Modeling The Best Time to Attempt a Field Goal in the NBA

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1 Introduction

In the NBA, players and teams are trying to become as efficient as possible in order to give themselves the best chances of winning any given game. In order to do this, it is important for players and coaches to understand the most efficient way to score points. Each possession in the NBA is dictated by a "shot clock." The shot clock is a timer which acts as a time limit which a team has to attempt a field goal each possession. At the start of a possession, a team is given a 24 second shot clock, and if a field goal is not attempted in this time, a violation is given to the offensive team, and possession of the ball is turned over to the other team. Certain situations can also result in the shot clock being reset for the offensive team with 14 seconds rather than 24 [1]. This occurs when the offensive team misses a field goal and is able to regain possession with an offensive rebound, or when a player on offense is fouled with under 14 seconds remaining on the shot clock. The NBA shot clock adds an aspect to the game which players must consider when playing and adds many layers to analyze, such as whether it is best to wait for a shot until later in the shot clock to set up for a good shot, or whether it may be better to attempt a shot early when trying to increase scoring efficiency. The NBA also features multiple possible point values as a result of made field goals, with shots attempted from behind the 3-point line being worth 3 points, and those from inside the line only being worth 2. This adds another layer to be looked at, as it is possible for 3 point or 2 point shot attempts to be more efficient at different times in the shot clock.

With this in mind, and with the increase in popularity and use of advanced statistics and analytics in the NBA in mind, I aim to model the efficiency of NBA field goals attempted throughout different times in the shot clock. This could be interesting to look at, and show whether a faster or slower pacing may be beneficial to NBA teams.

Similar Questions to this have been looked at previously. For example, 82games.com [2] has done something similar, looking at offensive and defensive ratings and their correlation with each shot clock interval looked at, but did this using only four intervals, and only used 29 observations with data from the

2003-04 season, before the shot clock would reset to only 14 seconds after an offensive rebound.

Inpredictable.com also did something similar, looking at the effect of resetting the shot clock to only 14 seconds rather than 24 after an offensive rebound on pacing in the WNBA [3], and found a significant decrease in average seconds per possession after the change.

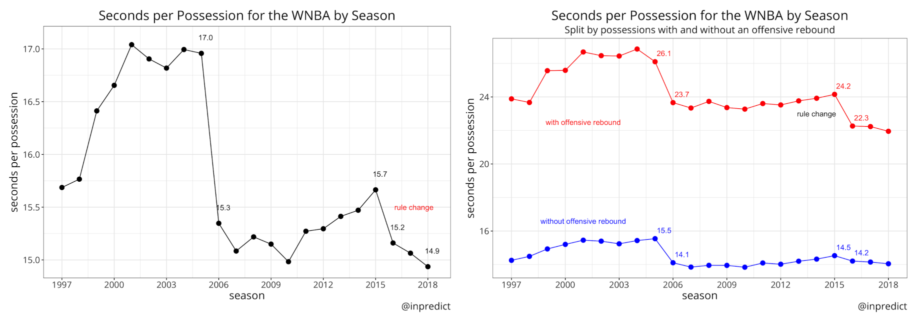


Figure 1: Effect of shot clock on WNBA pacing. Used without permission from [3].

This is interesting, and makes sense, as second chance attempts have less time to be set up with the rule change. However, this is still a different question that is being asked and does not look at field goal efficiency depending on the shot clock.

Another interesting shot clock statistic which has been looked is the idea or question of which players are the most efficient while time is running out or which players are the most "clutch" and effective at scoring under time pressure. In fact, Chris Buetti looked into the most clutch players in the NBA and modeled each player's shooting percentage at each time in the shot clock to find which had an increase in field goal percentage as the shot clock ran down in order to determine who was the most clutch [4].

2 Description

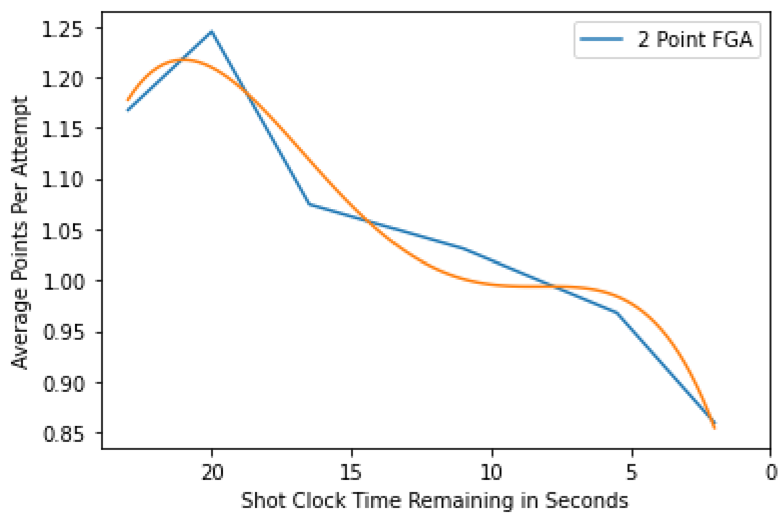
For this model, I will be looking at every NBA season starting with the 2018-2019 season, all the way to the current 2021-2022 season, as this is the only time which the 14 second shot clock reset has been in place. I use data from these years in order to model NBA shot clock efficiencies, for both 2 point as well as 3 point field goal attempts. I will be focusing on modeling the points per field goal attempt for different times at the shot clock. I will be doing this, rather than just looking at the field goal percentage, simply because 3 point shots will have a lower field goal percentage than 2 point shots, simply due to the fact that they are harder to make. However, a 3 point field goal make is worth 1.5 times what a 2 point make is worth, and therefore can be more efficient, even with a lower field goal percentage.

I have modeled 3 different models, for 3 point attempts, 2 point attempts, and for all attempts looking at league-wide effective field goal percentages, a stat which accounts the fact that 3 pointers are worth more than 2 point field goals $eFG\% = (FG+0.5*3P)/FGA$ [5]. I created the models by fitting a least-squares 4th degree polynomial to the 6 data points for shot clock range average values (5th degree polynomial results in interpolation with stranger results).

For each of the images below, the blue curve shows the data at the 6 shot clock intervals given in the data from NBA.com, the orange curve is the 4th degree least squares best fit model.

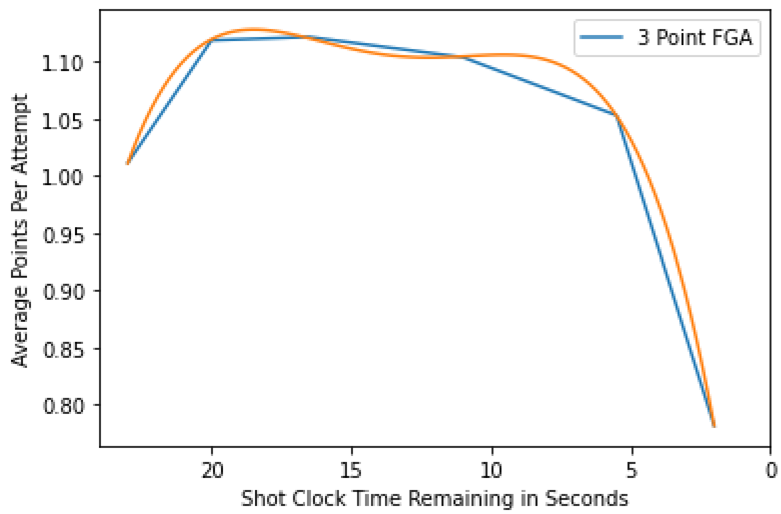
The first model is for 2 point field goal attempts. I found that at time x, the points per 2 point attempt $p(x)$ follows a curve similar to that of

$$-2.507e^{-5}x^4 + 0.001252x^3 - 0.0207x^2 + 0.1421x + 0.6434$$



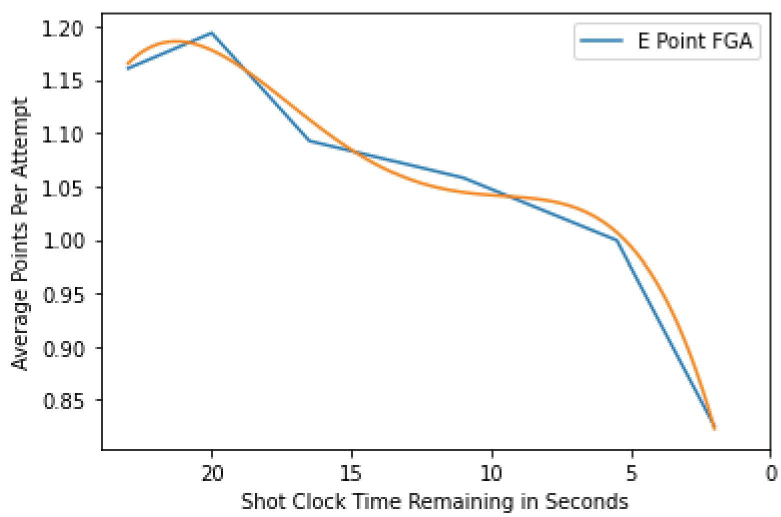
The next model is for 3 point field goal attempts. At time x, points per 3 point attempt $t(x)$ follows

$$t(x) = -2.565e^5x^4 + 0.001377x^3 - 0.02664x^2 + 0.2214x + 0.4348$$



The last model shows points per average field goal attempt, utilizing effective field goal percentage values. At time x, points per attempt $e(x)$ follows

$$e(x) = -2.069e^{-5}x^4 + 0.001109x^3 - 0.02045x^2 + 0.1611x + 0.574$$



3 Data

For these models, I utilized data directly from NBA.com [6], utilizing the nba_api package by Swar Patel [7] to collect data from the official NBA api. Therefore, this should be the most reliable data possible. The data shows teams' field goal percentages for 6 different shot clock ranges: 24-22, 22-18, 18-15, 15-7, 7-4, and

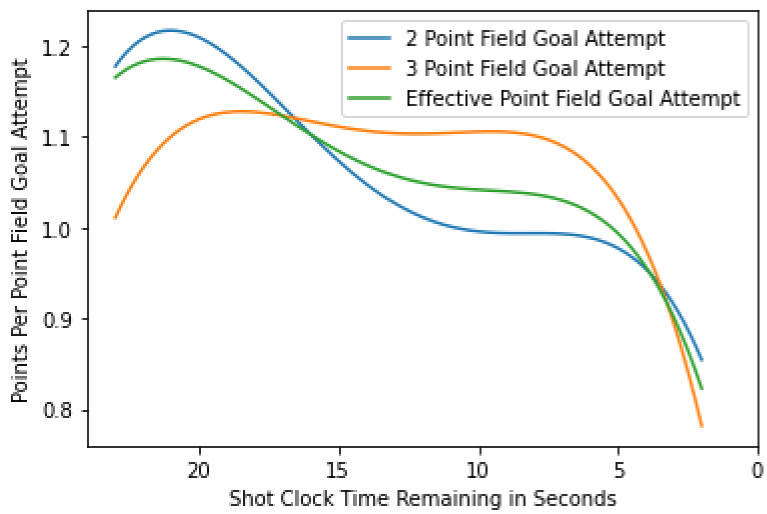
4-0 seconds remaining in the shot clock. Though the data is reliable, it has the drawback that it only shows shot clock percentages for clock ranges, rather than containing each shot's data and exact shot time, resulting in more limited ability to fit a more perfect model to the data.

4 Analysis

Looking at the models, some interesting results can be seen with the information drawn, as well as some clear drawbacks of the models.

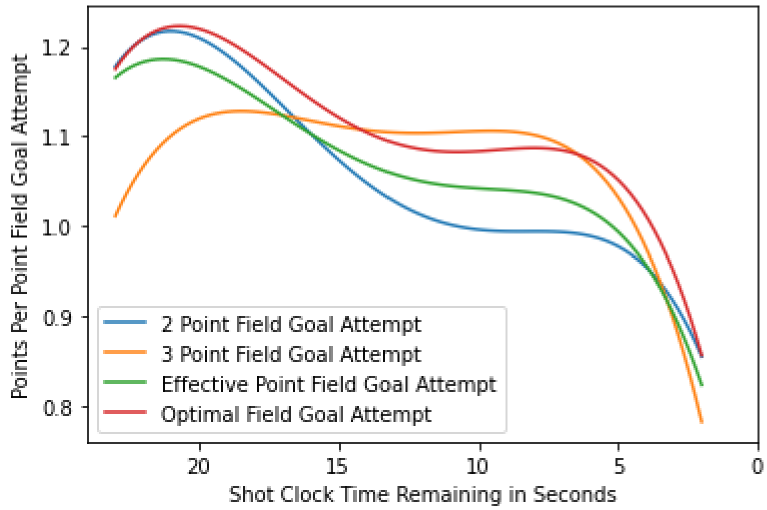
For starters, the models utilizing data at split shot clock intervals is clearly not optimal, as it clearly skews the model to follow heavily around these average points. This is also the main reason I chose to utilize only 4th degree polynomials to model the data, as 5th degree models become an interpolation of the averaged points, showing very little outside of a curve connecting the points.

With that being said, the data is still interesting and shows things which can be useful for NBA teams.



First of all, it is easily seen that the most efficient shots attempted are fast break 2 point field goals, taken at around the 21 second mark. It can also be seen that the 2 point field goal quickly loses value as time goes on, with 3 pointers becoming more efficient for the most part once the defense has gotten set, and taking some time to set up a good three pointer is about as efficient as shooting a 3 in transition. Another interesting thing which can be drawn from this, is that when it comes to desperation or last second buzzer beater shots, 2 point attempts are better than 3 point shots, showing that they are much easier to make in desperation moments.

One more interesting model to look at is the optimal shot model, which in theory demonstrates shot clock efficiency given completely optimal shot attempts. For example, only taking fast break 2 pointers, and only attempting 3s after that point.



This last curve does not have too much functional use, outside of further affirming the value of fast break 2 point field goals, but it is fun to look at nevertheless.

5 conclusion

In conclusion, the answer to the question of when the optimal time to attempt what type of field goal in the NBA is partially answered. If given the opportunity for a fast break, a 2 point field goal (likely a layup) is most optimal. Other than this, 2 point field goal value decreases as time goes on, while 3 pointers maintain their value for almost the entire shot clock, though being less efficient at the beginning and end of the shot clock, due to the difficulty to make a 3 pointer, especially rushed attempts.

Obviously, this model does not do a perfect job demonstrating the optimal shots, but it is very useful for coaches to see that the 3 point shot is very valuable, and most of the time is preferable to a 2 point attempt, as well as highlighting the importance of transition offense and defense.

There are, however still many scenarios which the model does not account for. For example, the free throw is statistically the most efficient shot in the NBA, [8] but is not accounted for in the model. Being able to account for shooting fouls drawn on different field goal attempts and different shot clock times would be able to greatly elevate this model's strength and utility.

Another important scenario this does not account for is the endings of games or periods. For example, in an NBA game, at the end of a quarter, a team with around 35 seconds left on the shot clock may attempt to take a shot earlier in their clock, as this typically results in an extra possession for them they otherwise would not have, as the other team will have more than 24 seconds left in their shot clock, preventing them from taking the final shot. Similarly, a team with less than 24 seconds left in a quarter may wait until the end of the shot clock to attempt a shot in order to force their opponent to take a very early shot, or run out time completely so the opponent does not get a shot. Lastly, a team up by a large margin towards the end of a game will likely take as long as possible for each field goal attempt in order to minimize the number of possessions the other team will be able to utilize in attempt to close the gap in scores.

In order to improve this model, the two most important changes would be to account for free throw attempts, as they are very important to the game of basketball, as well as use data with specific shot times rather than ranges.

References

[1] https://official.nba.com/rule-no-7-24-second-clock/

[2] http://www.82games.com/comm32.htm

[3] https://www.inpredictable.com/2018/09/the-nbas-new-shot-clock-rule-and-its.html

[4] https://medium.com/@chrisbuetti/the-most-clutch-shot-clock-shooters-in-the-nba-a-statistical-approach-8982deda01e3

[5] https://www.basketball-reference.com/about/glossary.html

[6] https://www.nba.com/stats/teams/shots-shotclock/

[7] https://github.com/swar/nba_api

[8] https://www.sbnation.com/2013/10/25/5023766/nba-shot-selection-nuggets-pistons-green-triangle