

Beyond the Arc: The Impact of 3 point Shooting in the Modern NBA*

Analysing the relationship between a team's 3 point shooting and their success in the regular season

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In recent years, the three-point shot has emerged as a key aspect of basketball strategy in the NBA. Analyzing season-wise NBA data, we assess how teams' three-point performance influences their overall wins. Employing Bayesian Generalized Linear Model, we quantify this relationship, considering factors like team three-point averages across regular seasons. The findings underscore the significance of three-point shooting in NBA success, offering insights into team strategies, player growth, and basketball analytics. Ethical considerations and study constraints are also addressed.

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*Code and data are available at: <https://github.com/aryamansuri/NBA-3PointAnalysis>

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1 Introduction

The three point line was introduced in the NBA in the 1979-80 season (NBA Media Ventures (1990)) and has since altered the nature and balance of the game. Instead of the game being centered around the big man or athletic wings, the 3 point shot gave everybody on the team a new powerful weapon on offenses. Today, there are 155 players who averaged at least one made three pointer in the 2022-23 regular season (NBA Media Ventures (2023)).

This paper explores the association between three-point shooting measures and win probability using advanced statistical techniques after analyzing season-wise data. The findings highlight the importance of three-point shooting efficiency as a predictor of team performance in modern basketball and how important it is to be a good three point shooting team for success in today's game.

Understanding this link has ramifications for numerous parties, including coaches, players, analysts, and team administration. This study adds to the ongoing debate in the NBA about strategic decision-making and player development by explaining the significance of three-point shooting in deciding game outcomes (Muniowski (2020)). Essentially, the estimand of this paper is analysing if an increase in a team's three point shooting ability contributes to an increase in the team's success, measured by wins.

This paper begins by exploring the underlying data in Section 2, which provides insights into the variables and metrics used in the analyses. Following that, the complexities of the modelling approach are explained in Section 3, including describing the reasoning behind the statistical techniques and justifying the methodology. The results of the analysis are discussed in Section 4, diving into the empirical findings and their implications for understanding the relationship between three-point shooting efficiency and NBA team success. Section 5 contextualizes the findings of this paper within the larger view of basketball analytics, emphasizing significant takeaways. Finally, the findings and proposed paths for future research are summarized in Section 5.3.

2 Data

This study, utilizes data sourced from the NBA's official database (NBA Media Ventures (2001a)) to examine the relationship between various team performance metrics and their cor-

responding winning percentages throughout the regular season. The analysis aims to uncover insights into the factors contributing to team success in the NBA, specifically 3 point shooting. The NBA's database serves as a complete repository of statistical information on teams, players, and games, providing valuable insights into the dynamics of professional basketball. The below sections provide a detailed overview of the data collection process, cleaning procedures, and subsequent analysis.

2.1 Data Sources

All raw data utilized in this study was collected from the official NBA database (NBA Media Ventures (2001a)), which aggregates statistics on team performance, player performances, and game outcomes throughout the league's history. Since this study only focuses on the modern NBA, which is defined as the era from the 2014-15 season onward (Schuhmann (2021)), the season wise data had to be individually downloaded and combined. Additionally, since the 2019-20 season was shortened due to the COVID-19 outbreak and an equal number of games was not played by all teams (staff (2020)), data from that season is excluded from this study to ensure consistency. The aggregated dataset is then stored as the `raw_data2.xlsx` file using the *writexl* package (Ooms (2024b)). This dataset comprises data from 30 teams over 8 seasons, including team statistics such as points scored, rebounds, assists, turnovers, and various other performance metrics recorded over multiple seasons.

2.2 Data Cleaning

Upon acquiring the raw data from NBA.com (NBA Media Ventures (2001a)), extensive cleaning procedures were implemented to ensure its suitability for analysis. This involved addressing missing or erroneous values, standardizing variable names, and aggregating data at the team level to facilitate meaningful comparisons across different seasons and teams. Additionally, I computed additional variables such as win percentages, and filtered the data to only include winning stats and 3 point stats using the *group_by* (Wickham (2024)) package. This dataset is then stored in the analysis data as a csv file (Ooms (2024a)).

2.3 Data Analysis

With the cleaned dataset in hand as seen in Table 1, I conducted a rigorous analysis to explore the relationships between 3 point shot performance metrics and team success in the NBA. Various statistical techniques were employed, including descriptive analysis, correlation analysis, and regression modeling, to identify significant predictors of winning percentages. Furthermore, I visualized the data through graphs and tables to elucidate trends and patterns in team performance across different seasons.

Table 1: Summary table of the cleaned dataset

Team	Games	Wins	Loss	Win%	3PM	3PA	3P%	Box +/-
Golden State Warriors	82	67	15	0.817	10.8	27.0	39.8	10.1
Atlanta Hawks	82	60	22	0.732	10.0	26.2	38.0	5.4
Houston Rockets	82	56	26	0.683	11.4	32.7	34.8	3.4
LA Clippers	82	56	26	0.683	10.1	26.9	37.6	6.6
Memphis Grizzlies	82	55	27	0.671	5.2	15.2	33.9	3.2
San Antonio Spurs	82	55	27	0.671	8.3	22.5	36.7	6.2

By segmenting the data by season and team, I was able to conduct a detailed examination of performance trends over time and assess the impact of various factors on team success. This analysis provides valuable insights for coaches, analysts, and basketball enthusiasts seeking to understand the drivers of success in the NBA.

2.4 Variables of Interest

In this study, our focus is solely on win counts and three-point statistics. With this objective in mind, our key variables of interest include Games Played (**GP**), Wins (**W**), Losses (**L**), Three-Pointers Made per game (**3PM**), Three-Pointers Attempted per game (**3PA**), and Three-Point Shooting Percentage (**3P%**). Our modeling approach will specifically incorporate Wins (**W**) and **3PM** to explore their relationship.

We've deliberately opted for **3PM** over **3PA** and **3P%** for several reasons. **3PM** serves as a accurate metric, capturing a team's volume of successful three-point shots with reasonable efficiency. Unlike **3PA**, which might bias the model towards teams overly reliant on three-point attempts irrespective of their success rate, **3PM** provides a balanced representation of both volume and efficiency in three-point shooting. Similarly, **3P%** could skew the analysis towards teams with lower volumes of three-point attempts, overlooking the broader spectrum of team performance.

By prioritizing **3PM** alongside Wins, our model aims to uncover insights into the impact of three-point scoring on overall team success while mitigating potential biases associated with alternative metrics. This strategic selection ensures a detailed exploration of the relationship between three-point performance and winning outcomes in NBA games.

3 Model

The goal of my modeling strategy is two fold. First, I want to analyze the effect of 3 point shooting on team success defined by wins. Secondly, I want to predict NBA team wins based on the number of 3-point field goals made by each team throughout the regular season.

Here I briefly describe the Bayesian analysis model used to investigate the relationship between 3-point field goals made and team wins.

3.1 Model set-up

Let y_i represent the number of wins for team i throughout a given season, and let β_{3pts} denote the effect of 3-point field goals made on team wins. The number of 3-point field goals made per game ($3pts_i$) by team i is the predictor variable considered in this model.

$$y_i | \mu_i, \sigma \sim \text{Normal}(\mu_i, \sigma) \quad (1)$$

$$\mu_i = \alpha + \beta_{3pts} \times 3pts_i \quad (2)$$

$$\alpha \sim \text{Normal}(0, 2.5) \quad (3)$$

$$\beta_{3pts} \sim \text{Normal}(0, 2.5) \quad (4)$$

$$\sigma \sim \text{Exponential}(1) \quad (5)$$

We run the model in R (R Core Team 2022) using the `rstanarm` (Goodrich et al. (2022)) package. The default priors from `rstanarm` are utilized.

3.2 Model justification

I hypothesize a positive relationship between the number of 3-point field goals made by a team and their number of wins throughout the regular NBA season. This hypothesis is rooted in the understanding that teams with higher 3-point shooting efficiency typically demonstrate stronger offensive capabilities, which often translate into higher-scoring games and, consequently, more victories. This relationship is particularly pertinent in today's NBA, where teams increasingly prioritize offensive strategies and exploit the scoring potential offered by 3-point shots.

The chosen Bayesian analysis model (Goodrich et al. (2022)) aims to quantitatively assess the impact of 3-point field goals made on team wins and to provide insights into the significance of this performance metric in determining overall team success. By modeling the relationship between 3-point field goals made and wins using a normal distribution for the response variable, we acknowledge the continuous nature of team wins and seek to capture the variability in win counts across different levels of 3-point shooting proficiency. This approach allows for an understanding of how variations in 3-point performance contribute to variations in team outcomes, thereby elucidating the importance of 3-point shooting in the context of NBA team success. Simply put, teams that excel in scoring 3-point shots are more likely to outscore their opponents and win the games.

4 Results

Our results are summarized in Table 2.

Table 2: Explanatory models of Team success based on 3 Points

Parameters	Mean	SD	P10	P50	P90	mcse	Rhat	n_eff
(Intercept)	27.8	3.5	23.4	27.8	32.2	0.1	1	3811
3PM	1.2	0.3	0.8	1.2	1.6	0.0	1	3848
sigma	11.6	0.5	10.9	11.5	12.3	0.0	1	3536
mean_PPD	40.3	1.1	39.0	40.3	41.7	0.0	1	3764

In the context of the NBA, the interpretation of the model is provided below.

The **Intercept (27.8)** represents the estimated mean number of wins when the number of 3-point shots made (3PM) is zero. In other words, when a team makes zero 3-point shots, the model estimates that they would win approximately 27.8 games on average. The **3PM (1.2)** coefficient represents the change in the estimated mean number of wins for each additional 3-point shot made by a team. In this case, for every additional 3-point shot made per game over the season, the model predicts an increase of approximately 1.2 wins on average. The **Sigma (11.6)** parameter represents the estimated standard deviation of the error term in the model. It indicates the variability in team success (measured by the number of wins) that is not explained by the number of 3-point shots made. The **Mean_PPD (40.3)** represents the average posterior predictive distribution of the outcome variable (number of wins). It provides an estimate of the average number of wins predicted by the model.

Overall, based on these estimates, it appears that there is a positive association between the number of 3-point shots made by a team and their success, as measured by the number of wins. Teams that make more 3-point shots tend to win more games on average, according to the model. However, it's essential to consider other factors not included in the model that may also influence team success.

Figure 1 shows us a visual representation of how 3 point shots made are related to the wins of a team. The graph illustrates a positive correlation between the number of 3-point shots made per game and team wins, indicating the importance of proficient long-range shooting in securing victories. However, outliers exist, suggesting that factors beyond 3-point shooting also influence team success. We discuss these in detail in the discussion portion.

If we group our statistics by team (Wickham (2024)), we can gain valuable insights into which teams benefit most from their three-point shooting prowess. Table 3 presents a detailed breakdown of win statistics and three-point shooting statistics grouped by team for the seasons of interest. The table is sorted in descending order of wins, allowing us to identify the top-performing teams. By examining this table, we can discern trends, such as the correlation

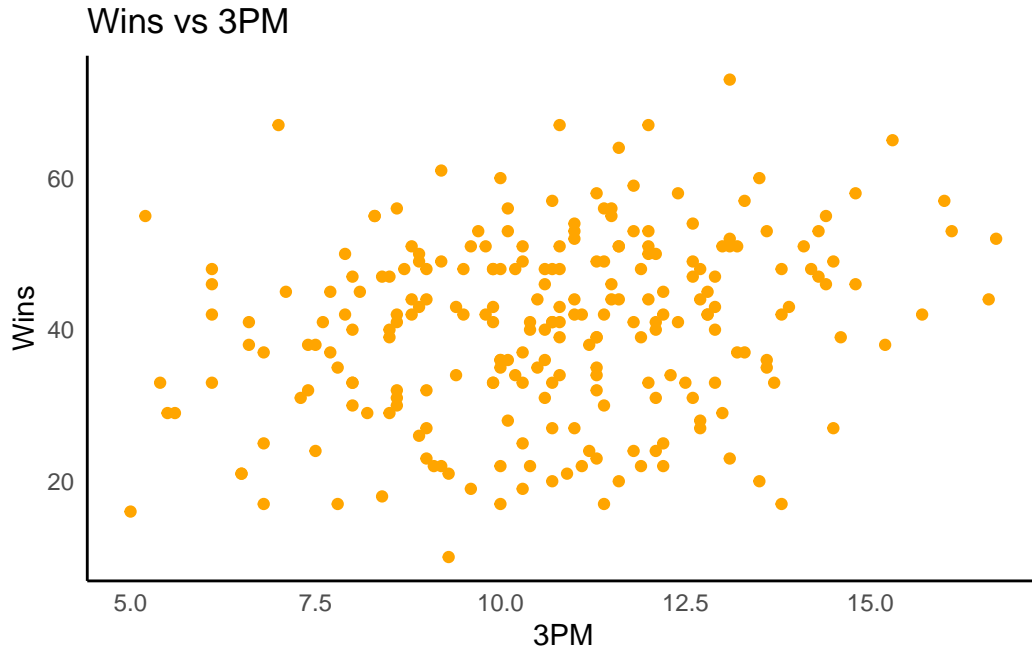


Figure 1: Scatterplot depicting the **Wins** vs the **3 Points Made** per game by all teams across the seasons 2014-15 to 2022-23

between three-point shooting and team success, and identify standout performers in each category.

Figure 2 shows the average 3 point shots made per game across the 8 seasons that are involved in our study.

Figure 3, plotted using ggplot (Wickham (2016)) illustrates the association between the average number of 3-point shots made per game and the average number of wins per season for NBA teams. The black points represent observed average wins, while the orange line depicts predicted wins based on a statistical model. This model suggests a relationship between 3-point shooting proficiency and team success. Comparing the orange line with the black points allows for an evaluation of the model's predictive accuracy.

Table 3: Summary of Team statistics across seasons 2014-15 through 2022-23

Team	Games	Wins	3PM	3PA	Avg Wins	Avg 3PM
Golden State Warriors	646	458	106.0	274.4	57.25	13.25
Boston Celtics	646	389	95.6	265.1	48.62	11.95
Toronto Raptors	646	389	87.6	245.1	48.62	10.95
LA Clippers	646	383	89.4	235.8	47.88	11.18
Milwaukee Bucks	646	375	86.4	236.3	46.88	10.80
San Antonio Spurs	646	367	75.2	206.5	45.88	9.40
Utah Jazz	646	365	92.9	256.3	45.62	11.61
Denver Nuggets	646	351	86.5	240.9	43.88	10.81
Cleveland Cavaliers	646	347	89.3	246.3	43.38	11.16
Miami Heat	646	346	83.6	235.0	43.25	10.45
Memphis Grizzlies	646	340	74.5	213.6	42.50	9.31
Portland Trail Blazers	646	340	93.3	255.1	42.50	11.66
Oklahoma City Thunder	646	330	82.6	241.8	41.25	10.32
Atlanta Hawks	646	329	89.1	247.0	41.12	11.14
Houston Rockets	646	329	105.6	302.8	41.12	13.20
Indiana Pacers	646	315	80.8	223.5	39.38	10.10
Washington Wizards	646	315	77.1	216.9	39.38	9.64
Dallas Mavericks	646	314	95.8	270.1	39.25	11.97
Philadelphia 76ers	646	313	85.1	238.1	39.12	10.64
Chicago Bulls	646	299	77.1	214.7	37.38	9.64
New Orleans Pelicans	646	299	77.8	220.6	37.38	9.72
Charlotte Hornets	646	295	86.9	245.9	36.88	10.86
Brooklyn Nets	646	286	87.8	243.4	35.75	10.97
Phoenix Suns	646	286	80.8	229.7	35.75	10.10
Minnesota Timberwolves	646	270	76.0	215.7	33.75	9.50
Sacramento Kings	646	269	80.2	220.5	33.62	10.03
Los Angeles Lakers	646	254	77.4	226.2	31.75	9.68
Detroit Pistons	646	253	82.5	238.1	31.62	10.31
New York Knicks	646	251	78.6	221.3	31.38	9.82
Orlando Magic	646	233	78.7	229.0	29.12	9.84

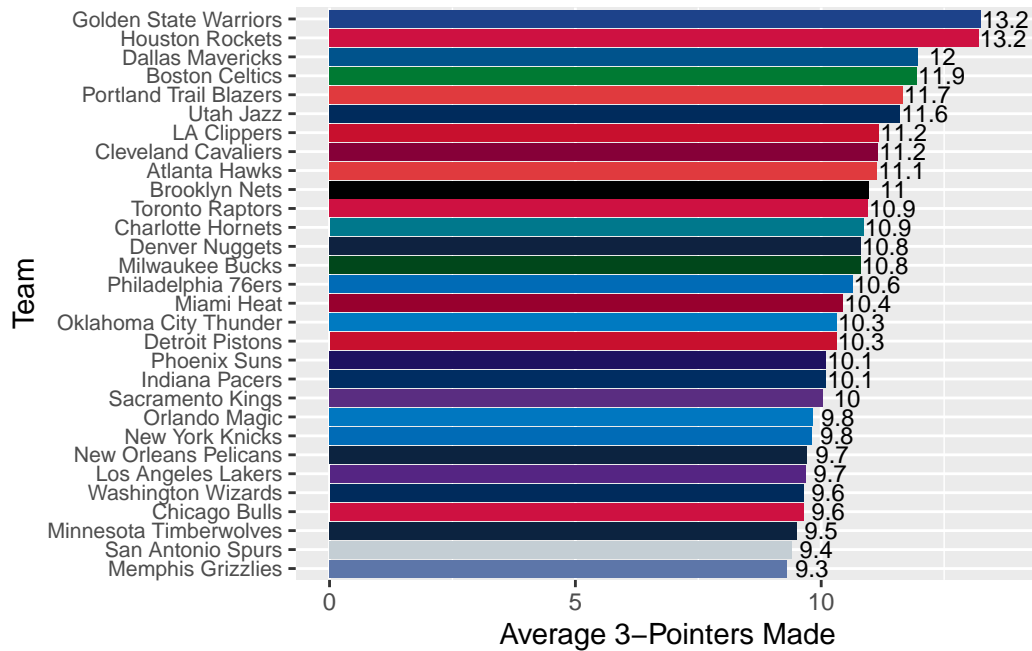


Figure 2: Visualization of Average 3-Pointers Made per Game Across NBA Seasons

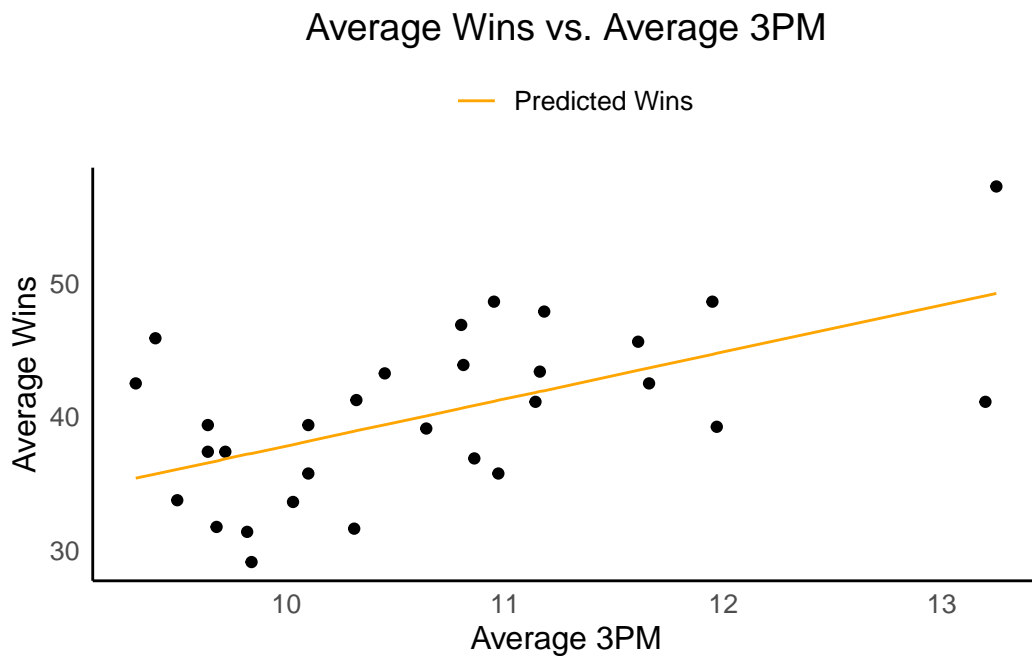


Figure 3: Relationship Between Average Team Wins, Predicted Wins, and Average Three-Point Shots Made per Game

5 Discussion

In this study, we aimed to investigate the relationship between three-point shooting efficiency and team success in the NBA. Our analysis involved a detailed examination of season-wise NBA statistics, focusing on variables such as three-pointers made (3PM) and team wins (W). We employed advanced statistical techniques, including data cleaning, correlation analysis, and regression modeling, to uncover insights into the impact of three-point shooting on team performance. By analyzing the data and modeling the relationship between 3PM and W, we sought to show the significance of three-point shooting as a predictor of NBA team success.

Our analysis revealed a compelling association between three-point shooting proficiency and team success in the NBA. We found that teams with higher rates of three-pointers made per game tended to achieve more wins over the course of the regular season. This suggests that three-point shooting plays a key role in determining the outcome of NBA games, with proficient long-range shooters contributing significantly to their team’s overall success. These findings underscore the strategic importance of three-point shooting in modern basketball and highlight its impact on team performance. Additionally, our analysis uncovered insights into the dynamics of three-point shooting and team success. We observed variations in the relationship between 3PM and W across different teams and seasons, indicating that the impact of three-point shooting may vary based on contextual factors such as team composition, playing style, and opponent strategies. Furthermore, our findings suggest that while three-point shooting is a significant predictor of team success, it is not the sole determinant, with other factors such as defense, rebounding, and overall offensive efficiency also influencing and determining game outcomes.

5.1 Weaknesses

Despite the rigor of our analysis, several limitations warrant consideration. One potential limitation is the reliance on aggregate team statistics, which may overlook individual player contributions and team dynamics that could influence the relationship between 3PM and W. Additionally, our analysis focused solely on regular-season data, excluding playoff games, which may have different dynamics and performance factors since the game is known to “slow down” in the playoffs. This can be caused by teams specifically executing strategies to identify and take advantage of the opponents weaknesses over a 7 game series.

Furthermore, while our modeling approach accounted for various factors, including team performance metrics and game outcomes, it may not capture all relevant variables that could impact the relationship between three-point shooting and team success. Success in the NBA cannot simply be boiled down to efficient volume three point shooting since it is a complex game with many other factors contributing to a team’s overall success.

5.2 Drawbacks of the 3 point revolution

Although this paper discusses the upside of the three point line, I feel it is important to also include its drawbacks. An interesting example of this in the modern NBA is the 2017-18 Houston Rockets. The Houston Rockets' general manager was a huge fan of the three point shot and in the 2017-18 season built an entire roster around 3 point shooting (Altridge (2017)). This team was a huge success in the regular season and they shot more 3 pointers than any other team in league history. What he failed to take into account was that basketball isn't math. While the Rockets were the most successful regular season team with 65 wins (NBA Media Ventures (2001b)), they matched up against the Golden State Warriors in the western conference finals of the playoffs. The series went to seven games, and in game 7, the Rockets essentially shot themselves out of the game. They went 7 for 49 from the arc as a team, which was a record for the worst 3 point shooting in NBA history. This team lived by the three and eventually would die by the three.

In essence, while the three-point shot remains a potent weapon in the modern NBA, its effectiveness is contingent upon an understanding of its role within a team's overall offensive strategy. As the Houston Rockets learned, basketball is not solely a game of statistics—factors such as matchup dynamics, defensive schemes, and clutch performances can influence outcomes in ways that transcend numerical analysis.

5.3 Future Research

Looking ahead, there are plenty of opportunities for future research to build upon our discoveries and tackle the limitations of our study. One promising avenue is to look deeper into the data by analyzing individual player-level statistics. This approach could help us better grasp how specific players contribute to their team's success, providing a deeper understanding of the role of each player in three-point shooting dynamics.

Moreover, conducting longitudinal studies that span multiple seasons could offer valuable insights into the trends and patterns of three-point shooting in the NBA. By tracking team performance over time, researchers could uncover long-term dynamics and factors that influence the effectiveness of three-point strategies.

Additionally, qualitative research methods, such as interviews with players and coaches, present an opportunity to gain unique perspectives on the strategic significance of three-point shooting. Engaging directly with those involved in the game could offer valuable insights into the decision-making processes and team dynamics surrounding three-point strategies.

By exploring these avenues of inquiry, future research has the potential to deepen our understanding of the relationship between three-point shooting and team success in the NBA, contributing to advancements in basketball analytics and strategy.

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