

Explaining the Trends of NBA Strategy through the Lens of Human Risk Tolerance.

Justin Chung
Seoul Foreign School

ABSTRACT: *The game of basketball has transformed dramatically. Throughout the entire NBA, and in all levels of basketball, more three-point shots are attempted. While the obvious explanation of the increased role of analytics would suffice, it does not explain why it has happened so late. The expected value of a three-point shot has been higher than a regular two-point shot for several decades. After running analysis, a high correlation was found between three-point attempts and winning that drove this increase of three-point attempts. The real driver seems to be twofold. The NBA is a copycat league and the more finalists deviate from the league average. Also, while there are more skilled players who can make a three-point shot at a consistently high rate, the league average make-rate has not changed. All these trends indicate that the humans have a natural tendency to be risk-averse, to overvalue success rate when making decisions, and to follow proven strategies winning teams employ.*

KEY WORD: *NBA, Make Rate, Three-point Shots, Risk Averse, Basketball Players*

I. INTRODUCTION AND LITERATURE REVIEW

The NBA has been evolving and changing as a league, but the most recent changes are the most transformative ones in its storied history. Offering dynamic plays with moving parts and strategies, the changes can be boiled down to just one factor: teams shooting more three-pointers. The change had taken place about

five years ago. From the 2011-2012 season until the most 2016-2017 season, the number of three-point attempts increased from 18.4 to 27 per game, which is an increase of 47% over the five years. This is the largest increase in the modern NBA history.

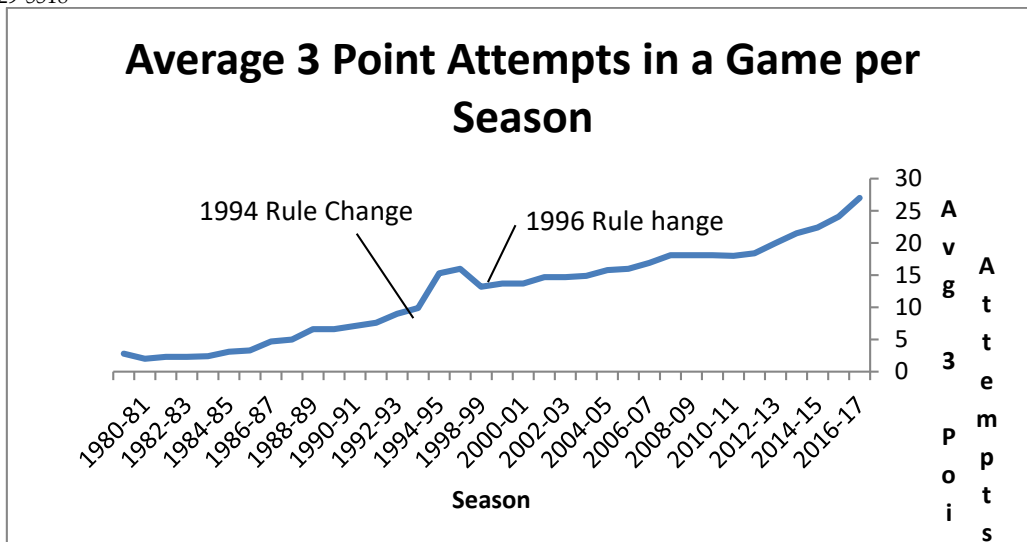
An interesting aspect of this completely revamping of basketball in the fact that it wasn't triggered by a rule change. Since 1998, there have been no rule changes regarding the three-pointers. There have been two other instances of large increase in three-point attempts; from the mid-80s into the late 90', the both instances have been led by a league-wide rule change. In the 80s, teams were forced to adapt to an addition of the three-point line, and in the 90s, the three point line had been shortened. In addition to these rule change, the average number of attempt from three point range stayed in fairly defined range.

Therefore, this paper analyses the origin of this rule change. One can posit three theories before embarking on an investigation. First, the evolution of NBA players' attributes and skillsets is one theory. A marked change in strategy may have invited more players who are versed in the three-point shots, or the adoption of new players that were good at defending against inside play and the two-point shots. Second, it is likely that rule changes for other aspects of the game indirectly caused this change. Lastly, it is possible that teams seeking competitive advantage changed strategies as a result of statistical analysis.

II. LITERATURE REVIEW

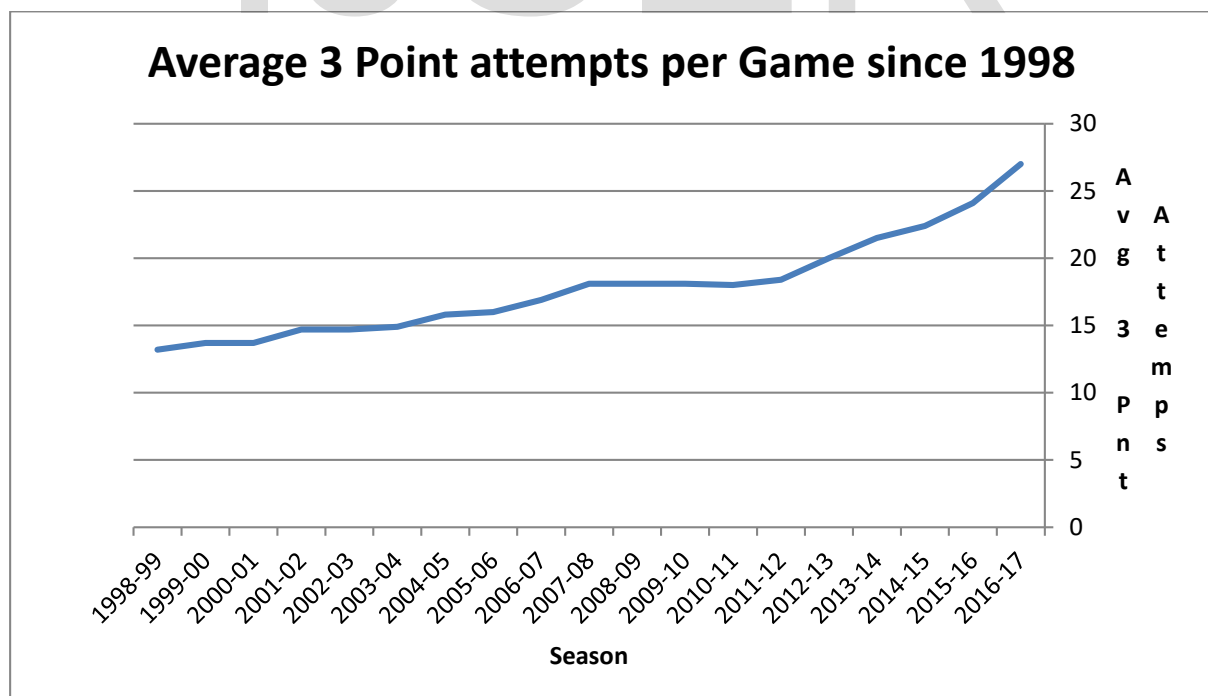
1.1 Historical Perspective

Figure 1. Average 3-point Attempt in a Game per Season



The number of three-pointers has been on the rise and the most recent changes might be a continuation of an already established trend since 1979. However, if we zoom in on the chart and look at the seasons since the last rule change, the picture looks quite different.

Figure 2. Average 3-point Attempts per Game since 1998



The increase was fairly gradual, even reaching a five-year plateau in the late 2000's. But something changed in 2011, and this altered the trajectory. This visible change was written all over the sports magazines and media. While academic source may be limited, many journalistic articles have been written about the change in the game. With the trend drawing a continuous upper slope, the current season's average three point attempts at 28.8 per game, and 1.8 attempts higher than the last season's record breaking mark, this new trend is worth investigating.

1.2. How the Game Changed

“The game is changing before our eyes,” said Vogel said while shaking his head in amazement. Quotes John Danton. Frank Vogel shares a sentiment, which is prevalent in the leagues, sparking heated conversation about the NBA today. Many editorials have written about how different the league is compared to five years ago. David Aldridge, an analyst for TNT in an NBA.com notes that “Team aren't just shooting more 3s; they are making more as well and the onslaught in bending the NBA game into a new and different shap.” Finally, Max Seng, in an editorial for hoopshabit.com writes “it's no longer an option to shoot the three balls, it's a necessity.” Teams have to increase their three-point shooting volume or be left behind in the league. It is not a matter of contention that the NBA is experiencing a dramatic change, but the reasons are still remain unsurfaced

1.3 Defensive Rule Changes

“There are actually two rules which have changed that have made the game different. First there's what is commonly referred to as, “the hand-

check rule” and the other is the change in allowing for zone defense. Both rulings have their own impact(Scaleta, 2011)”

The hand-check rule states that a defender cannot extend his/her hands unto a ball handler on the perimeter in order to check him. The rule had been around before the 2004-2005 season but it had not been enforced. Kelly Scaleta conducted a statistical analysis to see if this rule change had benefited perimeter players and found that players that get the ball outside the three-point line are the guards and wings. Had this rule truly had an impact, the number of unassisted field goals should have risen. “The six years with the lowest assist to field goal ratio in the NBA since 1985 are the years since the hand check rule was imposed. From 1985, the cumulative ratio was .604. (Scaleta, 2011)”

The number of 50 point games by perimeter players has increased by 80% after the stricter implementation of the “hand check rule.” Another measure of the impact of this rule is to see how MVP voting distribution has changed. Scaleta broke down the MVP voting between perimeter players and post players to examine whether or not the distribution had changed. He finds that post-2005 MVP voting heavily tilted toward perimeter players.

Finally, the last factor that Scaleta analysed was the number of 20 points per game season that players had before and after the enforcement of the rule. Again, he found that the scaled tipped towards perimeter players after the institution of the rule. The logic as to why the rule changed the game and contributed to an increased number of three points taken is explained. First, it is accepted norm that the perimeter players are more versed in taking three point shots. Seeing how perimeter players have been the beneficiaries of this rule change, one could assume that the players had taken bigger role in offenses, thus taking more shots. Since a larger part of their shot selection is the three-point shot, it could be inferred that the rule change led to an increased three points taken. This theory fails to account for the most recent changes, however. The rule went

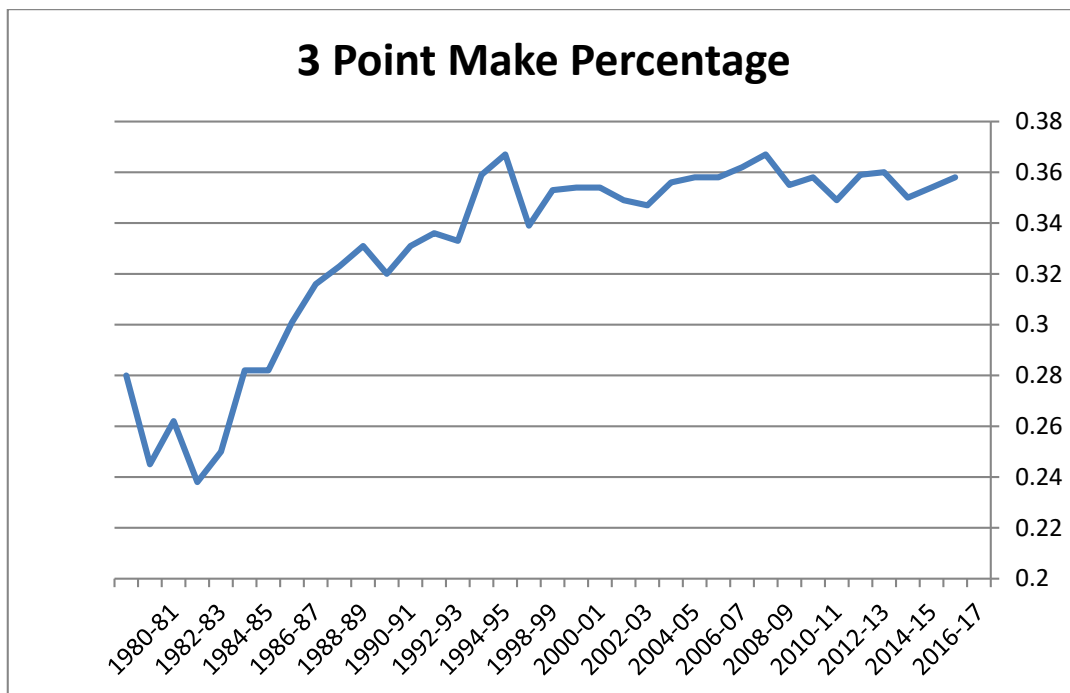
into effect in 2005. Before 2005, the rate of three points taken was steadily increasing, and after the rule, a visible jump was found. This doesn't explain the current phenomenon, the game being dominated by three point attempts. The most marked change came around five years ago. The number of attempts per game had hardly changed from 2007 to 2012. The big change came most recently, and it wasn't coming from the hand-check rule.

1.4 Change in Talent

The number of three point attempted should be explained by the increased presence of players that specializes in the shot. Only then can the increased attempts be a result of a higher three point make percentage. However, this is not the case.

IJSER

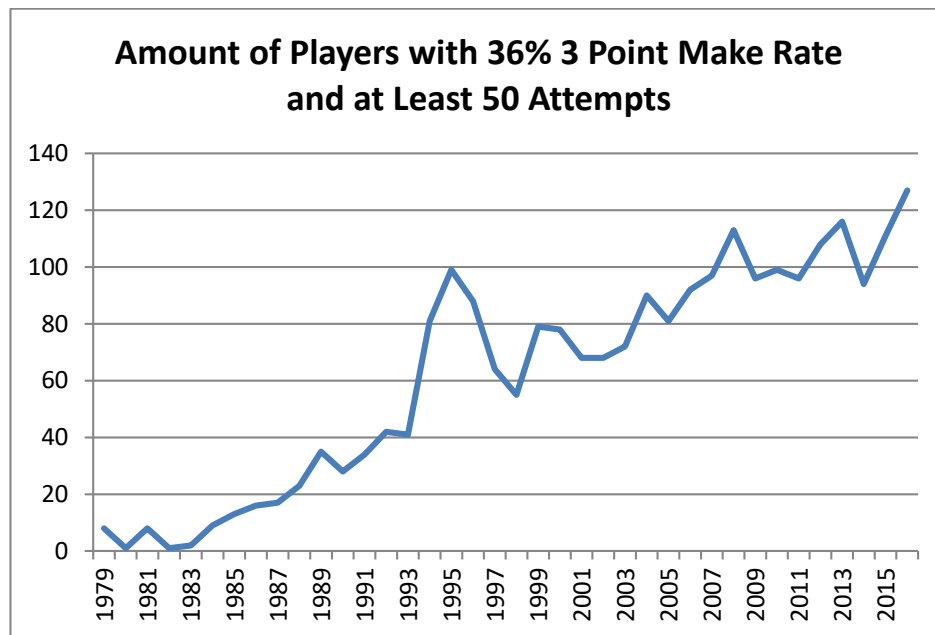
Figure 3. 3-point Make Percentage



For the last 25 years, the three point make rate had plateaued in the range of 34 to 36 percentile. If an influx of players talented with the three point shots caused the increase in attempts, the logical assumption to make is that make rate would go in tandem with the three point attempt. What has actually happened lately is that the make rate has stayed level. Despite anecdotal evidence that might surface, citing the emergence of Steph Curry, this theory is easy to disprove. While Steph Curry and Klay Thompson, the “Splash Brothers” duo of the Golden State Warriors, might be good examples of three point shooters in the new NBA, they are easily countered with the example of Reggie Miller and Ray Allen who were equally skilled at three point shots. But they played in the era where the three point shot was not as prevalent as it is now.

Another way to analyse this theory quantitatively is to look at the number of shooters that have a 36% or better make rate from the three point line over time. One of the statistical tests addresses this phenomenon. If the talent has really gone up, then the number of players that shoot a high percentage from the three point line should rise as a result.

Figure 4. Players with 36% 3-point Make Rate with 50 attempts



1.5 Analytics

Plenty of articles describe the effects of analytics, and they usually center around on person in particular. It is hard to underestimate the effect that Daryl Morey has had on the NBA. The typical nomenclature that this effect has been given is “Moreyball.” The use of analytics in the NBA followed by Morey. He began his NBA career as SVP of special operations for the Boston Celtics. After several years in the post, he moved onto the assistant general manager of the Houston Rockets in 2006 and onto the general manager in 2007. This means that he became the first statistically oriented general manager in the league. To wit, Michael Lewis of Slate notes,

“Back in 2006, when he was hired to run the Houston Rockets and figure out who should play pro basketball and who should not, Daryl Morey had been the first of his kind: the basketball nerd king. His job was to replace one form of decision making, which relied upon the intuition of basketball

experts, with another, which relied mainly on the analysis of data. He had no serious basketball-playing experience and no interest in passing himself off as a jock or a basketball insider.”

Michael Lewis outlines the path that Daryl Morey took to reach his post and the decision he made while serving as the general manager. The biggest factor that Morey changed, according to Lewis, was the reduction of human biases such as the confirmation and the hindsight bias when making decisions. Apparently, the owner of the Houston Rockets brought Morey to manage the team’s roster after seeing the success of “Moreyball” as espoused by Billy Beane, the general manager of the Oakland Athletics. The success of advanced statistical analysis in baseball spread similar ideas in basketball under the direction of Morey; he was the first non-player or non-coach to be general manager in the league.

Morey was not the first to apply analytics to the NBA. After Bill James’s research on baseball analytics gained traction in the early 2000s, the same approach was copied by several parties in basketball. John Hollinger was one such pioneer. The paper titled, “quantifying Shot Quality in the NBA” by Chang et al. (2014) was a major development of basketball analytics. It marked a paradigm shift in the NBA in that it made clear that the three point shots should be valued more.

Many sports writers have noted the impact that Morey had on the game. David Aldridge notes,

“[T]he game has shifted in the last decade. The overwhelming prevalence of analytics in the modern game, with its emphasis on the superior value of 3s, ushered in small ball and greater spacing—the better spacing you have, the harder it is for defences to react and get to the next open shooter. And there is almost always an open shooter on the floor these days (Aldridge, 2016).”

Aldridge posits that the league has changed dramatically that the game is hard to watch. He notes that the Rockets, whose general manager Morey is usually credited with ushering in this new era and examples of team that are hard to watch. He cites their approach in particular as something that fans might not enjoy. His view highlights the fact that opinion on the issue of analytics is still polarizing in both the eyes of the press and the eyes of the fans.

Max Seng of hoopshabit.com notes that,

“For decades, the consensus was, “closer to the rim, better shot.” That is no longer a viable stance to have, as there’s simply too much data to state otherwise.

There are so many tracking tools at the disposal of all 30 NBA teams now, the trick is turning the massive amounts of data into something meaningful. Changing the culture has been a progression, one that the NBA has fully adapted to, and is trickling down to lower levels of basketball. Teams are shooting the 3-point shot at a higher volume than ever before, designing their offenses around the long ball to ensure quality looks.”

His comment about the analytical advances in basketball permeating all levels of the game hints at the theory that changing talent is not the issue. If this change is only happening in the NBA, then it would be reasonable to think that new talent in the NBA may be the drive. But because the change applies to all aspects of the game, it is more likely that the new analytics are relevant regardless of the players’ skillset. If this is always applicable, then it means the new style of basketball is the dominant form that everyone should accept.

One of the biggest watershed moments of basketball analytics was the publication of Predicting Point and Valuing Decisions in Real Time by Cervone et al. (2014). They introduced the concept of expected possession value, which measures all possible outcomes as a result of a ball possession. Therefore, this paper builds upon the research done by Kubatko et al. (2007) entitled a Starting Point for Analyzing Basketball Statistics, which highlighted the value of three-point shot. At the heart of the analytics revolution was the concept of expected value. It identified the midrange jumper as having the lowest expected value and the three-point shot as having a much higher expected value than previously thought.

III. METHODS

To test whether “Moreyball” was the driving factor behind the changes in the league, concerning the higher number of three-point attempts, various statistics particular to the movement were analysed. The first theory to test is whether or not a change in talent and skills is the primary factor driving the change in the play. The number of players who shoot the three point at a good rate—36%—was counted for each season. Any players that took less than 50 three-point shots in a season were not counted. It could be predicted that the number of players who could consistently make the three-point shots at a high rate. Finally, if talent was indeed a driving force behind the change, then the number of attempts league-wide should correlate with the number of skilled three-point shooters. The correlation will be tested by conducting a regression analysis.

The next theory to test is the theory that three-point attempts began to correlate with wins. If this theory holds true and a high correlation may appear in

recent years between the team's three-point attempts and the number of games it wins, then it would show that teams simply started shooting more threes to "keep up." In other words, once a correlation is developed, other teams are forced to start taking more threes. If this theory holds true, the three-point attempts and wins would correlate more strongly in recent years and perhaps even more so before the large increase in the attempts. The high correlations between winning and taking three-point shots would lead to increased three-point attempts around the league and then weaken after the practice is copied throughout the league. After every team starts taking a higher number of threes, teams would seek other competitive advantages to secure an edge. Higher three-point attempts would lose their competitive advantage because everyone is already copying this strategy.

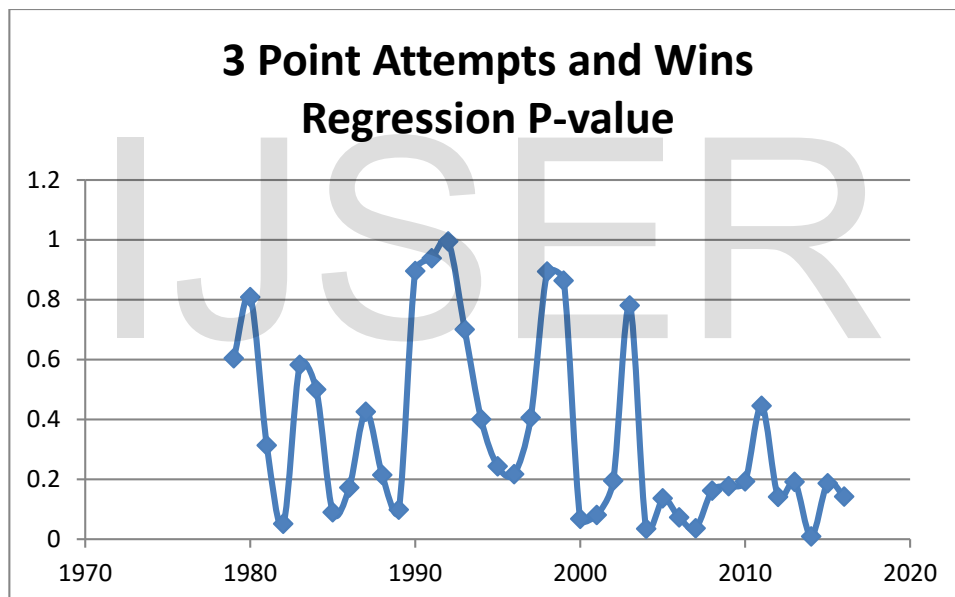
To test this hypothesis, a regression model was fitted for three-point attempts and wins for each team in every season because the three-point line is established. Using the p-value of the correlation between the team's three-point attempts and wins for each season, the p-value will be charted to find a pattern or a trend. The p-value or the probability that the data is random, should slope downward overtime if this theory holds true. Also, before—or the start of—the recent surge in three-point attempts, dating back to five years ago, should offer a point of low p-value.

Another hypothesis posits that the rest of the league did not conduct deep statistical analysis and did not look for correlation in such a way. This hypothesis would test whether or not the most visible signs of success prompts the league to change. Therefore, the average three-point attempts of the four remaining teams in the semi-finals is measured against the average number of three-point attempts of the league. The logic behind this hypothesis is that general managers, before the move into analytics and the adoption of statistical analysis, simply eyeballed to see what worked. Therefore, the success of the new strategy involving taking more three-point shots needs to be evident. If the best four teams are taking a new and different approach, it would drive other general managers to adopt the

strategy. If this hypothesis that teams copy other teams that are visibly winning holds true, a correlation between the discrepancy in three-point attempts of the top four teams as compared to the league average and the change in the league average in three-point attempts the next year.

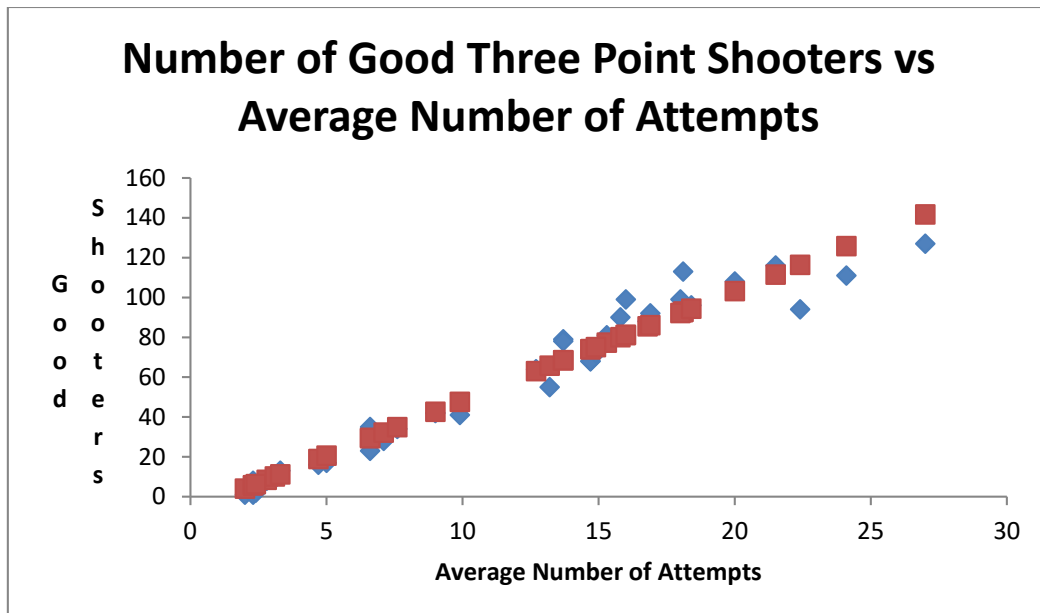
IV. RESULT

Figure 5. 3-point Attempts and Wins



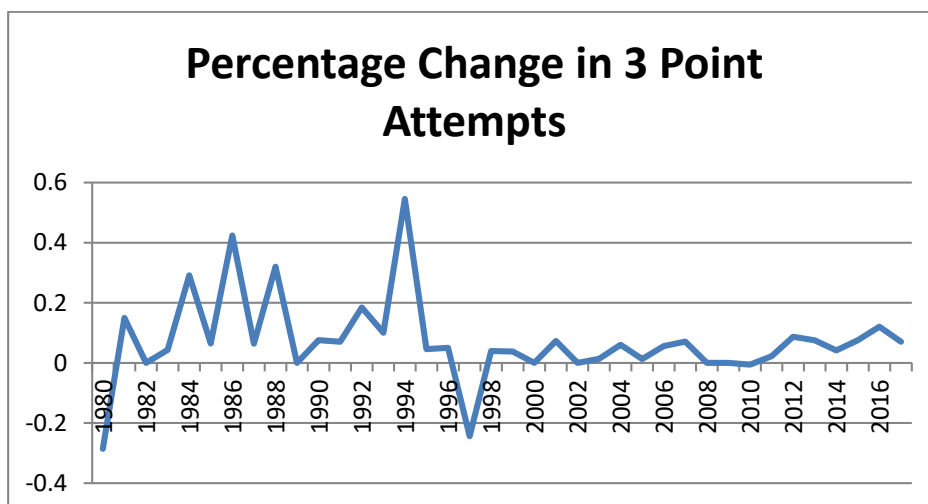
The p -value for the correlation between three-point attempts and wins for the teams showed a downward trend. Before 2000, only three seasons had a p -value lower than .2 and in one of those seasons, the 1982-1983 season, the correlation was negative. Teams that took few shots had more wins. Since 2000, however, there has been a fairly low p -value. Before 2000, two out of the 18 seasons had a p -value lower than .2 while after 2000, 14 out of 16 seasons had a p -value lower than .2.

Figure 6. Good 3-point Shooters vs. Average Number of Attempts



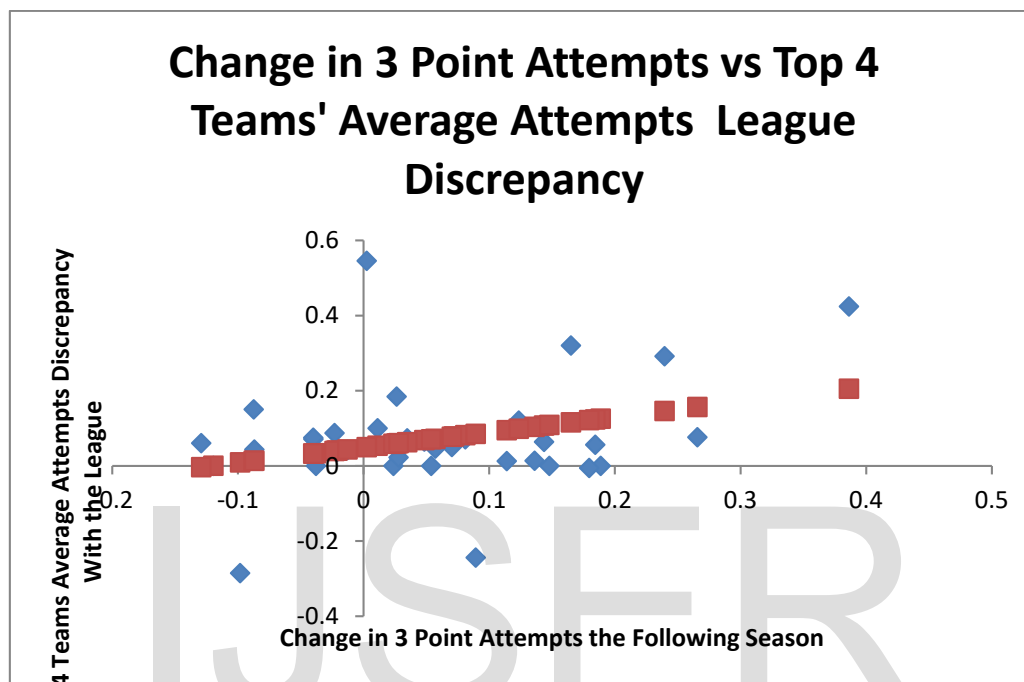
There is a strong correlation between the number of capable three-point shooters in the league and the average number of attempts with a p-value of 8.03159E-26.

Figure 7. Percentage Change in 3-point Attempts



The number of three-point attempts did not change much until recently. It did rise considerably in the 80s as team adapted new rules.

Figure 8. Change in 3-point Attempts vs. Top 4 Teams Average



There is a correlation between how many attempts the top four teams make compared to the league and the number of average attempts league-wide the next season. The p -value of the correlation is 0.055, so it failed to jump over the common threshold, the α level of .05.

V. DISCUSSION

The hypothesis that the correlation between wins and three-point attempts is the driving force behind the increase in the attempts does not hold true. While there seems to be a strong correlation between the two factors in the last twenty years than in the first twenty years, the recent correlation is not strong enough to

be significant. Obviously, the data is not random, so the correlation with a p-value lower than .2 doesn't happen by chance. However, a few seasons when three-point attempts and wins exhibited a strong correlation. A consistently weak correlation is not indicative of much. It may be that wins and three-point attempt are related, but it seems safe to say that there has never been a point where three-point attempts started to correlate strongly with winning in such a way that teams simply had to take more three-point shots.

The copycat league correlation has much more merits. The fact that the final four team's deviation from league averages correlated strongly with the change in three-point attempt league-wide confirms the narrative. The narrative is that before the early 2000's teams did not conduct analytics. Talent assessment and strategy was based on intuitions of the managers, not to mention other conventional methods. Teams didn't perform statistical analysis for what strategy worked and what didn't. They simply relied on eyeballing. If they saw that the top teams in the league shot more threes than the league average, then they would see it as a good strategy. If not, they would shy away from the three-point shots. Therefore, league-wide acceptance of the three-point shots would just follow the most visible examples of success. This correlation shows that teams copy what they see working, without putting too much thought into it.

The most interesting hypothesis tested in the analysis was the one about the players' skillset. The correlation between attempts and the number of competent three-point shooters seems clear. The more attempts are made, the more likely the skill is sought after and more players with the skill are more brought onto the court. Interestingly enough, the number of competent three-point shooters is rising visibly, but the league-average remains steadily unchanged. Since 2000, the number of good shooters above 36% make rate has doubled but the league-wide three-point shots make rate remained locked at around 34 to 36 percent. This may indicate that there has been a change in strategy where players with a lower than average three-point make rate have been encouraged to take

more three-point shots. While good three-point shooters have become more prevalent, analysis has shown that even below average three-point shooters should be taking those shots. Therefore, the league-wide three-point make rate has remained the same because those three good three-point shooters have been ruled out by below average shooters taking more shots. Perhaps this interesting angle about the three-point shots reveal much about human nature.

VI. CONCLUSION

People, like most animals, are known to be risk-averse. They are risk-averse to the point not being able to properly gauge expected values of their actions. Instead of aiming for the action that will yield the highest expected value, they instead look for the outcomes that yield the highest rate of success. Besides, teams have had a higher expected value from three-point attempts from three-point shots than 2-point field goals since the mid-1990s. It took the best teams taking that shots more than the rest of the league for the whole league to catch up.

People naturally prioritize success rate when making decisions, much to their own detriment. The information about the higher expected value of a three-point shot is made available since the early 2000s. Points per possession was a concept that had been around since the inception of analytics. Since the concept of Bill James made the migration to basketball in the early 2000, the fact that the three-point was undervalued. Even while armed with this information, teams still shied away. They simply didn't want to take the risk of shooting more threes. They only took the risk after they saw winning teams take the risk. In this way, the NBA is even more risk-averse. First, the league-wide philosophy is that because the three-point shot had a lower chance of scoring, it should be avoided. Second, after knowing that the three-point shot was more valuable despite the

lower make rate, teams had to wait to see teams attempting more of those shots in the conference finals of the league.

Future Research on this concept must be made in other areas of decision making. The fact that it is human nature to be biased toward higher rates of success can be tested in the financial spheres as well. For instance, the stock market takes the stairs up and the elevator down seems to indicate that this tendency to value the rate of success when calculating the expected value is prevalent in many spheres of our society. People are satisfied with low but consistent returns on their money rather than taking bigger risks with a higher return. This explains why the structure of bull market rises is different from the structure of bear markets that follow.

BIBLIOGRAPHY

- [1]. Aldridge, D., & N. (2016, December 26). Broad sweep of NBA illustrates game's transition. Retrieved from <http://www.nba.com/article/2016/12/26/morning-tip-evolution-and-state-nba-game>
- [2]. Basketball Statistics and History. (n.d.). Retrieved from <https://www.basketball-reference.com/>
- [3]. Cervone, D., D'amour, A., Bornn, L., & Goldsberry, K. (2014). Predicting Points and Valuing Decisions in Real Time with NBA Optical Tracking Data. MIT Sloan Sports Analytics Conference.
- [4]. Goldsberry, K. (2014, February 06). DataBall. Retrieved from <http://grantland.com/features/expected-value-possession-nba-analytics/>
- [5]. How an NBA team can use an expected points model. (2016, March 16). Retrieved from

- <http://www.basketballanalyticsbook.com/2016/03/16/how-an-nba-team-can-use-an-expected-points-model/>
- [6]. J. (2017, January 23). The 3-Point Shot More Valuable Than Ever Before. Retrieved November 30, 2017, from Shoals, B. (2016, March 25). The NBA Has a 3-Pointer Problem-But Don't Blame Steph Curry. Retrieved from <https://www.gq.com/story/the-nba-has-a-3-pointer-problembut-dont-blame-steph-curry>
- [7]. Kubatko, J., Oliver, D., Pelton, K., & Rosenbaum, D. T. (2007). A Starting Point for Analyzing Basketball Statistics. *Journal of Quantitative Analysis in Sports*, 3(3). doi:10.2202/1559-0410.1070
- [8]. Lewis, M. (2016, December 06). How Daryl Morey Used Behavioral Economics to Revolutionize the Art of NBA Draft Picks. Retrieved from http://www.slate.com/articles/arts/books/2016/12/how_daryl_morey_used_behavioral_economics_to_revolutionize_the_art_of_nba.html
- [9]. Moreyball. (n.d.). Retrieved November 30, 2017, from <http://www.northwestern.edu/magazine/winter2013/feature/moreyball.html>
- [10]. Pickard, C. (2016). A Descriptive Model for NBA Player Ratings Using Shot-Specific-Distance Expected Value Points per Possession . Retrieved June 5, 2016.
- [11]. Scaletta, K. (2017, April 12). Michael Jordan: Could He Really Score 50 with the Hand-Check Rule in Place? Retrieved November 30, 2017, from <http://bleacherreport.com/articles/833257-michael-jordan-could-he-really-score-50-with-the-hand-check-rules-in-place>
- [12]. Seng, M. (2017, January 18). The Evolution of NBA Defense. Retrieved from <https://hoopshabit.com/2017/01/18/nba-defensive-evolution/>
- [13]. Shoals, B. (2016, March 25). The NBA Has a 3-Pointer Problem-But Don't Blame Steph Curry. Retrieved from

<https://www.gq.com/story/the-nba-has-a-3-pointer-problem-but-dont-blame-steph-curry>

[14]. The Defensive 3-Point Revolution. (2016, September 23). Retrieved from <http://www.basketballanalyticsbook.com/2016/09/23/the-defensive-3-point-revolution/>

[15]. (n.d.). Retrieved from

https://www.google.co.kr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwjQ44_Z3sXXAhVGNbwKHR7LCJUQFggnMAE&url=http%3A%2F%2Fwww.slate.com%2Farticles%2Farts%2Fbooks%2F2016%2F12%2Fhow_daryl_morey_used_behavioral_economics_to_revolutionize_the_art_of_nba.html&usg=AOvVaw1rpvfMY0GCpSVgx3vLSTL6

IJSER