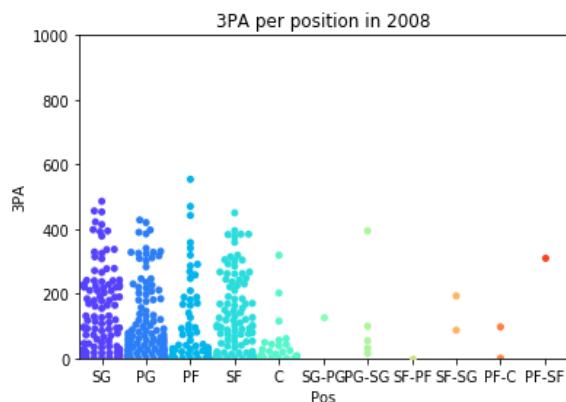


# How Stephen Curry Changed the Geometry of Basketball

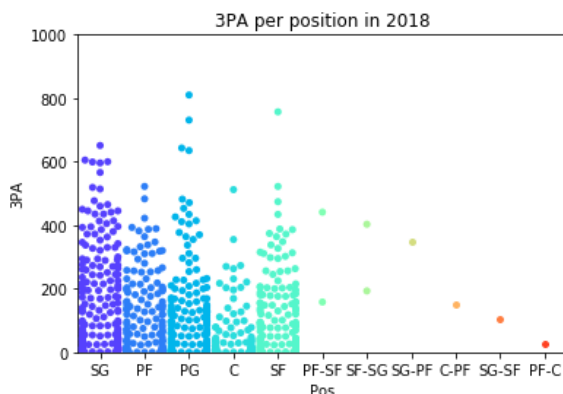
Venkat Ramaraju

Stephen Curry has long established himself as a household name – making his money as one of the league’s premier talents, and most importantly the greatest distance shooter the NBA has ever seen. He has single handedly changed half-century established defensive techniques, forcing his opponents to be at less-than-arm’s distance whenever he steps anywhere within 40 feet of the basket. Curry’s marksmanship spaces the Warriors’ offense, allowing his teammates more room to operate and show their skills. In this paper, I wanted to take a deep dive into the numbers on how Stephen Curry has impacted the game of basketball.

I received these datasets from [basketballreference.com](http://basketballreference.com), as linked in the references. All computations and visuals were made in A python-Jupyter environment using libraries like Scikit-Learn, NumPy, Pandas, Matplotlib, Seaborn, all of which are linked in the references. In 2008, the year before Stephen Curry entered the league, the NBA attempted a total of 50,535 three pointers. Last year, the league shot 92,113 three pointers – which is an 82.27% increase over a decade in which Stephen Curry won two MVPs and three championships. What is remarkable is the efficiency the league was able to sustain while attempting significantly more three pointers. Shooting efficiency usually drops with volume, i.e., the more threes/distance shots attempted, the lower the average player shooting efficiency usually is, as distant three-point shots are relatively tougher to make compared to the average two-point shot. However, the numbers indicate that the average three-point shooting percent has remained relatively the same (36.66% in 2008 vs 35.44% in 2018) over this span, despite over 42,000 more three pointers being attempted.



The densities of each category in these swarm plots pave the way for some interesting inferences of how basketball has changed over the last decade. There is a considerable difference in the sheer number of three



pointers that are being attempted by each position, indicated by the increased density in the second swarm plot. However, it is interesting to observe the “C” or “Center” category – a position that has historically attempted the least number of three pointers due to their mean heights and weights being the highest amongst all positions – and are, therefore, expected to exert their force closer to the basket. The plot for the center category is not only more stretched out, it is also significantly denser than its 2008 counterpart, showing that more centers around the league attempting three pointers in notable quantities. In 2008, the average center attempted a total of 9.35 threes per season, or one every nine games. In 2018, the average center attempts 46.09 threes per season (393% increase!), or over one every two games. For perspective: Brook Lopez, who did not attempt a single three pointer in 2011-12, now attempts over 6.3 threes per game on better than 36% shooting from beyond the arc. The reason for this sharp rise in three-point attempts amongst centers is simple – it’s a result of defensive scouting and planning. When the center of the team is a threat from beyond the three-point line, it forces the opponent’s centers to step outside and contest these shots on the perimeter (as opposed to under the rim, where they are contesting any shot that comes their way). With the major rim protector pulled away from the basket, due to the three-point prowess of the offensive center, it now gives iso-centric players better opportunities to score, as there will be less “help defense.” This is how the “geometry” of the game is slowly changing. Players are now expected to be able to defend on the wing more often, leaving the lanes wide open for “slashers” to score with ease. I attest this shift in play style to Stephen Curry’s marksmanship as the league’s greatest distant shooter, as he set a ripple effect across the NBA on how basketball should be played.

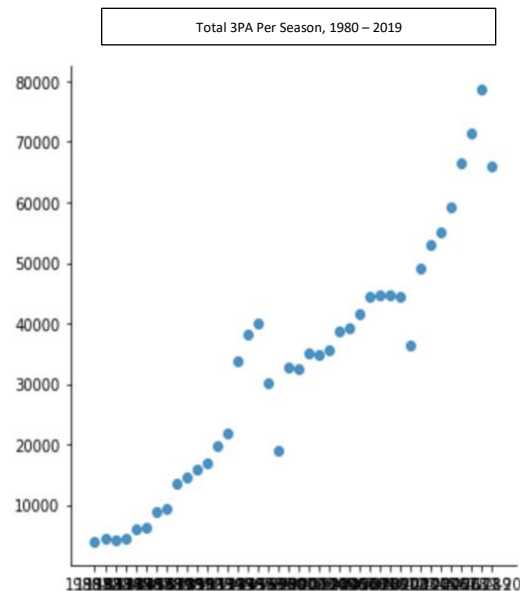
Statistics that have historically favored the forwards/centers have consequently plummeted with the volume of three-pointers being attempted in the NBA.

As players became better shooters with volume, offensive rebounding percentage dropped over 11% due to the higher volume of made threes, as now it is less likely that a big man will get tip-in offensive rebounds with the ball either going through the basket or caroming out for a long rebound, offensive or defensive. Therefore, not only have big men been forced to expand their skillsets by virtue of developing a three-point shot, some of their strengths have also been taken away as an effect of this changing geometry. Less free throws are being attempted as it is much more likely that players get fouled on a drive to the basket as opposed to an uncontested three pointer, the disparity of which has only been increasing over the last few years. There are some implicit statistics that are also being influenced by the proliferation of the three-point shot. Point guard rebounding is up almost 33% over the last decade, since the 80+% increase in three-point attempts has resulted in longer rebounds that point guards are snag out of the air. Considered as a “facilitator,” point guards have historically attempted, on average, the least number of shots on each team. However, with point guard scoring increasing 23.6% over the last decade, supplemented by a 33% rebounding increase and a slight increase in assists as well, the league seems to be shifting towards a more guard - driven league with more emphasis on the point guard being able to score and rebound, unlike the “old-school” point guards, who’s primary goal was to facilitate an offense through assisting the basketball. That is another major shift in playstyle, as it now opens up the league for “position-less basketball.” The notion of a fixed position with set responsibilities is being shattered before our eyes, as centers like Brook Lopez attempt over 6 threes a game, and point guards like Westbrook have now averaged 30+ points and 10+ rebounds per game for three consecutive seasons.

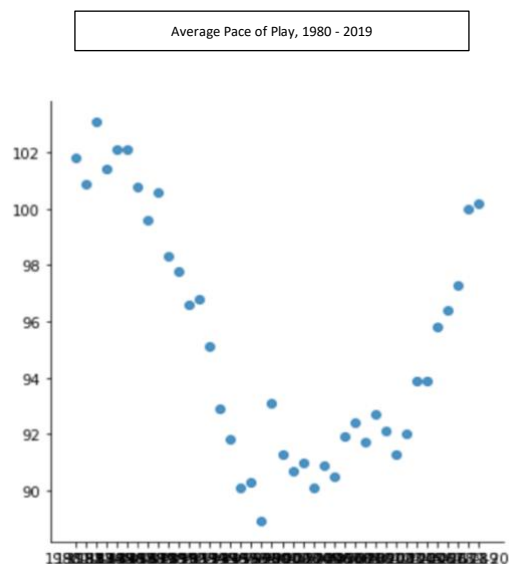
However, it is important to put into perspective the time at which Stephen Curry entered the league. I do not believe that the increase in three-point attempt rate is solely due to Stephen Curry’s shooting ability. A regression plot depicting the increase in the amount of three pointers attempted per season since the 1980s is shown below. The league had been taking a steady, linear rise in the number of three pointers being attempted per year for a twenty-year span. However, it is apparent that since the 2000s, and particularly since 2010, there has been an exponential increase in the number of attempts coming from three-point range distance. This, I do believe, is the result of Stephen Curry – he expedited the linear growth of the three-point shot in the NBA. Other important statistics have also been largely expedited the dominance of the three-point shot in the NBA. A prime example is the “pace of play.”

$$\text{Pace} = 48 * \frac{(\text{Team Possession} + \text{Opponent Possession})}{(0.4 * \text{Team Minutes Played})}$$

Pace of play is a strong measure of how fast a team operates: How quickly it gets into offensive motions, how often they get transition shots, how quick they work on the defensive side of the game, etc. With the number of attempts going up rapidly since 2010, it opens up the floor much more and creates a more “transition-based” game wherein players are constantly either attempting long range



shots or rebounding off them and setting up fastbreak scoring opportunities. In 1999, the pace of play was only 88.9. This past NBA season, the pace peaked at nearly 100.2. A higher pace of play roughly implies that there are a larger number of possessions per game for a team. A higher number of possessions means more opportunities to score, which means on average increasingly a larger number of three pointers being attempted, and the cycle repeats itself. We are able to connect the dots and see how merely attempting more three-pointers has sent a ripple effect across a myriad of statistics and have all raised them together as a group, one supplementing another. Moreover, the NBA is a league wherein many teams make attempts to replicate one team’s play style based on their success. The Warriors have gone to five consecutive NBA finals and won three of them due to this high-paced, position-less style of play, and slowly it became more prevalent across the league, causing aggregate numbers and statistics to skyrocket, in comparison to those of the 80s and 90s.



The line plot depicting the pace of play over this forty-year span may initially seem slightly counter-intuitive based on the three-point trend increasing linearly through the 80s and 90s to reaching an exponential-growth rate from 2010 onwards. However, in the early 80s, pre-Magic Johnson and Larry Bird, there was very little emphasis on defense, given the relatively low levels of athleticism of players in the league at the time. Therefore, the pace of play in the early 80s is largely inflated by the fact that offenses were simply allowed to score baskets with very little resistance due to the lack of emphasis on the defensive side of the basketball. However, as the NBA became more popular from the mid-80s onwards featuring some of the historically great teams, the game started to drift towards a more physicality-based play with larger defensive emphasis. Teams like the Detroit Pistons and the Chicago Bulls paid special attention to the defensive end as that would in turn benefit them on the offensive side of the court. Therefore, we see a massive dip in pace of play and scoring totals as basketball, in the 90s to early 2000s, transformed into a slow, half-court game set with a smaller number of fast breaks and transition baskets being scored. However, with the growing popularity of the three-point shot, defenses were once again unprepared to handle this new, shot-heavy offense and thus there was a large scoring spike that was facilitated by the rise in the pace of play. There is yet a perfect formulaic defensive plan that is to be enforced to be able to protect against large scale three-point shooting. Until a viable defensive scheme is found, it is likely that that pace and points per game will simultaneously rise.

As great as Curry was in his first 7 years in the league, his 8<sup>th</sup> year in which he won unanimous MVP along with the Warriors winning 73-games was the tilting point of the NBA, transitioning from a forward/center league to a more guard-driven league. Stephen Curry made a total of 402 three pointers, shattering the record that he previously held by a sizeable margin. He was able to maximize his productivity by keeping up his efficiency along with the volume. He attempted over 800 threes in the season, and therefore shot nearly 50% on three pointers, whereas the league average was only 35.4%. Therefore, the larger number attempts complemented by the ridiculous efficiency helps us understand why Stephen Curry was able to average over 30 PPG in a season in which he sat out 16 fourth quarters, and therefore effectively sat out four full games. The ability to shoot the basketball with efficiency and volume has now become the new focus of basketball, and it is being taught from the ground-up, even for big men, to have a jump shot to be able to survive and sustain a career in the NBA. It also makes it easier for younger, less-physical players to adjust to the NBA, as shooting is a novel skill that does not require much physicality and strength, which the average NBA player does not fully develop until 26 or 27, when they reach their athletic prime. It is for this reason that the NBA is also slowly turning into a younger league on average. Twenty years ago, in the 1998-1999 season, the average age of an NBA player was nearly 28 years old. Over time, that number has continually dropped down to under 25 today. This drop in average age is apparent by the “one-and-done” NCAA to NBA trend, in which players out of high school undergo one year of

college to be eligible for the NBA. In the late 90s-early 2000s, there were only a handful of players that would have either come directly from high school (Kobe, LeBron, etc.), or be one-and-done out of college. However, in 2017, over 33% of the entire draft class was one-and-done out of college, setting an all-time record for the highest number of college freshman students entering the NBA draft. College players feel that because they have the ability to shoot the basketball at a high clip, transitioning to the NBA will be much easier, even at their young age. Players no longer see a point in having to wait four years to grow into their proper musculature, as that would also put them at increased risk of injuries before being compensated enough for the work they had put in up to that point. Additionally, with the NBA in the midst of developing policies to allow kids to go through the G-League, the average age of a professional basketball player will likely drop slightly more in the years to come, somewhere around 23.5-24, which is a considerable step down from 28 back in the 90s. Therefore, the changed geometry of the game with more finesse and less physicality has allowed eighteen and nineteen-year olds to step into the league and instantly become productive. After gathering data from all of Stephen Curry's major statistics since the 2014-15 season, I have performed a regression analysis to predict approximately what his numbers could look like the upcoming season. I have not included all data from before 2014 since he did not play nearly as many games and minutes as he has since that year, and therefore including them would skew the results, as he is currently in the peak of his prime and is expected to play a large number of games with heavy minutes for the Warriors this upcoming season. Additionally, I did not use the season that is currently ongoing since Curry has played in only five games, missing a majority of them with a broken hand. I used the Scikit Python library to create a linear regression model that took 5 years' worth of inputs as a training data set, and used this to predict his points, rebounds and assists per game for the upcoming season. For the testing data set, I used the mean amount of minutes/games played and similar efficiency over the 5-year span, since it is likely that most of those statistics would remain the same and would improve the accuracy of our prediction. After creating the model, training and testing sets, and running a regression-based prediction, Stephen Curry's numbers would approximately be 23.29 PPG, 10.7 APG, and 5.08 APG.

It is quite evident that Stephen Curry dominance as a distant shooter has changed the gravity of basketball. NBA data analysis have found Stephen Curry's play style statistically more likely to put up higher points per game on better efficiency, and therefore the Warriors have simply been following what the math has been telling them for years. Shooting 3-of-5 from three-point range is better than 4/5 from two-point range. I wrote this paper out of curiosity to see how one small change in a play style can send a ripple effect across many statistical categories, causing the nature and style of the game to undergo a complete change. Knowing where on the court the team is most efficient is pivotal in tight-game situations. Curry will be revered as the player that, despite not being athletically gifted, understood the game of basketball at a much higher level than his competition.

## REFERENCES

- 2008-09 NBA Player Stats: Totals. (n.d.). Retrieved from  
[https://www.basketball-reference.com/leagues/NBA\\_2009\\_totals.html](https://www.basketball-reference.com/leagues/NBA_2009_totals.html)
- 2018-19 NBA Player Stats: Totals. (n.d.). Retrieved from  
[https://www.basketball-reference.com/leagues/NBA\\_2019\\_totals.html](https://www.basketball-reference.com/leagues/NBA_2019_totals.html)
- Abbott, H. (2016, March 18). Stephen Curry isn't just the MVP -- he is revolutionizing the game. Retrieved from  
[https://www.espn.com/nba/story/\\_/id/15001418/how-stephen-curry-revolutionizing-basketball](https://www.espn.com/nba/story/_/id/15001418/how-stephen-curry-revolutionizing-basketball)
- Brink, D. (n.d.). A Graphical Analysis of Stephen Curry and a Record-Setting Season of Dominance. Retrieved from  
[https://rstudio-pubs-static.s3.amazonaws.com/172348\\_0a9ad8e16d15484fb4e1546508c2b00f.html](https://rstudio-pubs-static.s3.amazonaws.com/172348_0a9ad8e16d15484fb4e1546508c2b00f.html)
- NBA League Averages - Totals. (n.d.). Retrieved from  
[https://www.basketball-reference.com/leagues/NBA\\_stats\\_totals.html](https://www.basketball-reference.com/leagues/NBA_stats_totals.html)
- Stephen Curry Statistics. (n.d.). Retrieved from  
<https://www.basketball-reference.com/players/c/curryst01.html>
- The Effectiveness of Using Pace, eFG%, TOV%, ORB%, FT/FGA ... (n.d.). Retrieved from  
[http://homepages.cae.wisc.edu/~ece539/fall13/project/Ferro\\_rpt.pdf](http://homepages.cae.wisc.edu/~ece539/fall13/project/Ferro_rpt.pdf)
- Wicklin, R. (2016, March 21). A statistical analysis of Stephen Curry's shooting. Retrieved from  
<https://blogs.sas.com/content/iml/2016/03/21/statistical-analysis-stephen-curry-shooting.html>