

Exploring Basketball: Value Differential Between 2 pt vs 3 pt Shots and Number of Shots

Abstract

This paper explores the question of: how does taking a 2 point versus a 3 point shot cause a difference in total points based on the number of shots taken for various players? We found that there was a correlation between total number of points and professional players. We then turned to investigate the relationships between point shot attempts, number of shots taken, and professional players. We also created linear models for each player to demonstrate the relationship, which indicated that using Monte Carlo simulation allows us to predict total points that a player will score based on the number of shots and which point shot they take. After discovering the significant relationships, we created a Shiny app, which is an interactive web app based on R that allows the user to determine the total number points based on 2 point or 3 point shots by providing the interested player and number of attempted shots. This app was created using the same logic as the linear graphs and a picture sample is pasted in Appendix B.

These findings seem to support the notion that sports teams are able to predict game outcomes. This makes it clear taking a 2 point or 3 point shot strongly relates to both the number of shots taken and the player which can be used to create strategies by teams and realize their advantages and disadvantages based on the opposing team.

I. Background and Introduction

The game of basketball was invented in 1891 by James Naismith, but it was not until 1979 that the game of basketball adopted the 3 point line. With current players and an evolving game, many have said that the 3 point shot has forever changed the game of basketball. Our team is concerned specifically with the question of: how does taking a 2 point versus a 3 point shot cause a difference in total points based on the number of shots taken for various players? By researching this, we explore relationships that touch on these varying topics of shot type, number of shots, and professional basketball players in order to better understand if there are any advantages or disadvantages for a player. The findings of this project can be used as evidence not only by professional basketball teams, but by any sports teams, to predict point outcomes of a game and show the importance of understanding the team's advantages compared to the opposing team.

We wanted to experiment and visualize the impact the 3 point shot has compared to the 2 point shot. To do this, we created a function for each player with the argument number of shots, which is the number of shots the user wants to simulate of each player, with their given 2 and 3 point percentages, taken from their season average of the 2020-21 season prior to April 16, 2021.

II. Data and Exploratory Analysis

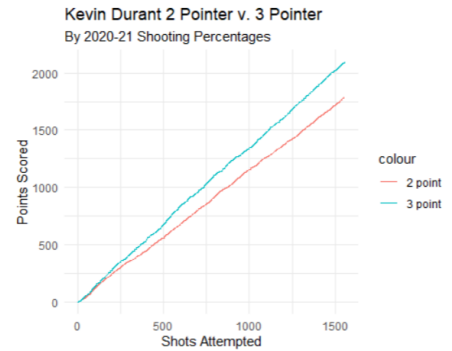
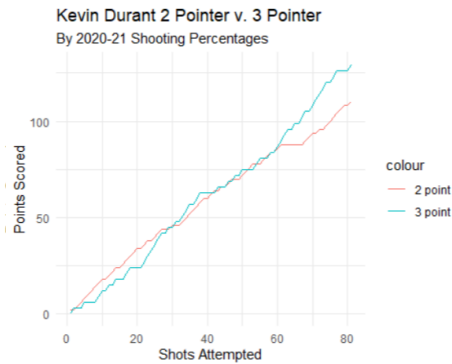
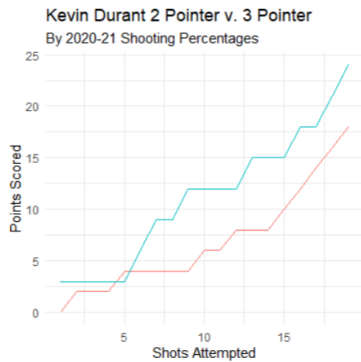
One dataset was used to address our research question. The dataset contained the season average of the 2020-21 season prior to April 16, 2021. This dataset was accessed from ESPN. The data itself was compiled by the National Basketball Association. This dataset contains variables describing the 2 pointer and 3 pointer shooting percentages during this season for multiple players. We wanted to understand the

differences in total points across multiple players in our dataset. The visualizations in Figure 1 allowed us to identify some preliminary trends regarding the relationship between total points, player, and number of attempted shots.

III. Results

We exclusively focused on data from the 2020-21 NBA season. To give a better story, we evaluated each player, based on a significant number of shots. 19 shots to represent the number of shots star players take per game on average, 81 shots to represent the number of shots a team takes per game on average, 1558 shots to represent the number of shots a player will take during a season given 19 shots per game and 82 games. and 100,000 shots to give a more clear visualization of what shot is most beneficial to the team for each individual player to take. To conduct this study, we chose 10 players, listed below, which includes some Superstars, some other high level players, and a couple of rookies: Kevin Durant, Stephen Curry, Damian Lillard, LeBron James, Saddiq Bey, James Harden, Kyrie Irving, Trae Young, Luka Doncic, Lamelo Ball

First, we will discuss how the Monte Carlo simulation helped increase the legitimacy of the research question by taking Kevin Durant as our player while increasing the number of attempted shots to show how a higher number of shots gives a better understanding of total points per shot attempt. Figure 1 shows the different linear graphs based on the number of shots attempted. The left-most graph shows a very jagged-lined line graph due to a low number of simulated shot attempts. The lower the number of shot attempts the less accurate we will be in predicting and assessing a players value based on the shot attempt. As the Central Limit Theorem states, as the number of simulations increase, in our case number of shots, the more accurate the assessment we can make and the more linear the graphs will appear. So, we experimented and continuously increased the number of shots for each player to understand how it affects the accuracy and simultaneously discover the advantages of taking a 2-pointer versus a 3-pointer or vice versa. In the middle graph in Figure 1, we increased the number of shot attempts to get a better accuracy. Even though the number of iterations, or the x-axis, is larger, it is still not accurate as the lines are still jagged, so it is not entirely a linear graph. Also, this graph completely contradicts graph 1 as it shows that Kevin Durant has a slight advantage if he only shoots 2-pointers under approximately 30 shots, unlike the first graph. So, there is no certain way for us to determine if the statistics are correct. So, we continued to increase the x-axis to comply with the Monte Carlo method until we reached the third graph in Figure 1. The lines are straight and show us a much better relationship between the player, shot type, and number of shots. By looking at this graph, we can see that Kevin Durant has a much higher advantage in taking 3 point shots, which tells us that the Brooklyn Nets should utilize his 3-point shot which will give them a very good chance of winning a game.



We have added graphs of the other players that we researched in Appendix A which will show similar graphs to the ones in Figure 1. These graphs will show that some players have a 2 point advantage while others have a 3 point advantage.

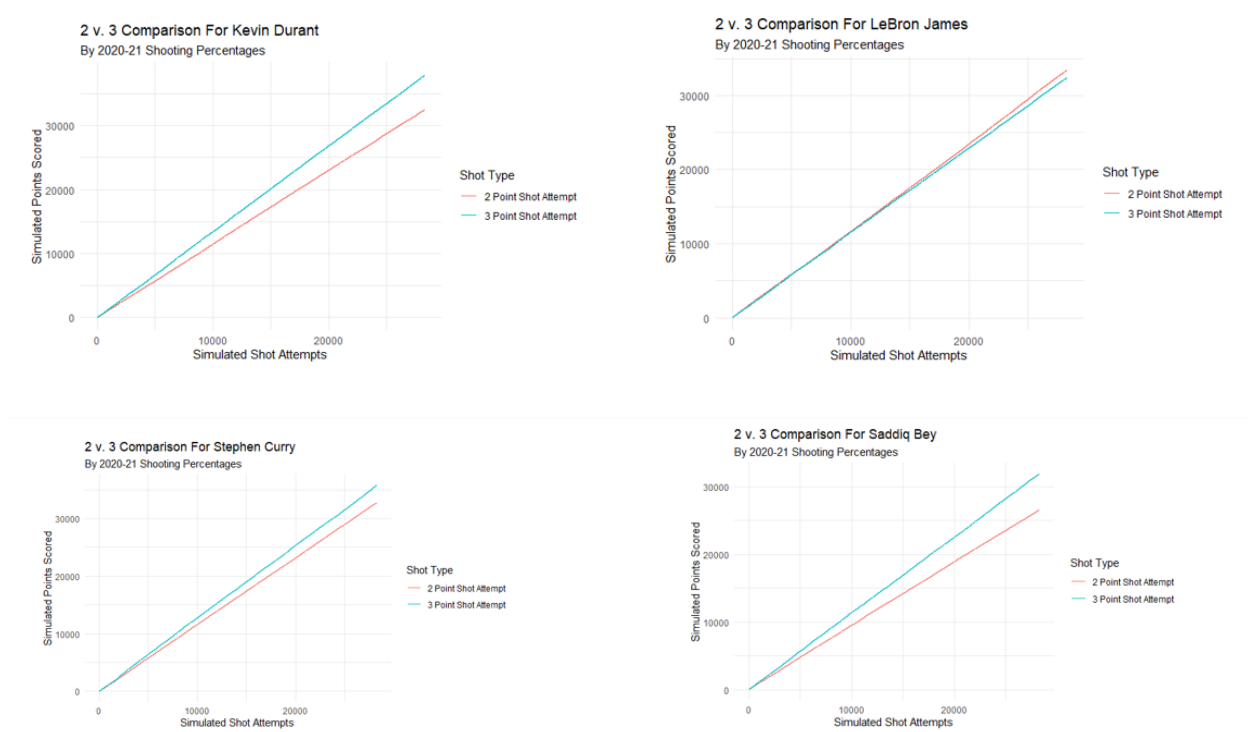
IV. Discussion and Conclusion

We began our investigation with the question, how does taking a 2 point versus a 3 point shot cause a difference in total points based on the number of shots taken for various players? To break down this question, we first found that there was a statistically significant relationship between total number of points and basketball players. We then turned to investigate the relationships between shot point type, number of shots, and player. We created multiple linear models in R using the Monte Carlo method which indicated there is a positive linear association between total number of points versus the player and number of shots. This model may also benefit from more explanatory variables that are not sports-related. We then found sufficient evidence to conclude that there are certain players that have a 2 point advantage while others have a 3 point advantage.

For further research, we may want to look into data that is from multiple seasons instead of only the 2020-21 season. For example, if we take Kevin Durant and look at his make and miss percentages since his debut season, we can find the trends in his make and miss percentages which can then be used to create these linear graphs for future years and games. This analysis can also be used to predict how he will score against a certain team in future games which can be used to create strategies by his team. We mainly focused on shot attempts, but there are other important trends in player make and miss percentages, like injuries or opposing teams, which may be interesting topics to explore.

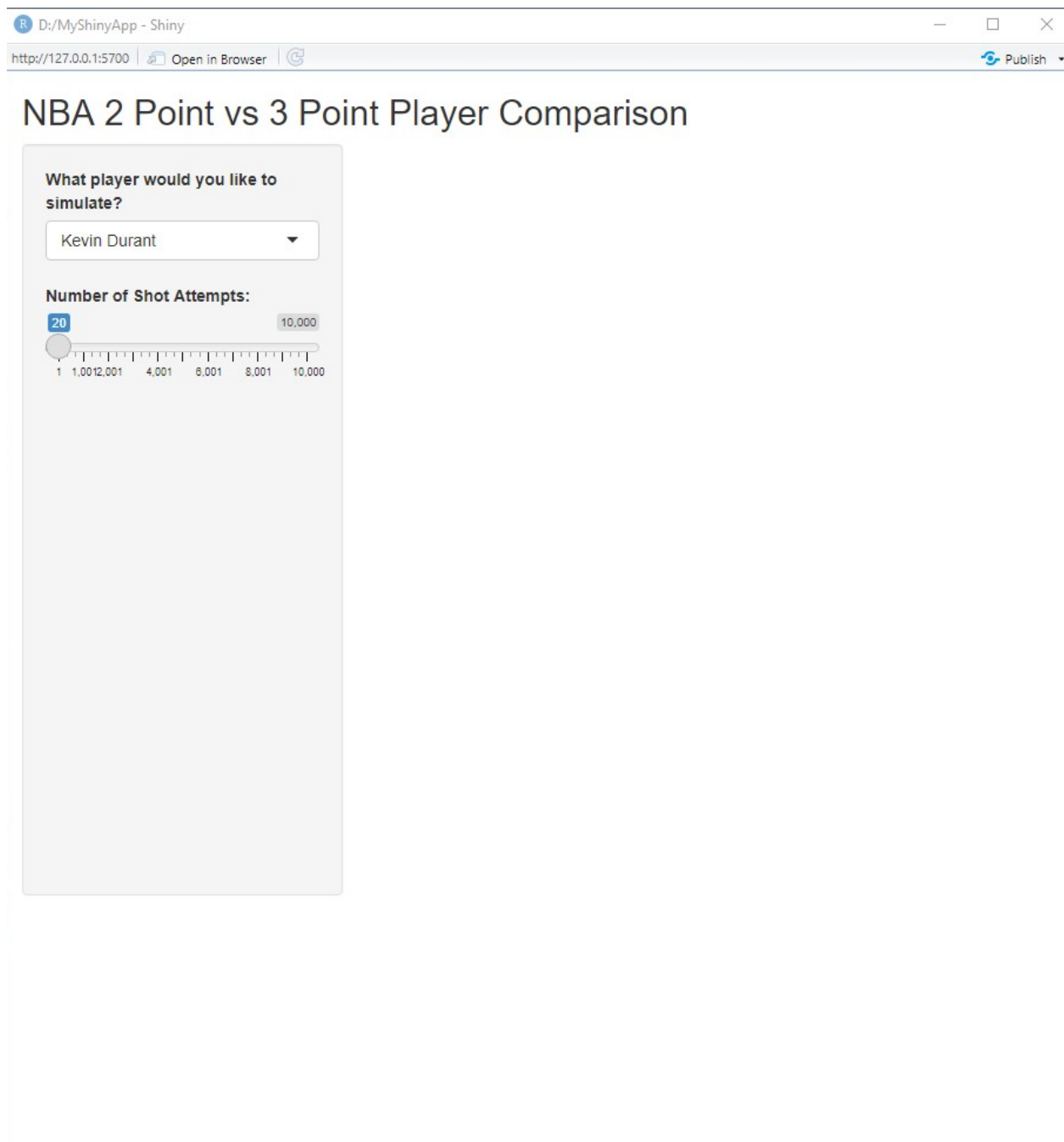
In conclusion, our exploration shows strong evidence that there is a positive correlation between player, shot point, and number of shots. It also provides important insights into how a player can be utilized to obtain the maximum amount of points in a game, which in turn can help create stronger advantages and strategies. These findings seem to support that sports teams are able to predict game outcomes. We did not explore other underlying factors, such as injuries, as a driving force of the relationship. We can expect that players with injuries have a higher miss percentage for both 2 point and 3 point shots. Although our analysis does have limitations, our findings can support advocacy for using statistics in sports as a way to predict outcomes and create better strategies.

Appendix A



These visualizations show the total number of points different players will score. By looking at these graphs, we can see that most of the players have a higher score when taking 3 point shots. However, LeBron James has an interesting case where it almost does not matter whether he takes a 2 point versus 3 point shot. This shows that in either case, LeBron James has equal advantage and has more flexibility in game strategies.

Appendix B



This is the app that we started to create. This app requires user selection of the player and number of shots and generates a graph that shows the total number of points, similar to the graphs discussed previously. The graphs are based in R and use the Monte Carlo simulation to calculate the points for each shot iteratively based on the make or miss percentages in the dataset. As these plots are generated in real-time, the user can interact and see how 500 shots compares to 5,000 shots and also determine the advantages and disadvantages of a player.