

A Study on the Correlation Between Athletes' Compensation Levels and Competitive Performance

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Abstract: This paper will mainly focus on studying the correlation between salaries athletes obtain and their on-court performance. It is about the gradual process of finding a rather common result to conclude this correlation, in which the paper hypothesized there being a positive relationship between them. To verify or falsify the hypothesis, this study takes the three most popular league in three different areas as samples, NBA-basketball, most popular in Northern America and China, Premier League-soccer, the most successful professional league in this decade, and NFL-American football, where athletes receive the top salaries in the whole sports area. The study makes three different data analysis within the NBA, and between basketball and soccer. Top salaries in cooperative sports can show something not included in data, which can make this research more objective and receivable. The results are clear and similar that in most cases, salaries do have a positive correlation with athletes' performance. Based on the results, the study gives some suggestions on how to build a more competitive league while still being commercial.

Keywords: Salary, professional league, sports.

1. Introduction

This paper made this investigation due to the interest in sports games. As a basketball fan, every transfer deadline is exciting since teams get the players they want and improve their overall strength. However, it is always reported that one of the famous teams Lakers has no salary cap space because of the Big three of LeBron James, Russell Westbrook and Anthony Davis who take up a really large part of the cap space of the team, disabling the manager from signing new players. The study gradually developed a curiosity in finding reasons of why this situation happens and what solutions can be operated. The main subject for this research is the correlation between the salaries of players and their performances.

The research will find the reason why some teams have no salary cap space and other problems, for example why does some players receiving relatively high salaries while they are performing really bad. At the end of the research, the paper will also give some suggestions on how can sports fans make the salary system work more fairly or help some teams with their salary cap problems.

During this research, some method used will include diagrams, hypothesis, certain value calculation, comparison, business related analysis. These methods will help with the data analysis and evaluation parts.

In the next few pages, the paper will include a literature review of the distribution in salary of the three main professional leagues and the relationship of salaries and performances. This part of the paper will cite from some similar research papers to help the following analysis. Then, the whole process of research method will be introduced, including the design of the methods, data collection and means of analysis, as well as the hypothesis. As the research part is finished, the results will be shown and it determines whether the hypothesis is correct or not. After leading to a result, the paper will analyze the relativity for this research and provide suggestions to improve the current problems. At last, a conclusion is necessary for the whole passage and will make the limitation of this passage clear.

2. Results from other Researches

Skin tone discrimination in professional basketball leagues, and more specifically at the NBA, has been the major concern of many researchers who have provided evidence of its existence (Figure 1). The nonlinear procedures are a key differentiation from previous studies as they may reveal patterns non-detectable by linear models. No evidence of discrimination, based on skin tone, was found [1].



Figure 1: Passer rating in Old vs New Contracts [2].

2.1. Correlation Between Salaries and Performances

This study founds the 10 quarterbacks who have signed the largest contracts over the last few seasons. This allowed us to collect data and compile it in a graph to show how their performance changed between the end of their old contract and the beginning of the new one.

All but 2 of the 10 players saw regressions to their passer rating between the final year of their old contract and the first year of their new contract.

On average, quarterbacks in this group saw a 13.48-point drop in their passer rating after signing a new contract. This demonstrates there is some correlation between increases in salary and player performance, just not in the direction that was expected.

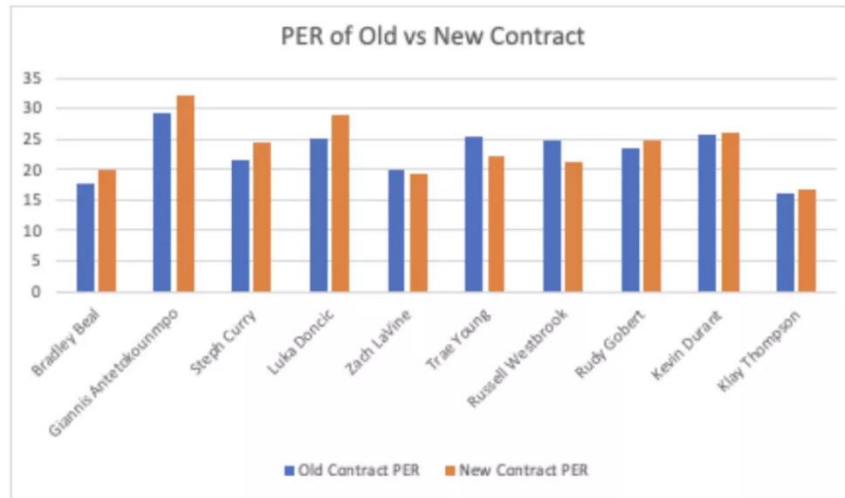


Figure 2: PER of Old vs New Contract [2].

This was surprising, as the NBA offers far more guaranteed money than the NFL. That should take away some incentive to perform at a high level, but instead, 70% of the players on this list improved their PER after signing a new contract (Figure 2).

2.2. Distribution of Salaries

Table 1: Average and median salary of all positions in 23-24 NBA [3].

Position	AVG salary(\$M)	Median salary(\$M)
PG	11.8	5.8
SG	8.9	4.0
SF	8.5	3.5
PF	9.9	5.6
C	9.4	4.2

On all the five positions, the average salary is always larger than the median salary, which means there are more high salary players in the league than low salary ones. Among all positions, point guards have the highest salary while small forward has the least (Table 1).

2.3. Research Method Reference

In-depth analysis of the causes: wage system, the instability of the player's commodity value, the dual pursuit of competitive and economic benefits, the scarcity of star players is the main factor generating wage differences and concluded that the competitive advantage is the basis of economic benefits [4]. Given player's performance and that of a 'replacement level' talent and multiply that difference by the number of minutes that player played. The result shows, theoretically, how many points the player added to his team's bottom line on the season"10 [5].

Value Added = ((Minutes * (PER – Position Replacement Level)) / 6711).

A replacement level player is defined as a player that can be easily acquired, such as a D-League player, someone on a minimum contract, or the last player on a team's roster. The replacement levels for each position group within the NBA are as follows according to Hollinger (Table 2) [4, 5]:

Table 2: The average VA for all positions in 23-24 NBA [5].

Position	VA
PG	11.0
SG	10.5
SF	10.5
PF	11.5
C	10.6

3. Research Method

3.1. Research Design

Similar to the method from Hollinger, the research introduces a new value called PE, simply representing the performance of players. PE can numerically find out how influential or effective a player can be on his position. This research only takes NBA as an example. 90 players are selected as sample (18 from each of the positions), including future hall of famers, all stars, rookies, and controversial players. Then carry out tables to record the points, assists, steals, rebounds, blocks per game to calculate the PE with a combination of offense and defense, salaries are also included in the table. Diagrams are plotted and Pearson correlation coefficient is calculated.

3.2. Data Collection and Analysis Method

All the data collected is from official statistics website of the leagues or some famous sports news website such as ESPN or SKY SPORTS. The data collected for each league will be conducted into a scatter diagram, x-axis being performance and y-axis being salaries, in which a correlation can be seen and a Pearson Correlation value will be calculated and the three values for the three leagues can tell which league has the fairest and scientific salary system. The similar relationship will be drawn through the tool of logger Pro.

To show the performance in a numerical way, a new stat PE is introduced, which shows the influence the players have on the game on the position they are at. This number can also tell the managers how well the players fit their teams. For example, if a manager wants a traditional point guard, he wouldn't prefer a point guard that has a relatively low PE because this player can't play as effectively as he should play.

Based on another research, we can find that:

Among the factors that caused significance in the experiments conducted in this study were a player's points per game, assists per game, rebounds per game, free throw shooting percentage, plus/minus [6].

Performance PE can be calculated in the NBA that

- 1) PG: $PE = 0.8PPG + 0.8APG + 0.4SPG$
- 2) SG: $PE = 0.8PPG + 0.6APG + 0.5SPG$
- 3) SF: $PE = 0.9PPG + 0.5APG + 0.4RPG$
- 4) PF: $PE = 0.6PPG + 0.8RPG + 4BPG$
- 5) C: $PE = 0.4PPG + RPG + 5BPG$
- 6) *PPG: points per game *APG: assists per game *SPG: steals per game
- 7) *RPG: rebounds per game *BPG: blocks per game

3.3. Hypothesis

This study concludes that player salary shares exhibit a relatively high (non-linear) accordance with their performance on court [7].

Through daily experience, it can be guessed that salaries have a strong positive correlation with performance, which may get an equation of $s=kp+c$ or $s=kp$ (Table 3-7).

4. Research Results

4.1. Display of Data Processing

Table 3: PE for point guards [8].

Name	PPG	APG	SPG	PE	Salary(M)
Kyrie Irving	25.6	5.2	1.28	25.152	41
Ja Morant	25.1	8.1	0.78	26.872	36.7
Jose Alvarado	7.1	2.1	1.05	7.78	1.8
Chris Paul	9.2	6.8	1.21	13.284	10.5
Stephen Curry	26.4	5.1	0.73	25.492	55.8
Tyus Jones	12	7.3	1.08	15.872	3
Jamal Murray	21.2	6.5	0.97	22.548	36
Mike Conley	11.6	5.7	1.4	14.4	10
Shai Gilgeous-Alexander	30.1	6.2	2	29.84	35.9
Anfernee Simons	22.6	5.5	0.5	22.68	25.9
Collin Sexton	18.7	4.9	0.79	19.196	17.3
Reggie Jackson	10.2	3.8	0.54	11.416	5.3
Davion Mitchell	5.3	1.9	0.24	5.856	6.5
Trae Young	25.7	10.8	1.33	29.732	40.1
LaMelo Ball	23.9	8	1.82	26.248	35.1
Josh Giddey	12.3	4.8	0.64	13.936	8.4
Darius Garland	18	6.5	1.3	20.12	36.7
T.J. McConnell	10.2	5.5	1.01	12.964	9.3

Table 4: PE for shooting guards.

Name	PPG	APG	SPG	PE	Salary(\$M)
Klay Thompson	17.9	2.3	0.65	16.025	15.9
Jalen Green	19.6	3.5	0.8	18.18	12.5
Desmond Bane	23.7	5.5	1.02	22.77	34
CJ McCollum	20	4.6	0.94	19.23	33.3
Cam Reddish	5.4	1	0.98	5.41	2.2
Amir Coffey	6.6	1.1	0.59	6.235	3.7
Kevin Huerter	10.2	2.6	0.7	10.07	16.8
Anthony Edwards	25.9	5.1	1.28	24.42	13.5
Kenrich Williams	4.7	1.3	0.55	4.815	6.7
Jordan Clarkson	17.1	5	0.64	17	23.5
Jrue Holiday	12.5	4.8	0.88	13.32	33.6
Killian Hayes	6.9	4.9	0.86	8.89	2.2

Table 4: (continued).

Tyrese Maxey	25.9	6.2	0.99	24.935	35.1
Josh Green	8.2	2.3	0.82	8.35	4.8
Seth Curry	9	1.8	0.62	8.59	3.3
Ayo Dosunmu	12.2	3.2	0.89	12.125	7
Malik Beasley	11.3	1.4	0.75	10.255	6
Cade Cunningham	22.7	7.5	0.9	23.11	13.9

Table 5: PE for small forwards.

Name	PPG	APG	SPG	PE	Salary(\$M)
Klay Thompson	17.9	2.3	0.65	16.025	15.9
Jalen Green	19.6	3.5	0.8	18.18	12.5
Desmond Bane	23.7	5.5	1.02	22.77	34
CJ McCollum	20	4.6	0.94	19.23	33.3
Cam Reddish	5.4	1	0.98	5.41	2.2
Amir Coffey	6.6	1.1	0.59	6.235	3.7
Kevin Huerter	10.2	2.6	0.7	10.07	16.8
Anthony Edwards	25.9	5.1	1.28	24.42	13.5
Kenrich Williams	4.7	1.3	0.55	4.815	6.7
Jordan Clarkson	17.1	5	0.64	17	23.5
Jrue Holiday	12.5	4.8	0.88	13.32	33.6
Killian Hayes	6.9	4.9	0.86	8.89	2.2
Tyrese Maxey	25.9	6.2	0.99	24.935	35.1
Josh Green	8.2	2.3	0.82	8.35	4.8
Seth Curry	9	1.8	0.62	8.59	3.3
Ayo Dosunmu	12.2	3.2	0.89	12.125	7
Malik Beasley	11.3	1.4	0.75	10.255	6
Cade Cunningham	22.7	7.5	0.9	23.11	13.9

Table 6: PE for power forwards.

Name	PPG	RPG	BPG	PE	Salary(\$M)
Jabari Smith	13.7	8.1	0.8	17.9	9.8
Jaren Jackson	22.5	5.5	1.61	24.34	26.2
Zion Williamson	22.9	5.8	0.67	21.06	36.7
Kyle Anderson	6.4	3.5	0.59	9	8.8
Jayson Tatum	25	9.7	0.68	25.48	34.8
Karl-Anthony Towns	21.8	8.3	0.66	22.36	49.2
Scottie Barnes	19.9	8.2	1.47	24.38	10.1
Onyeka Okongwu	10.2	6.8	1.09	15.92	14
Miles Bridges	21	7.3	0.48	20.36	27.2
Grant Williams	13.9	5.1	0.41	14.06	13
Kevin Love	8.8	6.1	0.18	10.88	3.9
Thomas Bryant	5.7	3.7	0.42	8.06	2.8
Franz Wagner	19.7	5.3	0.39	17.62	7

Table 6: (continued).

Paolo Banchemo	22.6	6.9	0.59	21.44	12.2
Marvin Bagley	13.2	8.1	0.79	17.56	12.5
Patrick Williams	10	3.9	0.77	12.2	18
Giannis Antetokounmpo	30.4	11.5	1.08	31.76	48.8
Bobby Portis	13.8	7.4	0.41	15.84	11.7

Table 7: PE for centers.

Name	PPG	RPG	BPG	PE	Salary(\$M)
Alperen Şengün	21.1	9.3	0.73	21.39	5.4
Victor Wembanyama	21.4	10.6	3.58	37.06	13.8
Christian Wood	6.9	5.1	0.66	11.16	3
Ivica Zubac	11.7	9.2	1.22	19.98	11.7
Jusuf Nurkić	10.9	11	1.05	20.61	17.5
Domantas Sabonis	19.4	13.7	0.59	24.41	40.5
Nikola Jokić	28.7	13.4	0.67	28.23	51.4
Chet Holmgren	16.5	7.9	2.32	26.1	10.9
Deandre Ayton	16.7	11.1	0.76	21.58	34
Drew Eubanks	5.1	4.3	0.81	10.39	2.3
Kristaps Porziņģis	12.3	4.4	1.57	17.17	29.3
Nic Claxton	11.8	9.9	2.06	24.92	27.6
Joel Embiid	34.7	11	1.69	33.33	51.4
Jakob Poeltl	11.1	8.6	1.52	20.64	19.5
Clint Capela	11.5	10.6	1.45	22.45	22.3
Evan Mobley	15.7	9.4	1.44	22.88	11.2
James Wiseman	7.1	5.3	0.62	11.24	2.2
Myles Turner	17.1	6.9	1.87	23.09	2.7

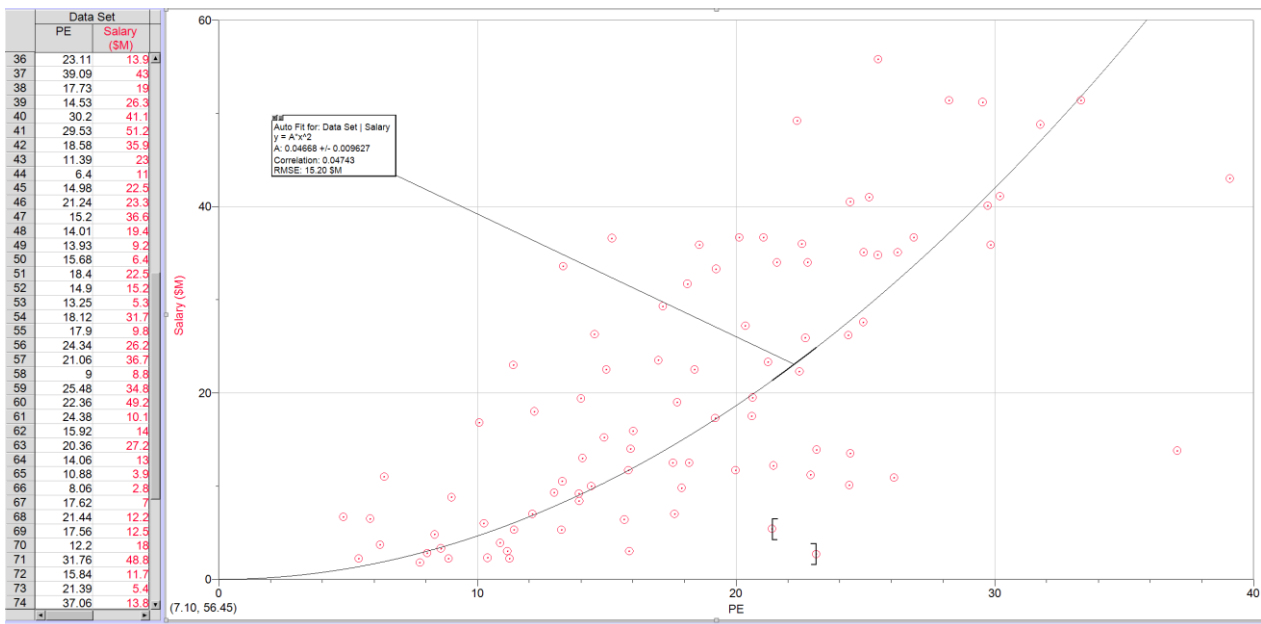


Figure 3: The scatter diagram of PE and salary.

Result Details & Calculation

X Values

$$\Sigma = 1740.786$$

$$\text{Mean} = 19.342$$

$$\Sigma(X - M_x)^2 = SS_x = 4548.438$$

Y Values

$$\Sigma = 1829.3$$

$$\text{Mean} = 20.326$$

$$\Sigma(Y - M_y)^2 = SS_y = 19172.011$$

X and Y Combined

$$N = 90$$

$$\Sigma(X - M_x)(Y - M_y) = 4455.386$$

R Calculation

$$r = \Sigma((X - M_x)(Y - M_y)) / \sqrt{(SS_x)(SS_y)}$$

$$r = 4455.386 / \sqrt{(4548.438)(19172.011)} = 0.4771$$

Meta Numerics (cross-check)

$$r = 0.4771$$

The calculation of the Pearson Correlation Coefficient is displayed on the left.↵

A coefficient of 0.477 shows that NBA has a moderately distributed salary system.↵

Figure 4: detailed calculation steps for Pearson Correlation Coefficient.

4.2. Verification of Hypothesis

From Graph 1, the paper can find out through a line of best fit that the correlation between salary and PE value can be written in the way of $Y=kx^n$, and through a deeper trial of various k and n , the best notation of the correlation is $S=0.047PE^2$.

The correlation is moderate and can be shown in a formula, which verifies the hypothesis mentioned before (Figure 3 and Figure 4).

5. Suggestions

During the data collection, a shortcoming of the NBA salary system is really obvious. Some players have an extremely low PE value but still receiving salaries higher than \$20M or more. This phenomenon can take place in all kinds of professional and commercial sports league. Reasons of this situation to happen can be either:

For players over the age of 30, they lose the ambition of chasing a championship, and turn to earn a larger and longer contracts to have a comfortable life after retirement. When they end up signing a three-year or more contract, some of them choose to give up instead of making positive influence to the team.

To turn the situation over, the NBA company has to improve the motivation of players. For example, the contracts for players over 30 years old must achieve one or two certain goals, such as reaching a PE value of 20, to get full of their salaries. Or a better and more ethical way is lower the salary line of those players with an additional bonus for better performance.

Still take the NBA as an example, in ideal condition (no postpone decision or unsafe game environment), a player has to play 8 pre-season games, 82 in regular season. Therefore, the least games played by a player in ideal condition is 90. With the introduction of In-season tournament, the two teams that get into final has to play an extra game than others. Which means to an extreme extent

(if a player is unlucky enough to play the maximum number of games), 83 in season games, 8 pre-season games, 28 playoff games, also during Olympic years, 6 additional games are required. In total, a player has to play 90 to 125 games a season, lasting from early October to June or July. The schedule cares nothing about the mental and physical health of players and may lead to unwillingness to spend efforts on the court.

The suggestion to this is that companies like the NBA or premier league cutting the number of games or shortening the schedule of extra tournaments. For example, the FA Cup includes 10 rounds of eliminated games, a draw will lead to an additional game and that is the worst situation players want to see. By shortening the number of teams can directly cut the games of this tournament.

Suggestions from this study will be studying some contract related legislations from the NBA, such as the salary cap of NBA, where the teams will have to pay luxury tax if they pass the salary cap. It allows the teams to offer more large contracts and therefore become more appealing to those big players in the market. This can promote to a positive competition between clubs with ambitions. Also, if the premier league really cares about low-income players, they should set up a minimum percentage of wage related to the games attended. For example, a player has to be paid at least 10K Euros per week if he is going to attend 10 or more games. In this way, both the chance to step onto the court and the wage of players are protected.

6. Conclusion

In the passage, researchers provide a step-by-step process of investigating the correlation between salaries and performance, from introduction to data collection, leaving hypothesis then through some analysis and come to a result. It is verified that the salaries of players do have a strong positive correlation with the performance of players, and can be shown as $S=0.047PE^2$.

The research only takes five types of stats from only basketball to find the correlation. Although most sports league work in similar way according to common knowledge, some uncommon conditions can make a difference. The players picked from each team may not be sufficient to be the samples, probably more middle-class and lower-level players can help with the effectiveness of the experiment

Because NBA rookies are asked to sign a rookie contract which has a lower salary than regular ones, outliers can't be avoided in Diagram1. However, the number of outliers can be reduced by selecting more of the experienced and famous NBA players who have higher and longer contracts.

The research can be put into further use and development in the area of balancing wage distribution of players in professional leagues. It can be a reference when managers are trying to improve the current situation that they are unsatisfied with.

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