

Stay out of the Paint: Measuring the influence of the NBA Defensive Three Seconds Violation on Offensive Playmaking

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Abstract:

The defensive three seconds in the key violation (or defensive three seconds for short) is a rule in the NBA that states a defender cannot stand in the paint (Appendix B) for more than three seconds (unless they are guarding a player on offense). The NBA implemented this rule to find the “next Michael Jordan” after he retired (for the second time) in 1998. Many teams’ defenses at the time focused on having their center play as the rim protector (someone who stands under the basket on the defensive end) trying to force players in shooting the ball from afar rather than attacking the basket (Appendix C). In the paper, I analyzed every shot taken in the NBA since 1998 to analyze the impact of the rule on offensive decision-making. In particular, I estimated the effect of the rule on incentivizing players to take more as layups/dunks instead of three-point field goals. Using R, I collected data from over 4.4 million NBA shots and illustrated my findings through popular data visualizations such as line and scatter graphs. In the end, the results concluded that the rule had minimal to no effect on offensive playmaking.

Intro:

The rules of basketball change over time as the people who are running the game want to control its features. One NBA’s earliest rule change was offensive three seconds in the key - where a player on offense could not stand in the paint (Appendix A) for more than three seconds. The NBA created the rule to deter taller players from standing under the hoop (Appendix A) and shooting every time and slowing down the game.¹

¹ S, E., 2022. Bill Russell: An Overrated NBA Legend. [online] Bleacher Report. Available at: <<https://bleacherreport.com/articles/441840-bill-russell-an-overrated-nba-legend>> [Accessed 5 May 2022].

In a way, offensive three-second in the key forced teams to evolve their offensive scoring options. A field goal (Appendix C) is worth two points unless it was made from behind the three-point line (Appendix B), then it is worth three points. The measurements vary among different leagues on the globe, but in the NBA the 3-point line is about 7.24 meters from the hoop.² When it came to two-pointers, players had the freedom to shoot from either the short corner, the low/high post (Appendix B), or at the top of the key (Appendix B). However, about 65 years later the NBA introduced the defensive three-second violation, which is given when a member on the defending team spends more than three seconds in the paint (Appendix B). Of course, there were exceptions to this rule: a violation is not called if the offensive player is in the act of shooting, and a violation would not be called if a defender is guarding an offensive player already in the paint/restricted area for more than three seconds (which, in this case, would be considered an offensive 3-second violation)³.

For the first 50 years in the NBA, the center (Appendix C) was considered the most important position in the NBA; then, Michael Jordan happened. He electrified the league with his explosive drives to the basket. Kelly Scaletta, a journalist at the Bleacher Report, described the NBA's hunt for its next Jordan after his second retirement from the NBA: "Harold Minor, Vince Carter, and Kobe Bryant were all dubbed the "air apparent" (a pun of 'heir apparent') at one time or another. However, even Bryant couldn't touch Jordan's level of success with the existing rules being what they were"⁴.

² Campbell, M., 2022. *Diagrams of Basketball Courts*. [online] Recreation Unlimited. Available at: <<https://www.recreunlimited.com/blog/diagrams-basketball-courts/>> [Accessed 5 May 2022].

³ NBA rule states an offensive player cannot stay in the paint for more than 5 seconds

⁴ Scaletta, K., 2022. *How Michael Jordan Changed the NBA's Center Position Forever*. [online] Bleacher Report. Available at: <<https://bleacherreport.com/articles/1383036-how-michael-jordan-changed-the-nbas-center-position-forever#:~:text=However%2C%20even%20Bryant%20couldn't,rules%20being%20what%20they%20were.&text=So%20the%20NBA%20started%20implementing,the%20same%20things%20he%20did.>> [Accessed 5 May 2022].

The defensive three-second violation was created to 1) create the next Michael Jordan and 2) increase the number of people watching the game by keeping them excited. The defensive three-second in the key opened the paint and enabled players to attempt more two-point shots. NBA officials thought that by unclogging the paint and influencing offensive players to make explosive plays (Appendix C) at the rim (Appendix B). Although the rule satisfied fans, it negatively impacted teams who used a zone defense. Zone defense (Appendix C) made a player (usually the center) always stand in the paint waiting for someone to drive to the basket. With this gone, some teams changed their defensive strategies from a zone to a man-to-man (Appendix C) defense.

The purpose of this paper is to analyze the impact of the defensive three-second rule on the NBA team's offensive strategies and efficiency, more particularly in the realm of taking 2 or 3-point shots.

Theory:

The NBA implemented a defensive 3 seconds rule to make it easier for players who weren't Jordan to emulate the same things he did. By not allowing players to defend the paint, it created an avenue for players to emulate Jordan. In addition, NBA Analysts also thought there would be a decrease in the number of threes taken. Owen Phillips, a data science analyst at the NBA, explains why this would be the case in his *The longest three seconds in basketball*. He explains how the rule forces defenses to stretch out. He shows this difference between two photos that show the typical type of defense played in different eras: **figure 1** comes from the 1991 NBA Finals while **figure 2** comes from the 2021 Bucks and Nets playoff games:

Figure 1⁵



Figure 2⁵



As shown in figure 1, before the rule was implemented, teams typically swarmed the paint,

whereas in figure 2 the defense had to spread out to not get called for the defensive 3 seconds in the key.

Due to this, it shows how players had an easier time driving to the basket to score.

Many NBA personnel were not fond of the defensive three-second rule. People outside of NBA personnel criticized the voting process because it only took the input of the NBA owners instead of players and there was no pilot/testing period to study the effects of the rule⁶.

In addition, two weeks before the vote on the rule, the New York Times published an article presenting the opposing sides of the rule. Jerry Colangelo, the Phoenix Suns former owner, was a proponent of this rule. He believed that basketball was moving in a bad direction after Jordan retired. He stated “There’s no fluidity[...]. There [was] less ball movement and less player movement than

⁵ Phillips, O., 2022. The longest three seconds in basketball. [online] Thef5.substack.com. Available at: <<https://thef5.substack.com/p/three-in-the-key?s=r>> [Accessed 5 May 2022].

⁶ Sources, S., 2022. The Defensive Rule Change That Sparked the Modern Game. [online] Sideline Sources. Available at: <<https://sidelinesources.com/nba-news/the-defensive-rule-change-that-sparked-the-modern-game/>> [Accessed 5 May 2022].

there's ever been."⁶ Him and other NBA owners believed this rule could make watching basketball more fun.

Pat Riley, then head coach of the Miami Heat, was on the other side of this spectrum and lamented this new rule at the time. Ira Winderman, writer at the Sun-Sentinel, stated this in regards to Pat Riley's comments: "Riley spoke of league-wide "havoc" next season. He said the rules could eliminate Alonzo Mourning's polished post-game on offense, but also could leave Mourning effectively as a goaltender on defense"⁶. Pat Riley, whose team was facing a roster overhaul at that time, was afraid the rules would make it even harder for his players to play defense. To him, defense is a team sport and by eliminating a zone defense, more teams would opt for man-to-man defense. He felt as though it would slow the game down because instead of players passing the ball on the offensive side, many would instead opt to play isolation basketball (Appendix C) and drive to the basket (Appendix C) every time.

Overall, the analysis is supposed to show a reflection of what many NBA analysts, players, and coaches thought: the NBA 3-second rule will result in more 2-pointers (specifical dunks) taken, fewer 3-pointers taken, and overall more shots taken throughout an entire NBA season. Thus, in my analysis, we should see climbing trends in the number of three-pointers taken between and after the rule. Once that is broken down to the team level, we should see similar trends but account for teams then who were relying on the 3-ball to score. Then, at the player level, we should see a more accurate impact on a player's shot decisions. Across different positions, we should see the numbers change among guards since they tend to shoot the most. For big men (Appendix C), on the other hand, we should not see the

rule have much of an effect on these players because most of them would always opt to shoot two-pointers instead of threes.

Design:

I obtained the dataset from R's *NBAstat package*, which contains a function called *grab_data* which fetches every basketball shot taken during one NBA season. The dataset I created, called *allnbashots*, is an aggregation of every shot taken by every player in the NBA from 1998-to 2021. With around 4.3 million shots, the dataset contains variables such as the name of the player, what team they were on, the type of shot they took (i.e. two or three-point field goal), whether or not they made it, and where on the court it was taken from via x and y coordinates. Out of the 4.3 million shots taken in the NBA, about 3.2 million of those shots are two-point field goals and 1.1 million of those are three-point field goals.

My analysis focuses on shots taken 2 years before and after the rule was implemented to see the direct effect of the defensive three-second in the key violation on the number of 3-point shots taken, 2-point shots taken, and dunks taken. To do this, I create multiple variations of *allnbashots*, with some filtering on the type of shot (jump shot, layup, dunk) and others grouping the necessary data by the team and the game identification number. My analysis includes season by season illustration of the number of 3-pointers taken and dunks per team, team by team illustration of the number of 3-pointers and dunks taken per game per team, and finally, a player's three-point usage coefficient plot on the number of 3-pointers and dunks taken per season

Throughout many of these visualizations, I place a vertical dotted line that represents the date on which the defensive 3 seconds in the key rule was implemented. Overall, my hypothesis is in

alignment with the hopes many NBA personnel had about it: It will decrease the number of 3's taken, increase the number of 2's taken, and more specifically, increase the number of times a player attacks the basket.

Results:

Season by season illustration of the number of 3-pointers taken and 2 pointers taken

In **figure 3 and figure 4**, I utilized the *ggplot* package in R to 1) compare the number of dunks taken before and after the rule was implemented and 2) compare the number of three-point shots taken to two point shots taken around the time the rule was implemented. The graph is shown below:

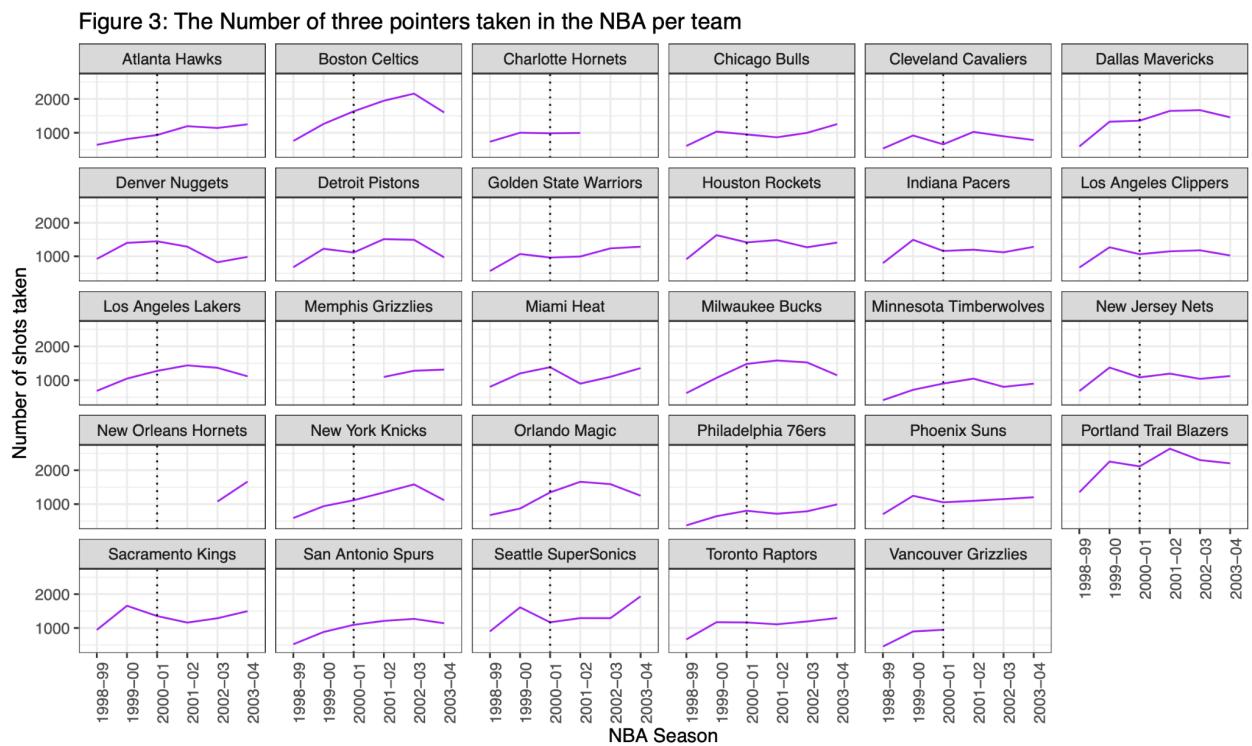
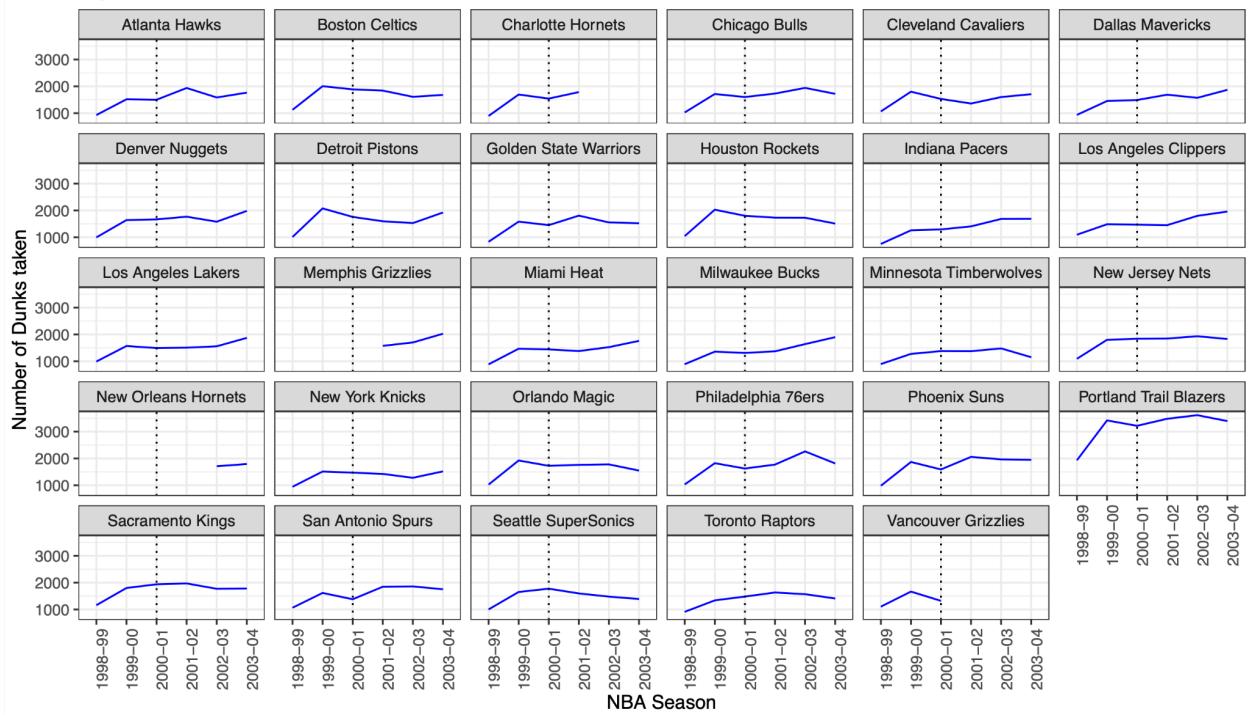


Figure 4: The Number of dunks in the NBA per team per season



It's important to take into account that there was an NBA lockout during the 1998-1999 NBA

season, meaning that the start of the NBA season was delayed from October 1998 to January 1999.

Due to this, the season was shortened to 50 games, which explains the huge spike in 3-point shots taken from the 1998-1999 season to the 1999-2000 season. The rule was implemented in the 2000-2001 NBA season (recognized by the dotted vertical line). In addition, the Portland Trail Blazers have extraordinary numbers in this dataset. It's safe to assume this is an outlier team (explained in Appendix D)

Of course, there are more dunks attempted than three-pointers because those shots are easier to make; however, with the implementation of the rule, we expected to see an inverse relationship between the two-shot types. The rule should have resulted in more 2-point field goals taken and fewer threes taken.

There was a small bump in the number of three-pointers taken for a couple of teams after the rule was enforced, but the number of threes taken stayed constant after the 2001-2002 NBA season. Outside of the Portland Trail Blazers, Detroit Pistons, and Seattle Supersonics (currently known as the Oklahoma City Thunder), no other team experienced significant changes in their offensive decision-making. The rule barely had barely affected whether players on average shoot more or fewer two or three-pointers.

Overall, this analysis shows the hope that people against the implementation of the rule was not realized. The rule did not show to have an immediate effect on the number two and three-pointers taken across the NBA. It kept the game the same.

Team by team illustration of the number of 3-pointers taken per game per Season

Nonetheless, in my first analysis, I wanted to see if there was an immediate effect on the threes and dunks taken. To do this, I created a scatterplot of each NBA game played and how many threes

and dunks were taken in **figure 5** and **figure 6** respectively. My graphs are below:

Figure 5: Number of threes taken per game between 1998–1999 to 2003–2004

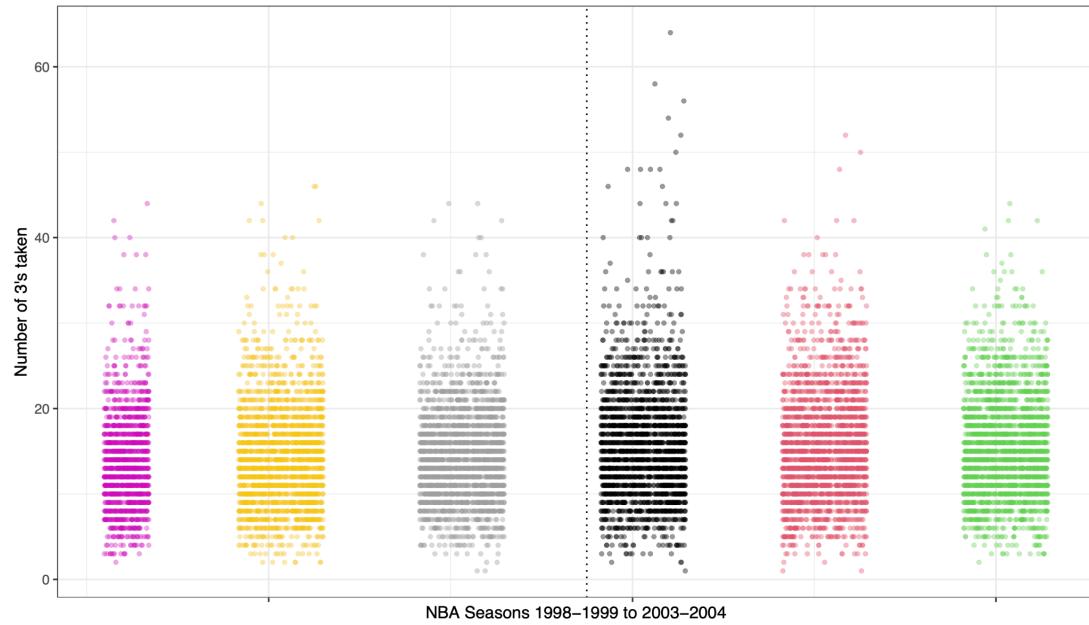
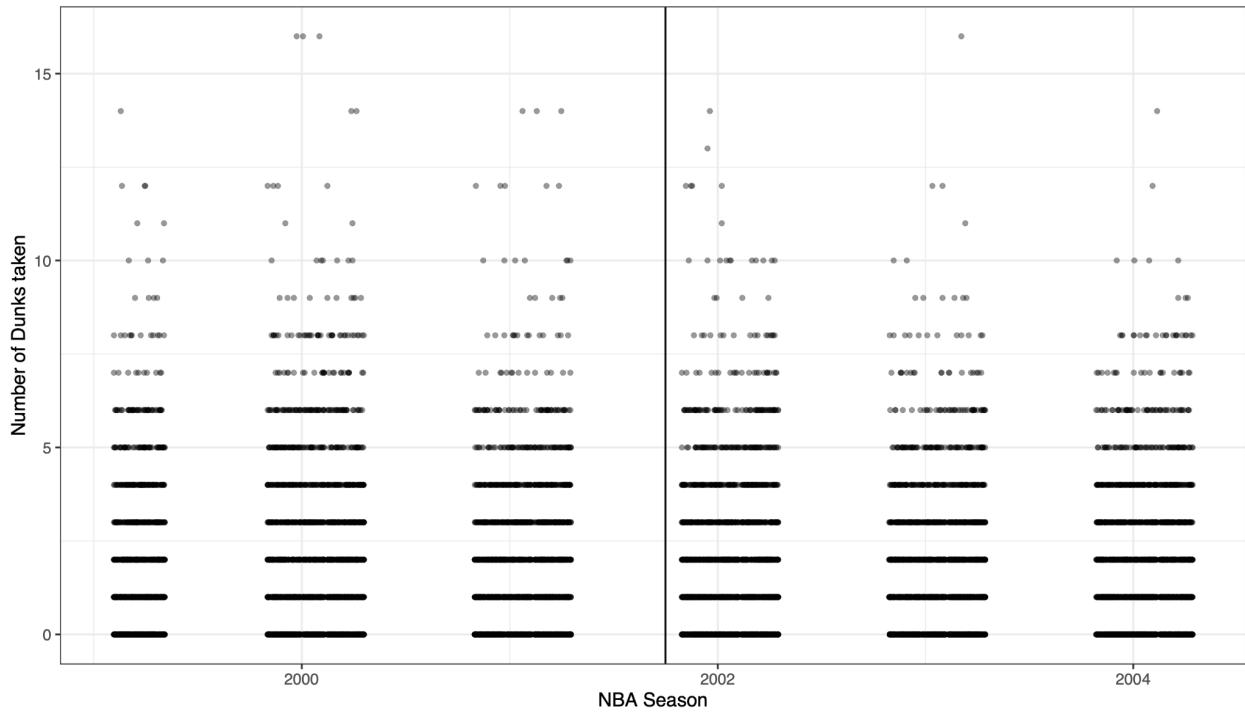


Figure 6: Number of Dunks taken per game between 1998–1999 to 2003–2004 Per team



Although figure 5 and 6 does not show any big changes in threes or dunks attempted among seasons, it's important to note that in figure 5's 2001-2002 there were more games where an abnormal number of threes were taken.

This is not what was expected at all. Figure 6 shows the number of dunks attempted per game stayed the same. The rule was meant to create a clear path to the hoop and enable players to attempt more dunks/layups. This visualization highlights how NBA teams did not take advantage of the rule; if anything, teams tended to take more threes during NBA games. This highlighted critics such as Pat Reilly who thought the defense would be harder to do because the rule would enable more teams to drive to the basket; however, it appears that the rule had no effect because offenses continued to take more threes after the rule was implemented.

Team by team illustration of the number of 3-pointers and Dunks taken per game per team

It's important to note that each time was affected differently by the rule. **Figures 7 and 8** look at the rule's impact on the number of three-pointers and dunks per game before and after the rule was implemented. This Analysis is the most important one because people wanted the rule to be implemented so that players are persuaded to take more dunks during a game.

Figure 7: Number of threes taken per game between 1998–1999 to 2003–2004

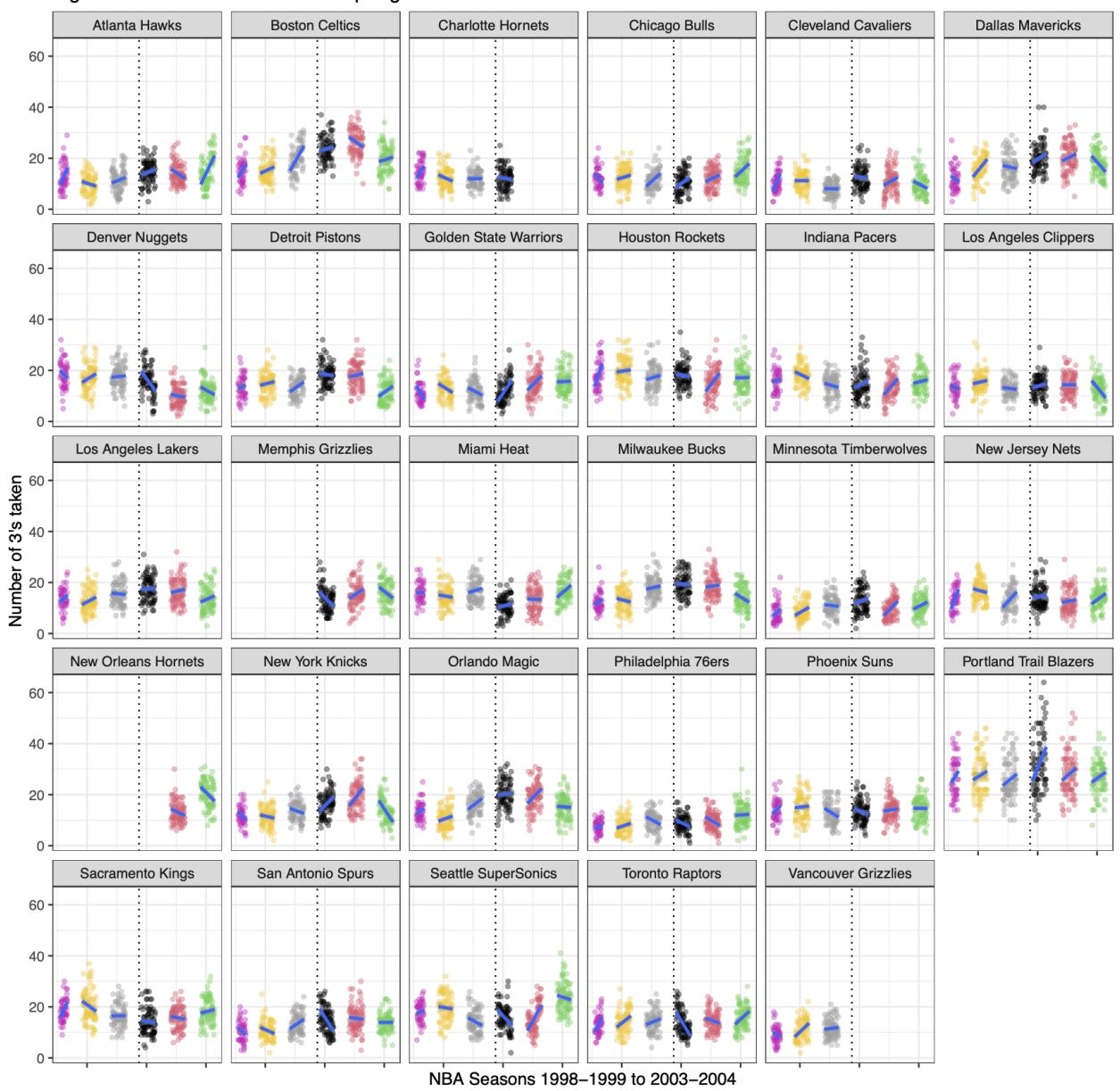
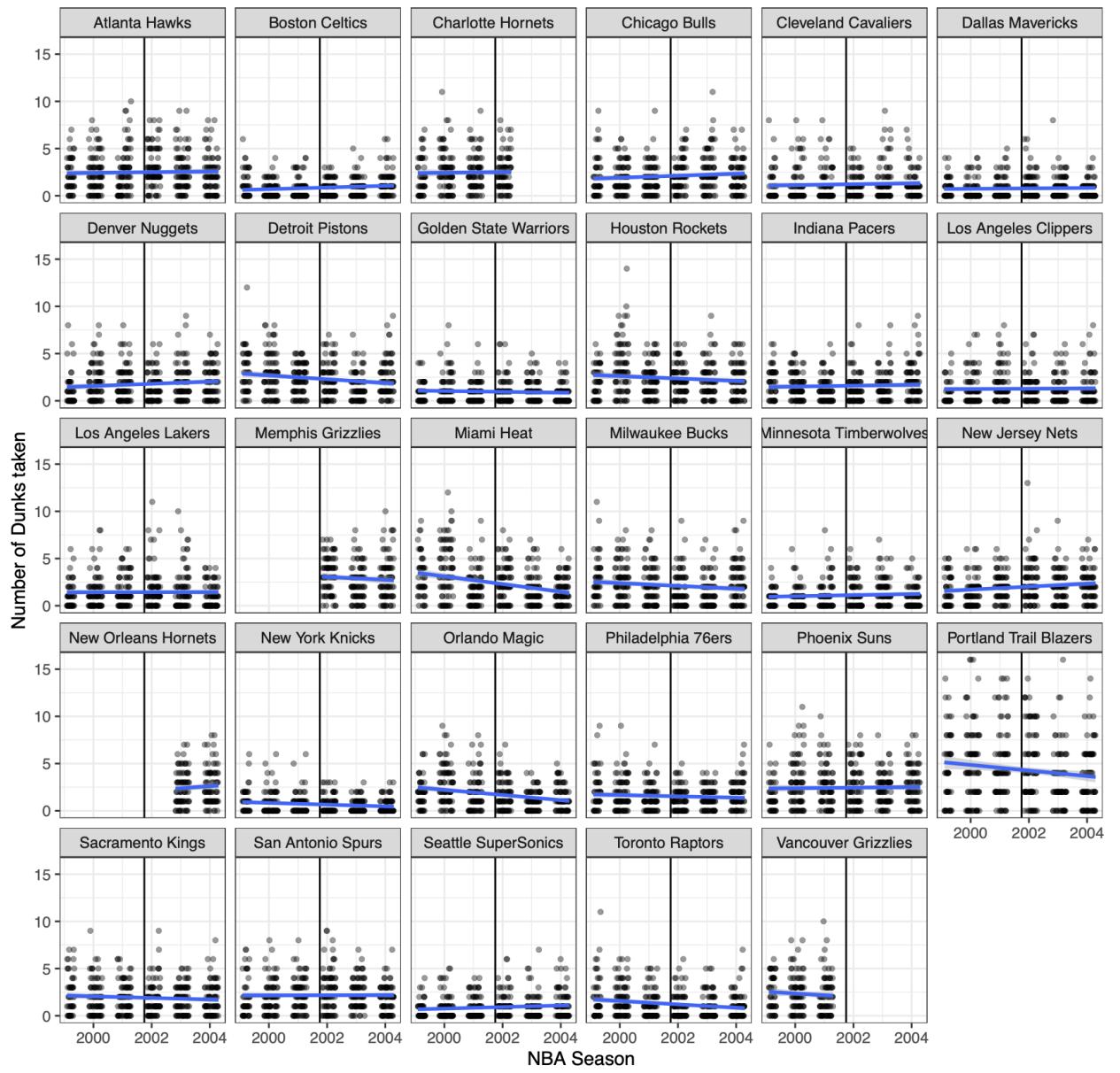


Figure 8: Number of Dunks taken between 1998–1999 to 2003–2004 Per team



In addition to the scatter plot, a linear regression model was used to track the trends of the number of dunks taken from season to season (indicated by the blue line). Like with three-pointers, the rule has shown to have a minimal effect on the number of dunks taken per game. If anything, when looking at cases such as the Miami Heat, Houston Rockets, and Orlando Magic, the rule looks like it influenced people to take fewer dunks during the game. The model shows that as the number of

seasons passed (especially after the rule was implemented in 2001, we see a small decrease in dunks attempted and maybe a tiny increase in shots attempted.

Season by season illustration of the player's three-point usage

A limitation of the *allshotsnba* dataset is that although it includes every shot taken in the NBA, the player who shot it, and the team the player is on, the dataset did not include the players' height and position. Thus, for many of the players I saw, my analysis was limited to the effect of the rule on a player's position. I did find a dataset that had every NBA player's name and the position they play, but many players were listed with multiple positions (i.e. Luka Doncic was listed as Point Guard, Small Forward, and Power Forward).

To combat this, I looked at players that 1) Played before and after the rule was implemented and 2) Played different positions. I used power forward Kevin Garnett, point guard Ray Allen, Center Tim Duncan, and shooting Guard Vince Carter. In **figure 10 and figure 11**, I highlighted the effect of the rule on taking three-pointers and dunks by these players:

Figure 9: Number of threes taken per game per player between 1998–1999 to 2003–2004

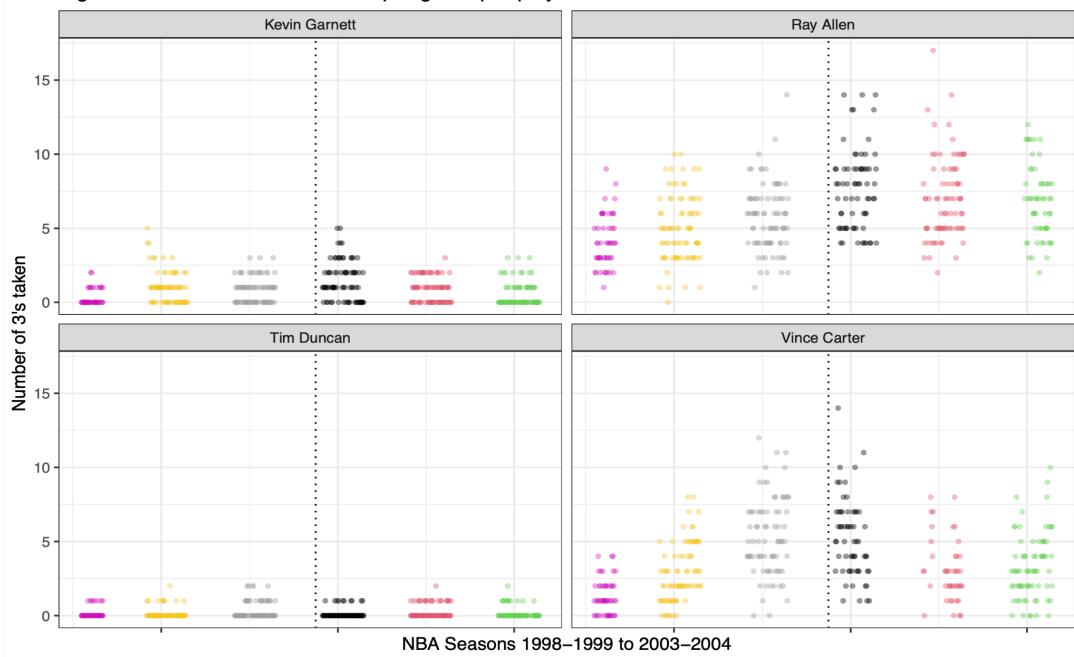
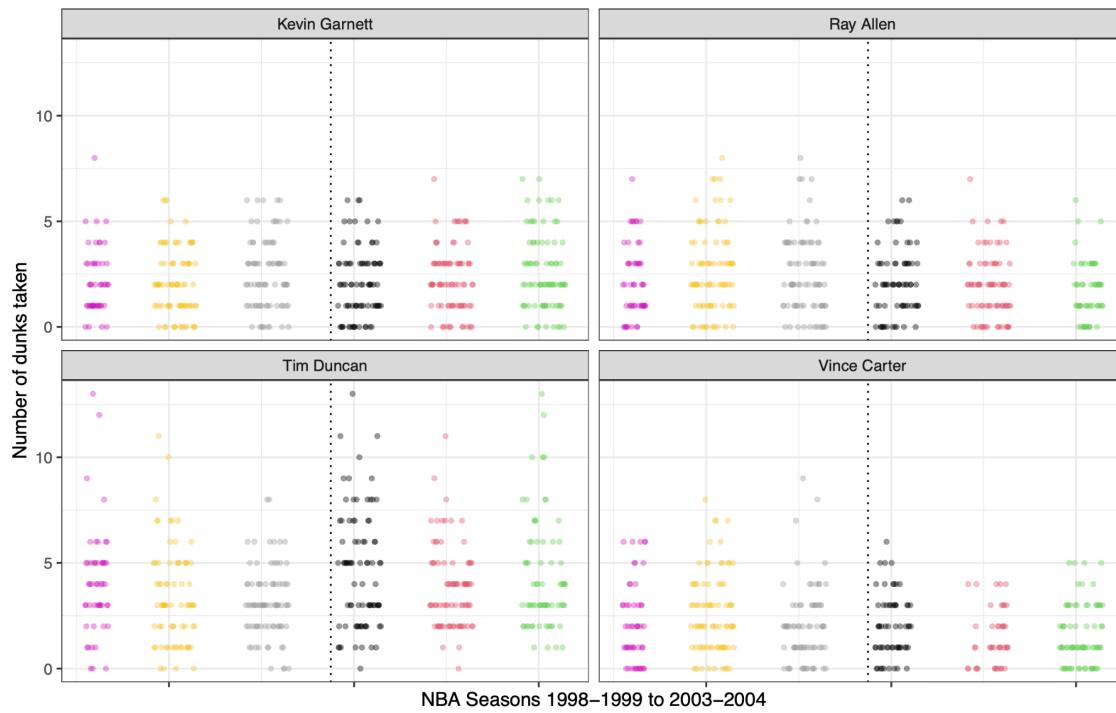


Figure 10: Number of dunks taken per game per player between 1998–1999 to 2003–2004



The visualization matches a lot of trends in the NBA when it comes to certain positions - point and shooting guards are more likely to shoot threes than big men. In most cases, big men score in the paint or on the post (Appendix C).

For Ray Allen, he saw an increase in the number of threes made after the rule was implemented. This makes sense because he is considered the second-best shooter of all time (behind Stephen Curry). Thus, he tends to shoot more than he dunks because he is simply better at the former. The rule had no impact on him, decreasing his number of three attempts.

Vince Carter, on the other hand, saw a decrease in the number of three-pointers attempted. This result highlights the small number of players who took advantage of this rule. Vince Carter is known as one of the most electrifying players at the basket. The winner of the 2000 NBA dunk contest, he is known as one of the greatest dunkers in NBA history. With that being said, this illustration shows that the defensive 3 seconds in the key rule allowed Vince Carter to exchange three-pointers for dunks.

For Tim Duncan and Kevin Garnett, these results were expected. Big men always tended to shoot more twos than threes because they are so tall. It's hard to defend taller players which is why most of them shoot and score from very close range. We should not see much effect of the rule as illustrated in the graph.

Significance test on the number on the number of 3-pointers and dunks taken per season

Seeing the discrepancies among these 4 players, **figure 11 and 12** attempt to illustrate the other point of implementing the rule: to get more players to make more exciting plays such as dunks. A coefficient plot was created using only data from the 1999-2000 and 2000-2001 NBA seasons and a

significant test was run to the difference between the number of dunks attempted before and after the rule was implemented. The visualization is below:

Figure 11: Difference in dunk attempts between 1999–2000 and 2000–2001 NBA Season

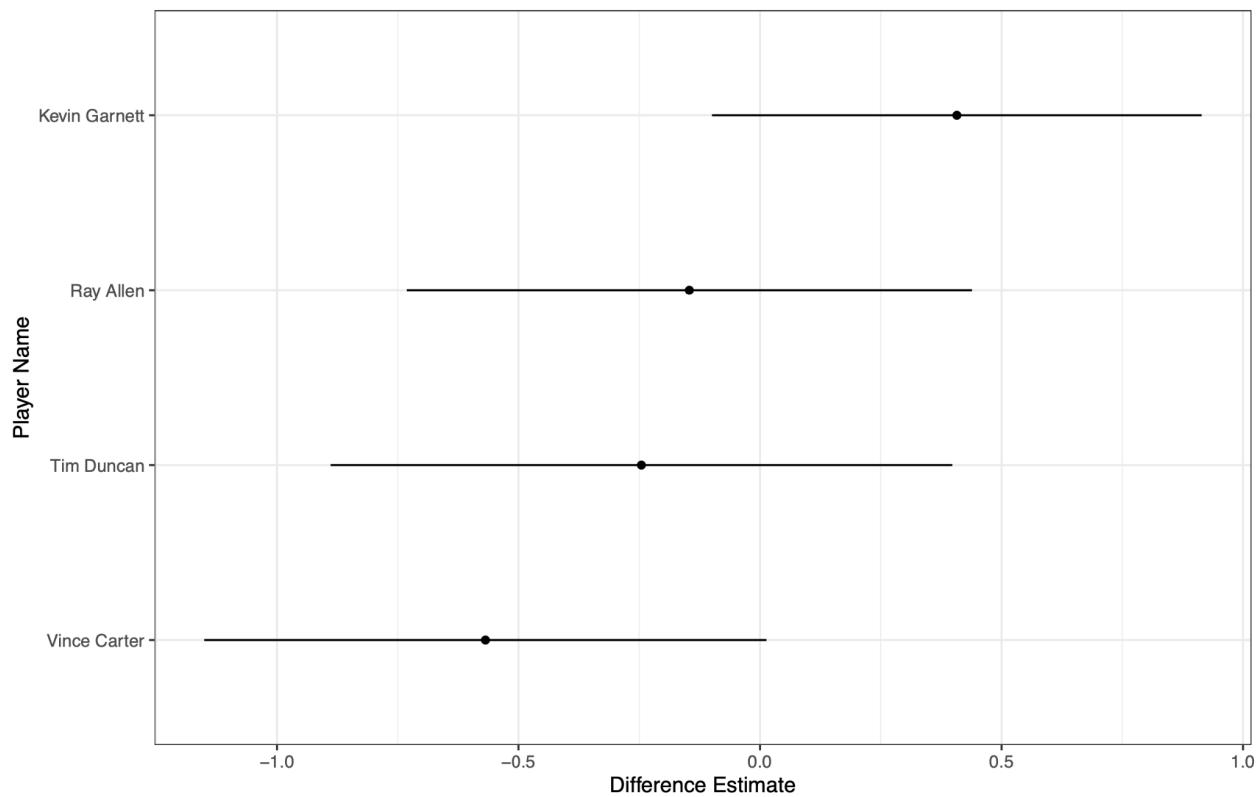
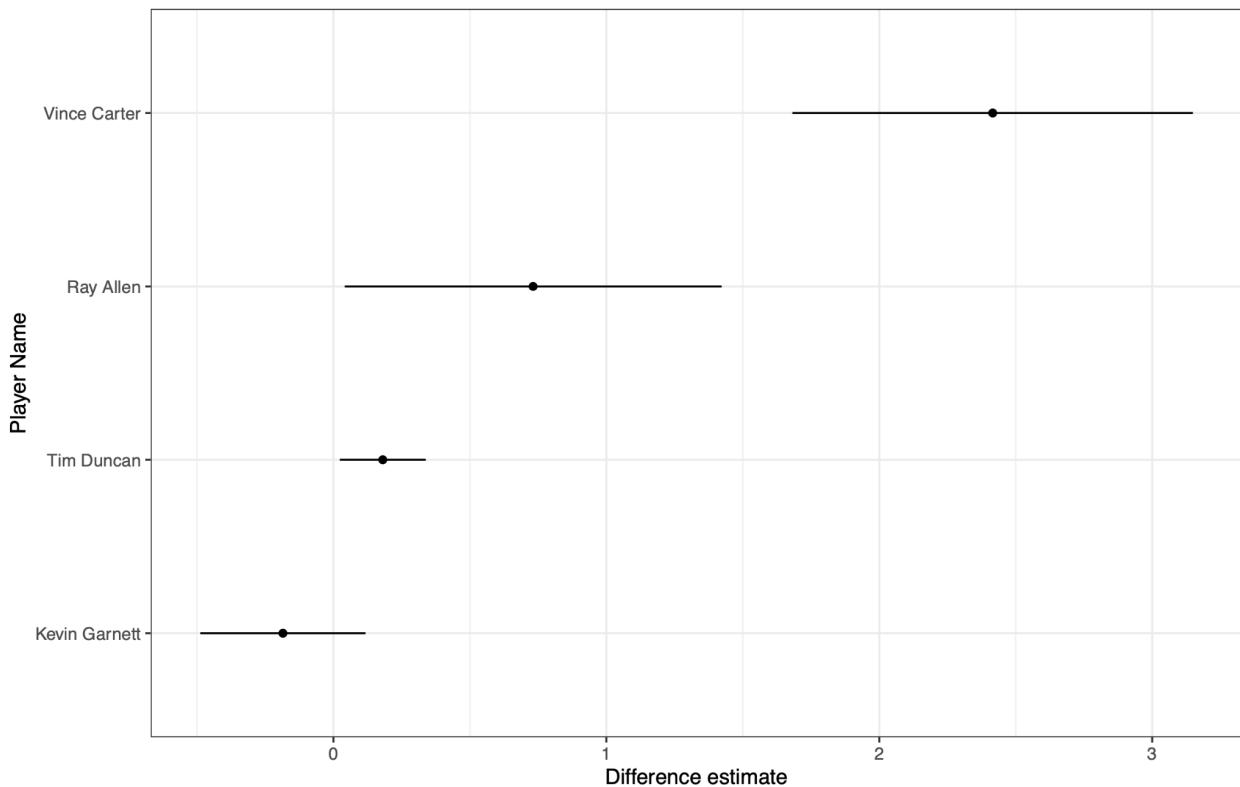


Figure 12: Difference in three point attempts between 1999–2000 and 2000–2001 NBA Season



The only player that attempted more dunks after the rule was implemented was Kevin Garnet; even then, he only averaged about .04 more dunk attempts per game. Overall, the graphs show that the rule has not changed the offensive play-calling of these players. If anything, they mostly played the same way.

Nonetheless, these players may not be a great representation of this rule, **figure 13 and 14** replicates figure 8 but is aggregated to the team level and looks at the number of threes attempted instead of dunks:

Figure 13: Change in three pointer attempts between 1999–2000 and 2000–2001 NBA Season

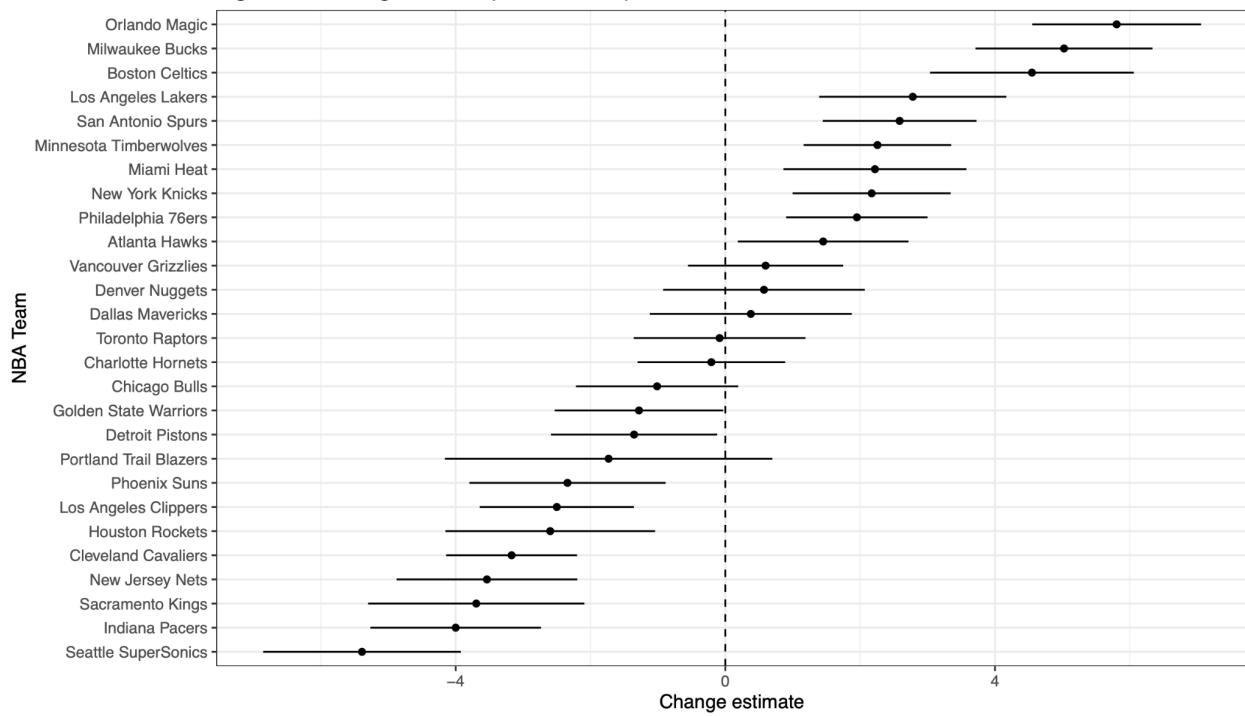
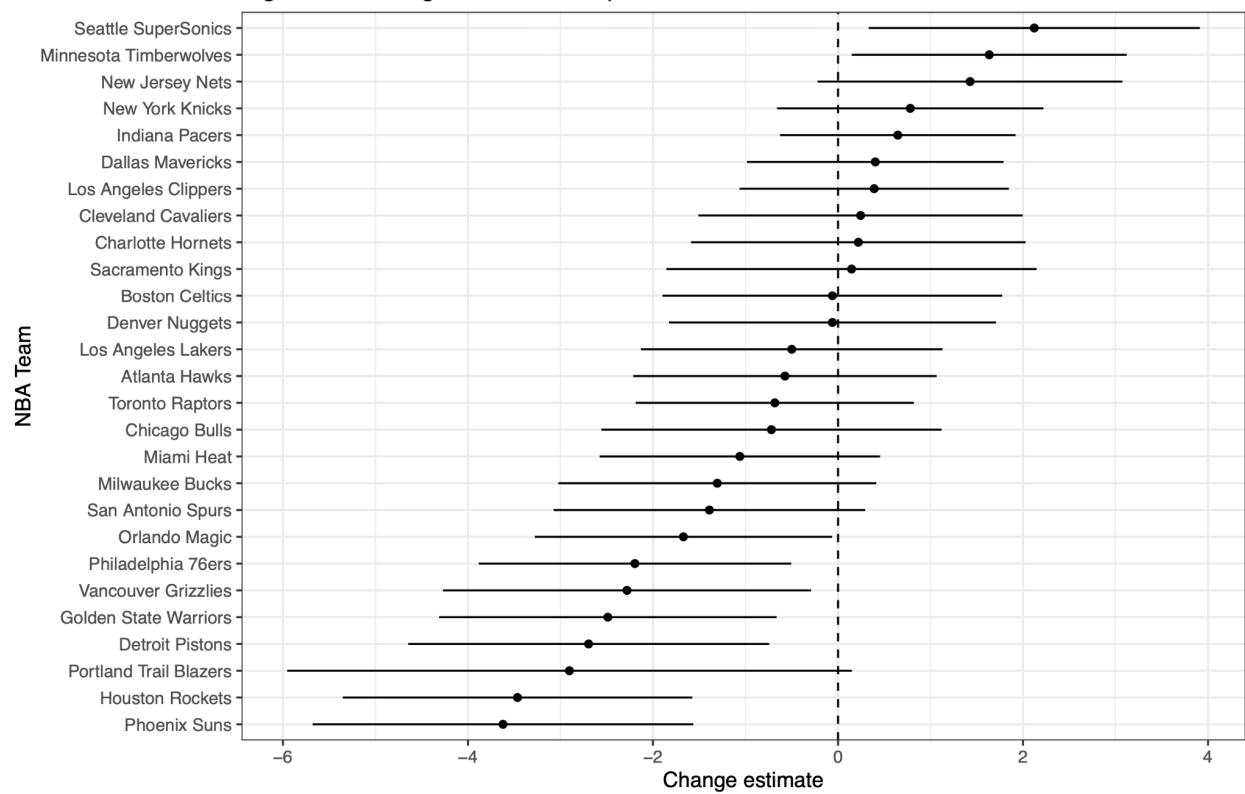


Figure 14: Change in dunk attempts between 1999–2000 and 2000–2001 NBA Season



This graph shows a much better representation of the rule. Around half of the teams saw an increase in the number of threes attempts and the other half saw a decrease. Nevertheless, for teams that did see an increase, the average of it was around 2-2.5 more threes attempted per game. This is not significant enough to show that the rule had a big impact on the number of threes taken.

To ensure that these results were consistent, I ran a placebo experiment in Appendix A using 2 seasons before the rule was implemented. The estimates in Appendix A also show similar trends, providing less legitimacy to the rule having an effect.

Conclusion:

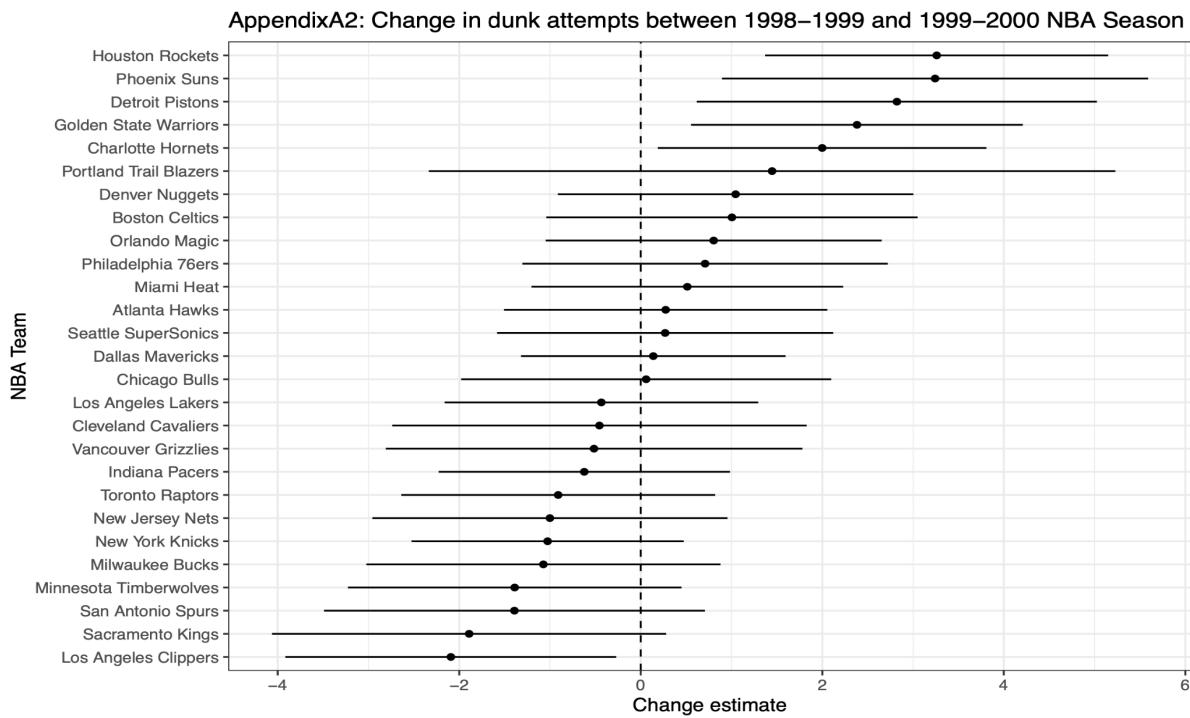
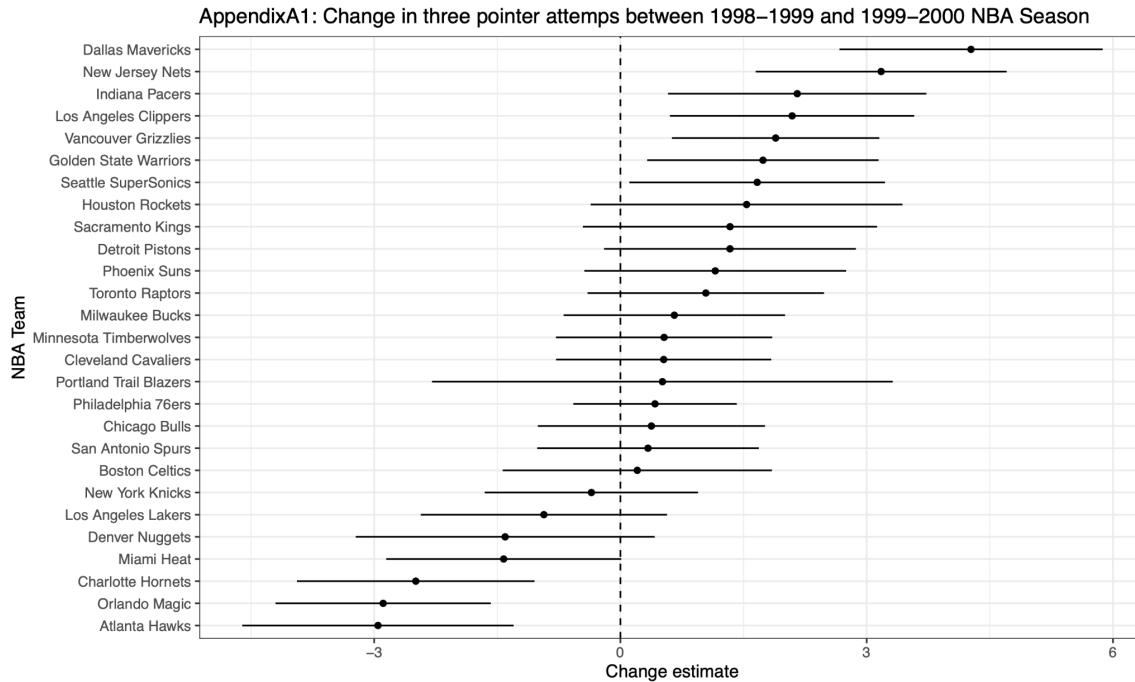
The data shows the NBA defensive 3-seconds in the key rule had a minimal effect on offensive play calling. It had little to no effect on influencing the type of shots players take. People for the rule assumed players would shoot more 2s (preferably dunks) and fewer threes; however, in figures 3 and 4, there tends to be a slight increase in the number of threes taken after the rule was implemented. In figure 6, in many cases, we tend to see a decrease in the number of dunks taken after the rule was made.

People who were skeptics of this rule and proponents of it respectively were proven wrong. The game, in terms of two's and threes taken, did not change at all. From face value, the graphs have shown no significant changes in the number of 3s taken per game per season in the NBA. From these results, it appears that the defensive 3 seconds rule in the NBA had no significant effect on the number of shots taken per NBA season.

Future explorations of this analysis include analyzing whether the rule improved offensive efficiency. Although the data did not show an effect on the types of shots taken, I want to look into whether the rule effected shots being made.

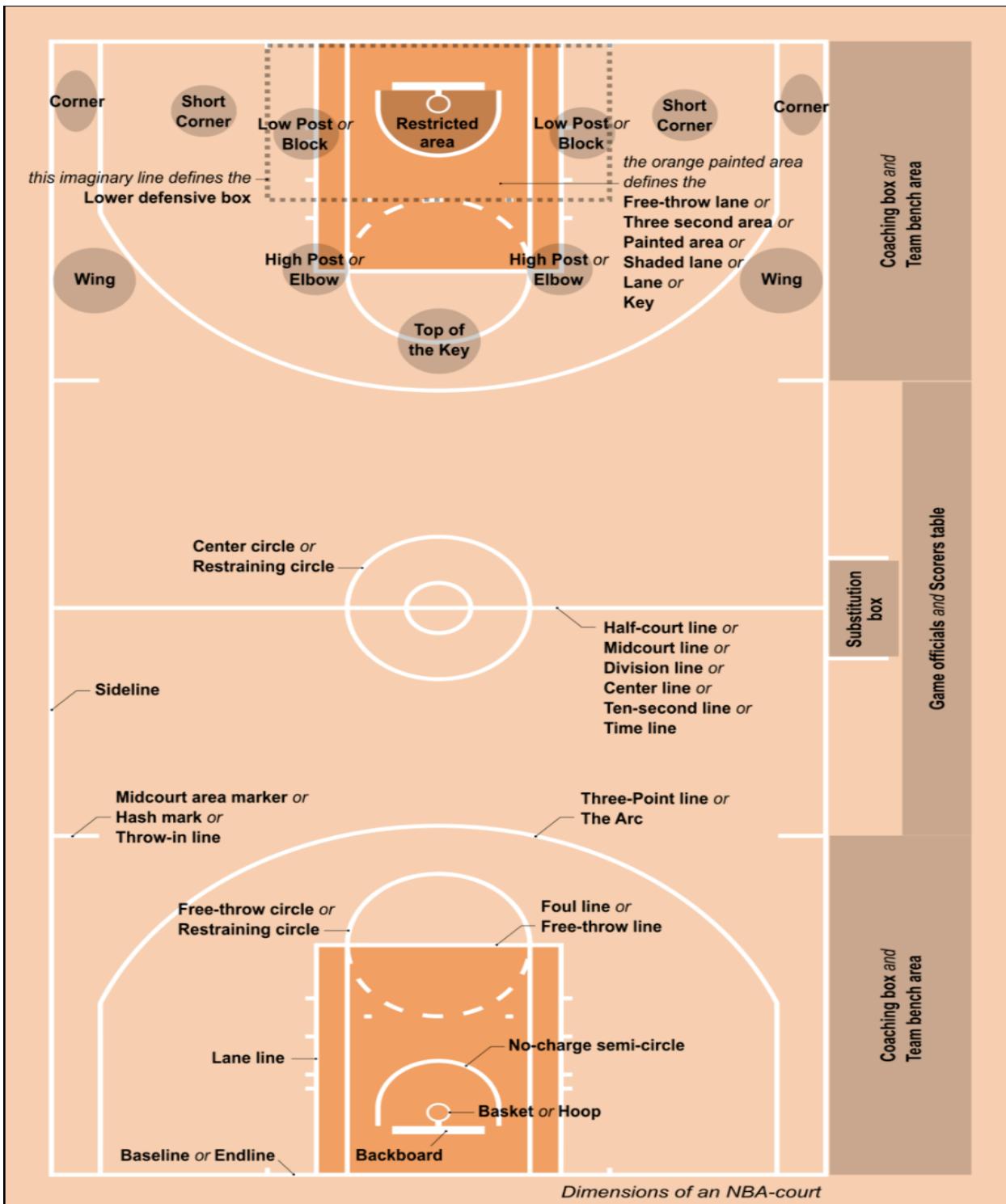
Appendices

Appendix A: A placebo that runs the code similar in figures 13 and 14 except we use the two years before the rule was implemented: Here are the diagrams:



Appendix B⁷:

Appendix B is a diagram of a basketball court with labels



⁷ https://www.wikiwand.com/en/Basketball_court

Appendix C:

Appendix C is a glossary of basketball terms that may be unknown to the average reader.

Field goal: a basket scored on any shot or tap other than a free throw, worth two or three points

depending on the distance of the attempt from the basket

Explosive play: having the ability to run past opponents with the ball and score

zone defense: a type of defense where each defensive player is given an area to cover.

man-to-man defense: each player guarding a corresponding player on the other team

isolation basketball: It is when the player will play against another player on the opposing team to try to score. Usually, the ball handler will be the team's superstar player, and they will take advantage of the hole in the opponent's defense

drive to the basket/attack the basket: A brisk advance toward the basket to shoot

big men: a physically large player. This comes with the expectation that the player will play a certain position; usually a center.

Point Guard, Shooting Guard, Small Forward, Power Forward, Center are the different positions you can play in the game of basketball

Appendix D: Portland Trail Blazers Data entry error

I ran the following code to obtain the number of shots attempted by the trail blazers during the 2002-2003 NBA season:

```
AppendixD <- shots_99_04 %>%
  filter(nameTeam == "Portland Trail Blazers", slugSeason == "2002-03") %>%
  group_by(idGame) %>%
  summarise(shots_taken = sum(isShotAttempted == "TRUE"))
```

After obtaining the manipulated dataset, I looked at the top 10 games with the highest number of shots taken and did the same for the bottom 10.

#	idGame	shots_taken	#	idGame	shots_taken
1	20200717	196	1	20200436	126
2	20200427	194	2	20200731	126
3	20200596	194	3	20200324	136
4	20200332	184	4	20200899	136
5	20201143	184	5	20200828	138
6	20200264	182	6	20200858	138
7	20200612	182	7	20200919	138
8	20200777	180	8	20200289	140
9	20201188	178	9	20200933	140
10	20200307	176	10	20201111	140

This is a graph of all of the average NBA statistics per season:

Team and Opponent Stats

Ranks are per game (except for MP, which are total) and sorted descending (except for TOV and PF); opponents ranked are flipped; year/year calculations are also per game

	G	MP	FG	FGA	FG%	3P	3PA	3P%	2P	2PA	2P%	FT	FTA	FT%	ORB	DRB	TRB	AST	STL	BLK	TOV	PF	PTS
Team	82	19855	2987	6491	.460	379	1150	.330	2608	5341	.488	1450	1947	.745	992	2378	3370	1860	725	316	1248	1634	7803
Team/G		242.1	36.4	79.2	.460	4.6	14.0	.330	31.8	65.1	.488	17.7	23.7	.745	12.1	29.0	41.1	22.7	8.8	3.9	15.2	19.9	95.2
Lg Rank		10	10	22	5	19	16	24	8	18	2	20	17	20	13	25	22	8	3	24	19	2	15
Year/Year		0.1%	-0.6%	-2.7%	+.010	-18.7%	-12.7%	-.024	2.8%	-0.2%	+.014	-0.1%	2.4%	-.019	-8.6%	-2.7%	-4.5%	-3.4%	3.3%	-14.1%	6.5%	1.3%	-1.5%
Opponent	82	19855	2942	6540	.450	438	1285	.341	2504	5255	.476	1267	1659	.764	912	2292	3204	1863	683	391	1270	1670	7589
Opponent/G		242.1	35.9	79.8	.450	5.3	15.7	.341	30.5	64.1	.476	15.5	20.2	.764	11.1	28.0	39.1	22.7	8.3	4.8	15.5	20.4	92.5
Lg Rank		10	16	12	21	18	23	11	13	7	24	1	1	19	6	2	2	23	20	10	9	26	11
Year/Year		0.1%	-0.3%	0.5%	-.004	-6.0%	0.0%	-.022	0.8%	0.6%	+.001	-3.4%	-6.3%	+.023	2.5%	-1.5%	-0.4%	-4.2%	11.6%	-4.6%	5.1%	1.2%	-1.2%

8

In the picture above, FGA is synonymous with shots taken. With an average of 79.2 NBA shots attempted per game, The trailblazers game to game numbers in the dataset is extreme outliers because every game has more field goal attempts than their season average, which mathematically does not add up. Overall, it seems to be that the data was collected incorrectly for the Portland Trail Blazers around this area.

Appendix E:

The link to all of my code and graphics can be found [here](#)

⁸ <https://www.basketball-reference.com/teams/POR/2003.html>