^2 = .905552
NYK	y=131.462*1.05152^x	R^2 = .970131
OKC	y=53.4482*1.06989^x	R^2 = .902967
ORL	y=62.0656*1.05741^x	R^2 = .920889
PHI	y=104.023*1.00844^x	R^2 = .494071
PHO	y=109.677*1.02018^x	R^2 = .413786
POR	y=69.2966*1.04919^x	R^2 = .656356
SAC	y=112.007*1.00015^x	R^2 = .00036
SAS	y=85.1332*1.04619^x	R^2 = .844658
TOR	y=80.2235*1.04464^x	R^2 = .81624
UTA	y=75.0766*1.04126^x	R^2 = .858882
WAS	y=90.73*1.02074^x	R^2 = .533917

4. <u>Player Efficiency Rating Calculation</u>

Begin with unadjusted PER (uPER):

$$\begin{aligned} uPER = \frac{1}{min} \times \Bigg(3P + \left[\frac{2}{3} \times AST\right] + \left[\left(2 - factor \times \frac{tmAST}{tmFG}\right) \times FG\right] \\ + \left[0.5 \times FT \times \left(2 - \frac{tmAST}{tmFG} + \frac{2}{3} \times \frac{tmAST}{tmFG}\right)\right] - [VOP \times TO] \\ - [VOP \times DRBP \times (FGA - FG)] \\ - \left[VOP \times 0.44 \times \big(0.44 + (0.56 \times DRBP)\big) \times (FTA - FT)\right] \\ + [VOP \times (1 - DRBP) \times (TRB - ORB)] + [VOP \times STL] \\ + [VOP \times DRBP \times BLK] - \left[PF \times \left(\frac{lgFT}{lgPF} - 0.44 \times \frac{lgFTA}{lgPF} \times VOP\right)\right]\Bigg) \end{aligned}$$

Where

$$VOP = \frac{lgPTS}{lgFGA - lgORB + lgTO + 0.44 \times lgFTA}$$

$$DRBP = \frac{lgTRB - lgORB}{lgTRB}$$

$$factor = \frac{2}{3} - \left[\left(0.5 \times \frac{lgAST}{lgFG}\right) \div \left(2 \times \frac{lgFG}{lgFT}\right)\right]$$

With

- *tm*, the prefix, indicating of team rather than of player;
- *lg*, the prefix, indicating of league rather than of player;
- *min* for number of minutes played;
- *3P* for number of three-point field goals made;
- *FG* for number of field goals made;
- *FT* for number of free throws made;
- *VOP* for value of possession (but in reference to the league, in this instance);
- *RB* for number of rebounds: *ORB* for offensive, *DRB* for defensive,*TRB* for (total) combined, *RBP* for percentage of offensive or defensive;
- *FGA* for number of field goals attempted;
- *FTA* for number of free throws attempted;
- *PF* for number of personal fouls;
- *AST* for number of assists;
- *STL* for number of steals;
- *BLK* for number of blocks;
- *TO* for number of turnovers

Once uPER is calculated, it must be adjusted for team pace and normalized to the league to become PER:

$$PER = \left(uPER \times \frac{lgPace}{tmPace}\right) \times \frac{15}{lguPER}$$

5. PER Reference Guide

Year For the Ages: 35.0

Runaway MVP Candidate: 30.0

Strong MVP Candidate: 27.5

Weak MVP Candidate: 25.0

Bona fide All-Star: 22.5

Borderline All-Star: 20.0

Solid 2nd option: 18.0

3rd Banana: 16.5

Pretty good player: 15.0

In the rotation: 13.0

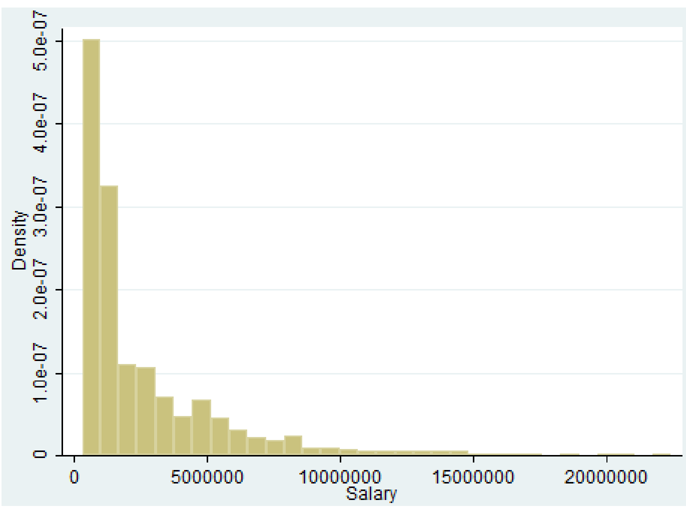
Scrounging for minutes: 11.0

Definitely renting: 9.0

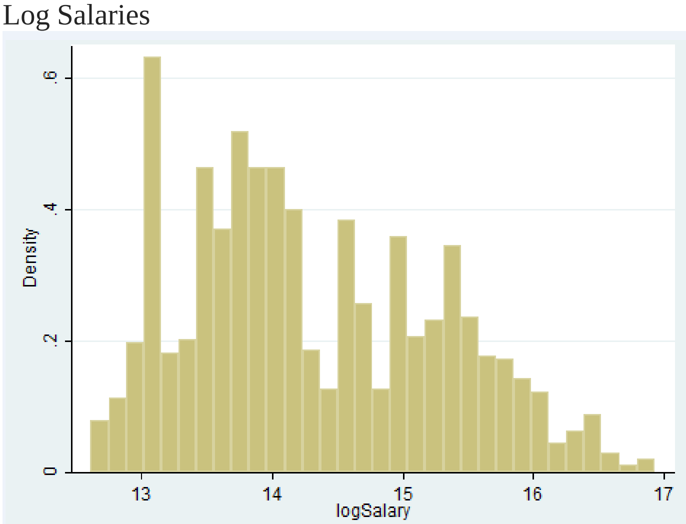
The Next Stop: DLeague 5.0

6. Histogram of Salaries and LogSalaries

Salaries



Log Salaries



7. Player Salaries Level-Level Regression Results

	OLS
Coefficient	
Constant	-3738383 (3407145)
D_1	-3110786*** (835192.6)
PER_{it-1}	193463.3*** (50620.87)
D_1PER_{it-1}	259116.1*** (68816.48)
Height	85658.99* (45036.13)
Weight	20714.79*** (5746.85)
Age	-323201.1*** (44025.96)
Experience	391050*** (46540.14)
Center	-1342014*** (513554.3)
Power Forward	-1342315*** (443586.3)
Small Forward	-792841.1** (338139.6)
Shooting Guard	-150139.5 (254759.2)
Observations	1590
R^2	0.3124

Note: Standard Errors given in parenthesis
***p<.01 **p<.05 *p<.10