The Effects of the NBA COVID Bubble on the NBA Playoffs: A Case Study for Home-Court Advantage

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ABSTRACT
The 2020 NBA playoffs were played inside of a bubble at Disney World because of the COVID-19 pandemic. This meant that there were no fans in attendance, games were played on neutral courts and no traveling for teams. In theory, these conditions should remove home-court advantage from the games. This setting generated discussion and concern, as analysts and fans debated the possible effects it may have on the outcome of games. Home-court advantage has historically played an influential role in NBA playoff series outcomes. The 2020 playoffs provided a unique opportunity to study the effects of the bubble and home-court advantage by comparing the 2020 season with the seasons in the past. While many factors contribute to the outcome of games, points scored is the deciding factor of who wins. Thus, scoring is the primary focus of this study. The specific measures of interest are team scoring totals and team shooting percentage on two-pointers, three-pointers, and free throws. Comparing these measures for home teams and away teams in 2020 vs. 2017-2019 shows that the 2020 playoffs favored away teams more than usual, particularly with two-point shooting and total scoring.

KEYWORDS
NBA; NBA Covid; NBA Bubble; HomeCourt Advantage

INTRODUCTION
Home-court advantage is often discussed in sports circles as a contributing factor to the outcome of games. It is well-known that the home team typically benefits from some competitive edge while playing at their home court, resulting in a better chance of winning. Thus, the NBA playing the 2020 playoffs in a bubble due to the COVID-19 pandemic brought a great deal of concern for fans, teams, journalists, and others. The bubble environment would not be able to replicate many of the factors that normal home-court advantage relies on. Among the biggest is the effect from the crowd. The home crowd has the ability to energize home teams, help control momentum in favor of the home team and create a chaotic and stressful environment for away teams to play in. There is no way to replicate these effects in the bubble conditions. Also, there are geographic factors that are lost, like altitude and time-zone effects. There's evidence across all sports that teams in high altitude regions can rely on away teams coming in and struggling with the lower oxygen levels at a higher altitude, which the home teams are accustomed to playing with Lopez et al.[1]. Examples of high altitude teams in the NBA would be the Utah Jazz and Denver Nuggets, both of whom participated in the 2020 NBA bubble. Also, referees are known to be subject to favoring home teams. This is due in large part to pressure from fans, which is no longer in play in the bubble. Refs may still have biases, but there's nothing to sway that bias towards the home team like normal. Any positive effects of the home team playing in the arena they're most comfortable in and living in the comfort of their own home are also lost. Travel is also normally discussed as a factor hurting away teams, but in the context of the playoffs being played in the bubble, losing this may not be significant. In the playoffs,

many times (aside from the first game of the series when the away team travels), both teams often travel at the same time, since they're both going back and forth between the two cities to complete the series.

Aschburner[2] discusses the anticipated effects, sharing concerns from former players, coaches and other experts about the potential effects of removing home-court advantage. Aschburner notes that the NBA did make attempts to recreate the effects by putting the "home" team logo on the court and allowing the "home" team to play crowd noise and music, but most people doubted these small attempts would recreate a true playoff atmosphere. During the 2020 NBA playoffs, home teams only won about 48.2% of the games. This is lower than normal, which Aschburner claims usually floats around 60%. This shift in the home team winning percentage surely indicates the opportunity for thorough investigation.

So, what happened? Did the home teams fail to perform up to normal standards without the help of home-court advantage? Were away teams able to rise to the occasion and perform better not having to deal with the headache of going on the road? We seek to answer the questions using scoring totals and shooting percentages as indicators of team performance. This will deepen understanding of how home-court advantage affects home and away teams in the NBA.

Our study is quite different from earlier NBA home-court advantage studies. By using the neutral site games of 2020, we will get to compare home and away performance to a control. Typically, studies just compare home vs away performance. These studies do not separate the effects of home-court advantage into the specific effect on the home team and the specific effect on the away team. They show that home teams outperform away teams, but not if this is a result of home teams overperforming or away teams underperforming because of home-court advantage. Some of these studies are reviewed in greater detail in Section 2.

We will compare home team performance in 2020 at a neutral site with no fans vs. 2017–19 playoffs with fans. Likewise, away team performance in 2020 at a neutral site with no fans vs. 2017–19 playoffs with fans. By comparing home teams in 2020 to home teams in 2017–19 and away teams in 2020 to away teams in 2017–19, we add a new perspective to the field of research. This will allow for a more accurate understanding of the effects of home-court advantage on home and away teams in the NBA. We will not only see that home-court advantage helps home teams outperform away teams, but also separate the effects of home-court advantage on home teams' and away teams' performance individually.

Nine hypotheses were tested to understand the differences in 2020 vs. earlier years. First, whether or not the difference between home win percentage in 2020 and 2017–19 is zero. This difference is found to be statistically significant from zero. Then we assess for differences in home scoring in 2020 vs 2017-2019. Similarly, we can do the same test, but for differences in away scoring in 2020 vs 2017-2019. Also, differences in team shooting (for two-pointers, three-pointers, and free throws) from 2020 vs 2017-2019 for both home and away teams. The results from these tests bring a new perspective to the understanding of how home-court advantage impacts games by altering the performance of the home and away teams.

There is voluminous literature on the effects of home-court advantage. Many NBA home-court advantage studies analyze the effects by studying shooting percentages. Kotecki[3] reported significant evidence of home-court advantage by comparing field goal percentage, free throw percentage and points scored in home vs. away teams. He found all of these measures showed evidence that home-court advantage helps home teams play better. Cao et al.[4] studied the effects of pressure on performance in the NBA. Using free throws as their measure of interest, they tested whether home fans could distract and put pressure on opposing players to make free throws. However, they did not find significant evidence that home status has a substantial impact on missing from the free throw line. Harris and Roebber[5] used two-point shots, three-point shots and free throws as measures of interest to study home-court advantage. Two-point shots were found to be the strongest predictor of home-court advantage. They suggested that home teams should try to shoot more two-point shots and force their opponent to take more two-point shot attempts. This help home teams

have a greater control of the game play and help maximize the benefits home-court advantage.

Some studies focus less on shooting and more on other metrics. For example, Greer[6] focused on the influence of spectator booing on home-court advantage in basketball. The three methods of performance used in this study were scoring, violations, and turnovers. This study was conducted using the men's basketball programs at two large universities. The study finds that social support, like booing, is an important contributor to home-court advantage. Greer explains, whether the influence is greater on visiting team performance or referee calls is less clear. However, the data does seem to lean slightly in favor of affecting visiting team performance. Another study focused on scoring was conducted by Jones[7], he analyzes scoring patterns across each of the 4 quarters to analyze the effects of home-court advantage over the course of a game. He found that typically 2/3 of the benefits of home-court advantage are received in the first quarter with the remaining 1/3 slowly accumulating over the final 3 quarters. This implies home-court advantage is most effective when teams use it to build a lead early and maintain it for the remainder of the game. If they are losing after the first quarter, there is a sharp drop in win probability.

There are also surveys on the factors contributing to home-court advantage. Courneya and Carron[8] gave four main game location factors for home and away teams, namely, the crowd factor, which is the impact of fans cheering; learning factors, which is an advantage from home teams from playing at a familiar venue; travel factors, the idea that away teams may face fatigue and jet lag from traveling; and, rule factors, which says that home teams may benefit from some advantages in rules and officiating. They acknowledge that these factors would all be removed if games were played at a neutral site, even if one team was designated as "home team". This study was reviewed a decade later by Carron et al.[9]. The 2005 review goes over the new findings from studies about the significance of these four game location factors. Since 1992, they have found that results on these four factors are mixed. However, there is some evidence supporting crowd and travel factors impact games across all major sports. There is less evidence suggesting learning and rule factors impact across the various collegiate and professional sports. The NBA is not a league which has rules that may favor the home team, like batting last in the MLB, but these rule factors also account for referee bias which may impact the NBA. One interesting finding cited by Carron et al.[9] is that the absence of crowds results in overall performance increases. Another study by Price et al.[10] is able to find some evidence of referee bias. They focus on two measures, DTOs and NTOs. DTOs, discretionary turnovers, are defined as turnovers always caused by the ref blowing the whistle while the ball is in play. NTOs, non-discretionary turnovers, are determined directly by players with no ref whistle, or the ball going out of bounds. The use these to test ref bias by checking how variables, like home vs. away team, affect DTOs relative to NTOs. They found evidence that a home bias does exist. In fact, home bias increases both during the playoffs and in games with higher attendance. This is crucial to the NBA bubble, which consists of playoff games with no attendance. Lastly, as discussed in the introduction, Lopez et al.[1] find evidence that geographic factors like altitude may influence and strengthen home-court advantage for teams in high altitude regions.

There are a few examples of natural experiments in basketball. Harville and Smith[11] studied the effect of home-court advantage using the 1991-1992 college basketball season. Unlike the NBA, it is not uncommon to have a few games played at neutral sites during the college basketball season. This allowed them to construct two samples, one of home teams and one of neutral teams. They formulated their study in a regression predicting the expected difference in score for home teams. They set up their study to find if the home teams won games by more points when they had home-court advantage vs. when playing on a neutral court. This study concluded with evidence supporting home-court advantage. Also, Boudreaux et al.[12] is able to construct a natural experiment using the Los Angeles Lakers and Los Angeles Clippers. Since these two teams share a home stadium, many factors like travel and familiarity are nullified. However, the designated home team has larger crowd support due to attendance from their season ticket holders. By comparing Lakers–Clippers matchups, they single out the effect of having a sympathetic crowd and Boudreaux et al.[12] estimate crowd effects increase the chance of winning 21–22.8 percentage points.

METHODS AND PROCEDURES

Data were collected from the official NBA website. The main variables of interest are whether or not the home team won, scoring totals for home and away teams, and shooting percentages for home and away teams on two-pointers, three-pointers, and free throws. These variables were very popular and frequently used in the related literature discussed earlier. While many other measures could be used for examining the outcome of the game and team performance, scoring seemed to be the most important because the winner of a game is determined by who scores more points. Furthermore, the three types of shots are a natural discussion point in basketball, as they're all important and directly impact scoring totals. Free throws can often determine the winner of close games, especially when losing teams are forced to foul the winning team to stop the clock and hope for some missed free throws. The three point shot has grown very prominent in basketball. The entire NBA has increased their volume of three-point shot attempts in response to the recent success of the Golden State Warriors and Stephen Curry. Due to this fact, there is a growing consensus that the three-point shot is crucial because of the efficient scoring and floor spacing it provides offenses. However, two-point shots are not to be overlooked and may actually be most important, especially for home teams, according to Harris and Roebber[5]. In fact, the 2020 NBA champion Los Angeles Lakers actually led the league in two-point shooting percentage throughout the playoffs and were bottom five in three-point shooting percentage.

The data was collected on a game by game basis. This gave us two observations for each variable per game played, one observation for each team(home and away). There were 83 games played in the 2020 playoffs, giving 83 observations for each variable in 2020 for both the home and away teams (166 observations total). Likewise, there were 243 games played over 2017-2019, giving 243 observations of each variable for both home and away teams over 2017-2020 (486 observations total). There can only be one winner and one loser, making the outcome a binary variable, with one indicating a win and zero indicating a loss.

Home-court advantage is the basic idea that the home team is more likely to win given they benefit from positive effects of a few factors we discussed earlier. So laying a foundation of typical home-court advantage is crucial. Before focusing on the 2017 to 2020 playoffs, we can take a quick look at home team win percentages since 2010. Notice in Figure 1, the 10 years before 2020, the home team winning percentage ranged from around 0.56 to 0.7 and never dipped below 0.5. The 2020 bubble broke this historic pattern, dipping down below 0.5. Foreshadowing the confirmation of the expectation that the effect of home-court advantage was removed in the 2020 playoffs.

Moving on to the main focus of the study, comparing 2020 to 2017-2019. Figure 2 shows the histograms of the home (green) and away scoring (red) for 2020 vs. 2017-2019. All histograms are fairly bell shaped, which is important for statistical tests designed for normally distributed data. There appears to be little difference between the 2020 and 2017-2019 for home scoring. For away scoring, a more pronounced shift to the right in 2020 is observed compared to 2017-2019.

Our second target of inference is shooting percentage for home and away teams. Figure 3 shows home shooting for two-pointers, three-pointers and free throws for 2020 (top) vs. 2017–19 (bottom). The histograms appear to be fairly similarly distributed between 2020 and 2017–19. Likewise, Figure 4, shows the same percentages except for away teams. It appears that the two-point shooting percentage for away teams has a small shift to the right in 2020 relative to 2017-2019.

The 2020 bubble provides a new and exciting opportunity to study home-court advantage for the NBA. Unlike college basketball, aside from a few exhibition/preseason games, the NBA always has a home and away team. So, for the first time in NBA history, the bubble allows NBA home and away performance to be compared against a control/neutral field. The NBA bubble removed many, if not all, factors impacting home-court advantage. The NBA bubble featured 8 seeding games for each team, then a standard playoff format. The focus of this study was on the play during the playoff games, since it followed the standard playoff format and could be compared back to other playoffs. For this study, the
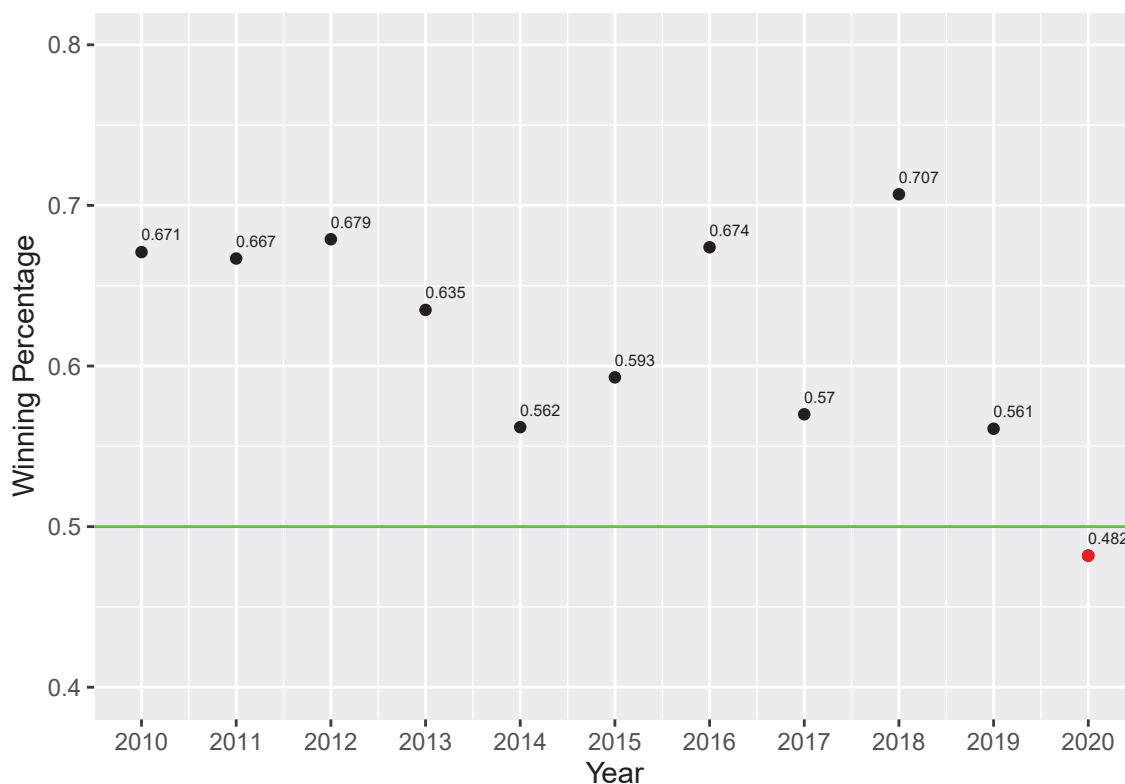
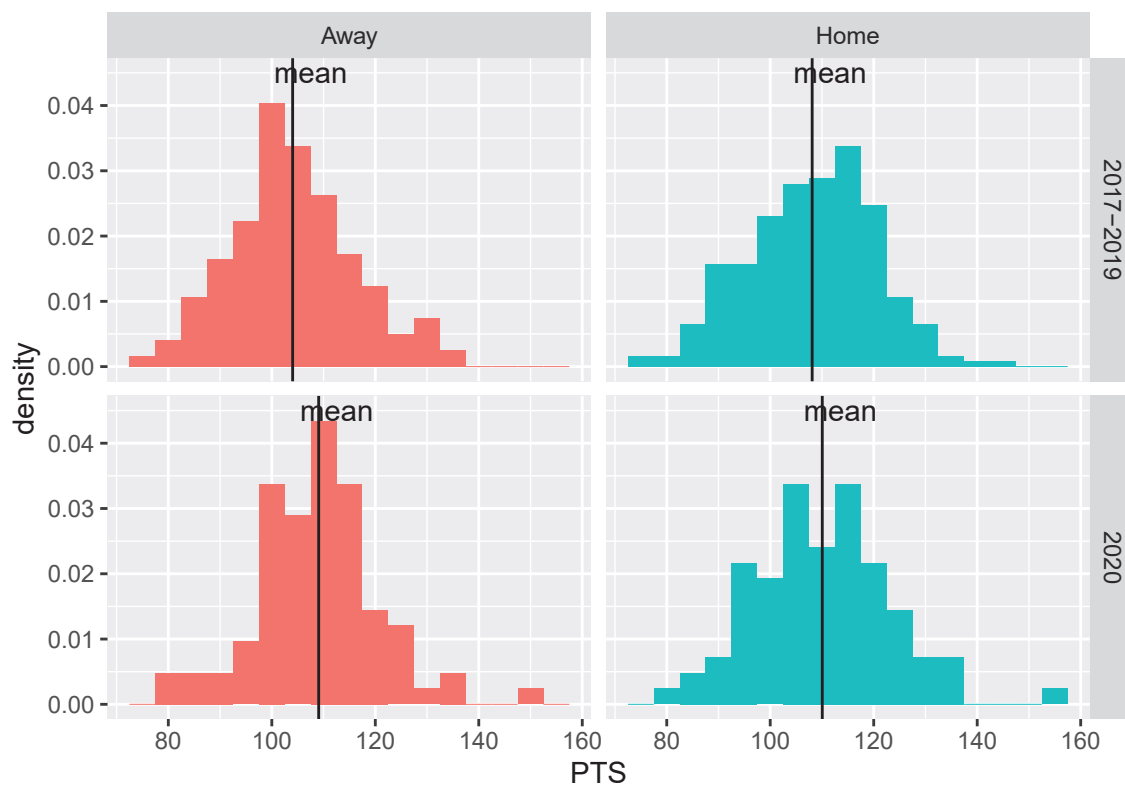**Figure 1.** Winning percentage of NBA home teams in the playoffs since 2010, the green line denotes .500.

Figure 2. Histograms of home (blue) and away (red) scoring for 2020 (bottom) and 2017-2019 (top).
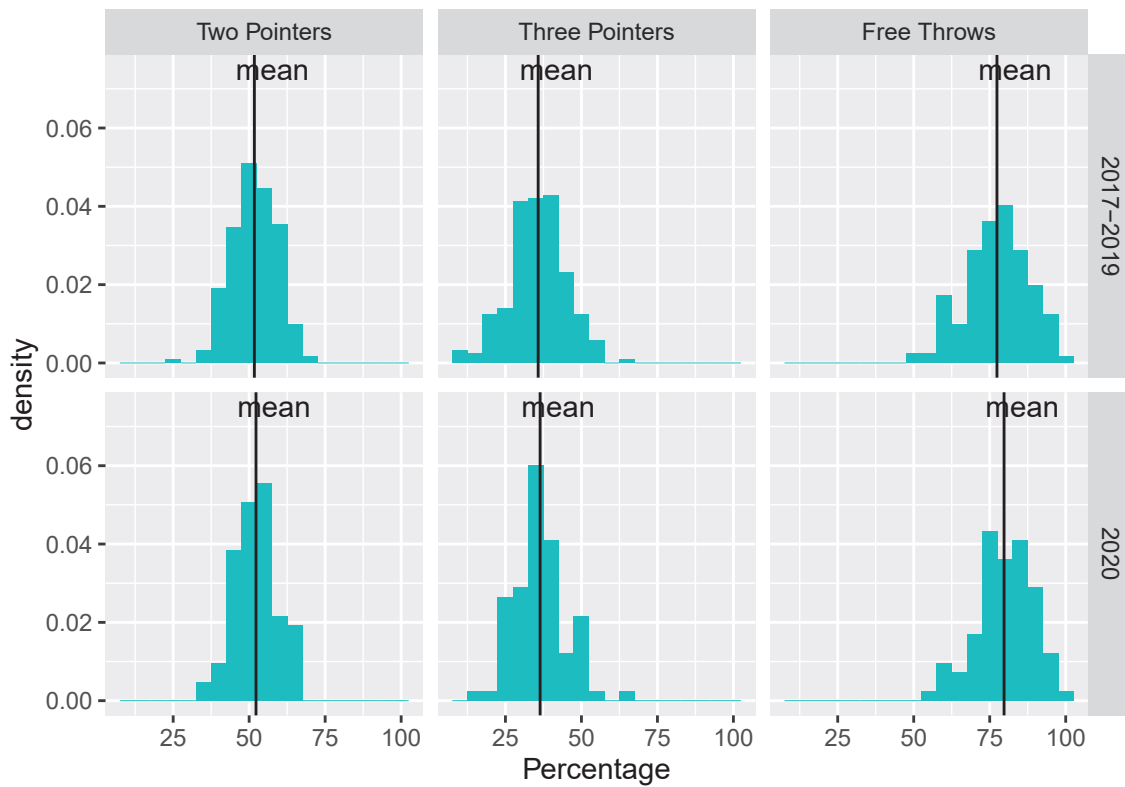
Figure 3. Histograms of home shooting percentages for two- pointers, three-pointers and free throws for 2020 (top) vs. 2017–19 (bottom).
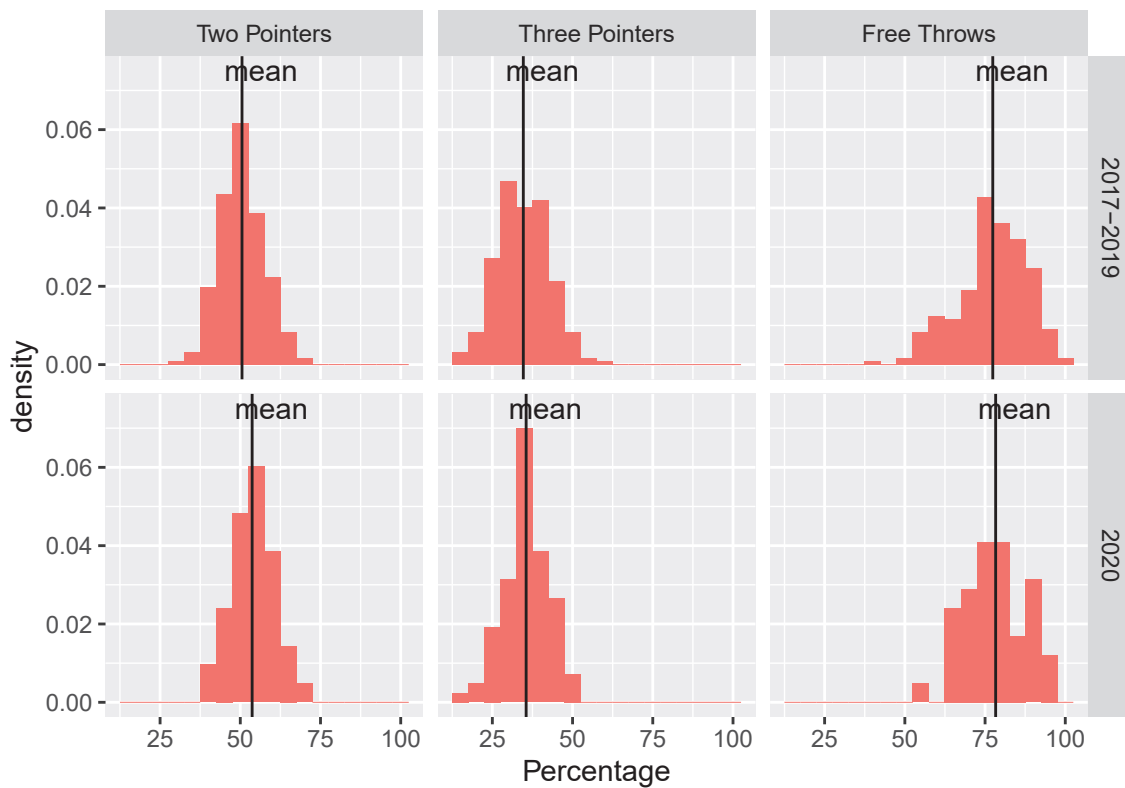

Figure 4. Histograms of away shooting percentages for two-pointers, three-pointers and free throws for 2020 (top) vs. 2017–19 (bottom).

2020 playoffs were compared against the three previous playoffs collectively. To control for the changing play style of the NBA, we limit the study to 2020 vs 2017-2019 due to the faster pace of play and more common use of the three-point shot in modern basketball. If we used data from say 10 years ago, or earlier, observed differences may not be from effects of the NBA bubble, but rather from the effects of drastic changes in the style of play between the seasons. However, basketball evolves slow enough that we can reasonably assume 2017-2019 are at least very close in pace and playing style to 2020.

Comparisons between 2020 and 2017–19 home and away teams were made on home team winning percentage, total team scoring and two-point, three-point and free throw shooting. Comparing the differences in these metrics for home and away teams in 2020 vs previous years will provide valuable insights to the understanding of home-court advantage. We can see how going on the road may negatively impact away performance and how playing at home may positively impact home performance. If there are differences in scoring for home or away teams, the differences can be used to show how home-court advantage affects the overall performance of home and away teams. While testing for differences in shooting will provide added context for how home-court advantage specifically affects performance. Shooting percentages are not the only possible metrics affected by home-court advantage, but they are the most obvious and likely most important one.

We formulate the following nine specific research questions to test the effects of the COVID bubble on the 2020 NBA playoffs:

1. Is the home team winning percentage in 2020 different than that it was in 2017-2019?

2. Is the average home team scoring different in 2020 than it was over 2017-2019?

3. Is the average away team scoring different in 2020 than it was over 2017-2019?

4. Are home teams making two-pointers at the same rate in 2020 as 2017-2019?

5. Are home teams making three-pointers at the same rate in 2020 as 2017-2019?

6. Are home teams making freethrows at the same rate in 2020 as 2017-2019?

7. Are away teams making two-pointers at the same rate in 2020 as 2017-2019?

8. Are away teams making three-pointers at the same rate in 2020 as 2017-2019?

9. Are away teams making free throws at the same rate in 2020 as 2017-2019?

All nine questions can be approached by a standard two-sample comparison with the z-test. The z-test statistic follows a standard normal distribution, which is a good approximation based on the central limit theorem given the sample size in this application.

We also conducted nonparametric tests that are distribution free to confirm the results from the z-test. For question 1, we used Fisher's exact test for a contingency table which summarizes the wins and losses of the home team in the 83 games in 2020 and the 243 games in 2017-2019. For all other eight questions, the data are the scores or shooting percentages from the 83 games in 2020 and the 243 games in 2017-2019. We used Wilcoxan's rank-sum test.

All three tests, namely the z-test, Fisher's exact test, and Wilcoxan's rank-sum test, were performed using R[13].

Regression was also considered, but it did not seem to add any additional useful insight to answering the questions presented. Regression is a popular tool in home-court advantage studies, but as mentioned previously, this study is very

Table 1. The results from the 9 tests(* denotes significant p-value at alpha=0.05)
Note: Home and Away scoring totals are divided by 100

	2020	2017–19	P-value		Adjusted P-value	
			Z-test	Wilcoxon	*Z*-test	Wilcoxon
Home Win	0.482	0.613	0.0497*	0.0400*	0.4473	0.3598
Home Scoring	1.101	1.081	0.2321	0.2985	1.0000	1.0000
Away Scoring	1.091	1.040	0.0008*	0.0004*	0.0075*	0.0035*
Home 2P	0.523	0.515	0.4335	0.5719	1.0000	1.0000
Home 3P	0.363	0.357	0.5733	0.8852	1.0000	1.0000
Home FT	0.793	0.774	0.0692	0.0496*	0.6228	0.4464
Away 2P	0.536	0.504	0.0003*	0.0003*	0.0030	0.0023
Away 3P	0.357	0.346	0.3256	0.3081	1.0000	1.0000
Away FT	0.783	0.777	0.6601	0.8370	1.0000	1.0000

different from past studies. Rather than trying to prove the existence of home-court advantage, like many previous studies, this paper was more interested in generating a clearer understanding of how home-court advantage affects each team. The most effective way to do that is hypothesis testing to compare performance in the neutral bubble to previous years with normal game conditions for both the home and away teams. Another potential benefit of regression would have been the ability to control for factors like the strength of opponent. However, we felt that the strength of team was already well enough controlled for by the fact that we focused on the playoffs. The playoffs only include the strongest 16 of 30 teams, then continue to remove the less competitive teams, so that the talent disparity between teams is much smaller than regular season play, where controlling for opponent strength is more likely to be important.

RESULTS
Starting from the top, Table 1 summarizes p-values of the nine hypotheses for both *z*-tests and Wilcoxon tests. The p-values are all fairly similar for both tests giving strong confidence in the conclusions drawn. Additionally, the adjusted p-values, calculated using a Bonferroni correction, and point estimates for each sample are provided.

First, we see a statistically significant change in home win percentage in 2020 from 2017–19, with a p-value of 0.0497 for the *z*-test and 0.0400 for Fisher's exact test. The 95% confidence interval (CI) of $(-0.255, -0.008)$ confirms our belief that home-court advantage was lost in the 2020 NBA playoffs. However, after accounting for multiple tests using the Bonferroni correction, the p-values for both tests are no longer significant. So, we may only cautiously say there is evidence that home-court advantage was not a factor in 2020.

Home team performance did not seem to be negatively impacted by losing home-court advantage like expected. Home scoring, two-point and three-point shooting all show no significant difference, on average, between 2020 vs. 2017–19 based on p-values from both tests. However, the Wilcoxon test and *z*-test have conflicting results for free throws. The *z*-test p-value of 0.0692 indicates no significant difference, while the Wilcoxon test p-value of 0.0469 indicates a difference at the 5% significance level. Since the p-value of the Wilcoxon test is so close to significance level and neither p-value is significant after a Bonferonni correction for multiple tests, this difference is likely not very meaningful. There appears to be no strong evidence suggesting home teams played at a lower level in 2020 than they did in previous years when they had home-court advantage.

Away teams saw more of an impact than home teams. For starters, there is a significant increase in mean points per

game, indicated by p-value of 0.0008 for z-test and 0.0004 for Wilcoxon. It is important to note both p-values also remain significant after a Bonferonni correction giving strong indication of significance. The average difference in points was estimated to be about 5 points, with 95% CI $(2.083, 7.988)$. Likewise, the away team two-point shooting efficiency increased significantly based on p-value of 0.0003 for both the z-test and Wilcoxon test. Again, both p-values remain significant after Bonferroni correction. The average difference was estimated to be about 0.03, with 95% CI $(0.015, 0.050)$. However, unlike two-point shooting, away teams did not see a statistically significant difference in three-point and free throw shooting. Overall, away teams have evidence of change in performance in the bubble. The away teams seemed to perform better than they would under normal conditions as a visiting team.

DISCUSSION

Generally, it seemed that away teams fared better in the 2020 NBA playoff bubble than previous years on the road. Starting from the dip in home winning percentage to below 0.482, it is clear that something was different. Although the difference was not significant after a Bonferroni correction, it is still informative to consider and understand that home teams seemed to struggle to win compared to normal conditions. Compared to Kotecki[3], who finds home teams consistently have a significantly better record than away teams, boasting about a 60.5% win percentage in his sample, the 48.2% home winning percentage of 2020 home teams is quite a shift. In this study, home teams did not appear to benefit from the usual advantages provided by being the home team.

Away team average scoring did increase by a statistically significant amount. This goes hand in hand with our intuition and conclusion about the home winning percentage decreasing. If away teams are scoring significantly more and home teams are not, then we expect to see away teams winning a larger number of games. This may give more reason to believe the conclusion that there was a significant decrease in home winning percentage in 2020, despite failing to be significant after the Bonferroni correction. Only away team scoring being significantly impacted by playing on a neutral court and not the home scoring indicates that home-court advantage stems mainly from adverse effects on the visiting team.

At least some of that improvement from away teams came from significantly higher two-point efficiency. This corresponds with the conclusion from Harris and Roebber[5], where they found home teams are best suited to capitalize on advantages from two-point shots. Normally, by shooting more two-pointers themselves and forcing away teams to shoot more two-pointers, the home team benefits most from effects of home-court advantage. However, with away teams significantly improving two-point shooting in the bubble, this strategy was no longer viable and home-court advantage disappeared.

To get a bit more detailed, we saw an estimated 3% increase in away two-point shooting percentage. Likewise, NBA teams shot an average of about 53 two-point shots per game, in our data, leading to a three-point increase in total scoring. Even this small swing in scoring for away teams can make a big difference in outcome of games. Around 1/3 of NBA games end by a decision of six points or less, these are the games where the three points matter most. Suppose there are 30 seconds left and the away team is losing. If the away team has the ball, only down three, they can take their time finding a good shot which can still either be a two or three given the score and remaining time. In the context of the NBA bubble, this crucial possession also has the benefit of the away team getting to work in silence without the jeers from enemy fans. However, in the same situation, while being down six, the offense must rush to get a quick shot off which probably has to be a three-pointer. The three point swing creates a much more desperate circumstance that is less likely to have a positive outcome. Even in the positive outcome case you're still going to be down three and likely have to foul the opposing team after you score. Alternatively, if the away team is playing defense with 30 seconds left, only down three, you can play regular defense without fouling, get a stop, then draw up a play to score a three-pointer with the remaining six seconds. In the same scenario, down six, you have no choice, but to foul. The free throws will likely put you down seven or eight points, but the alternative is letting the opponent run the 24 second shot clock down wasting time. Similarly, the away team may even be in a situation where they're leading by the three

additional points, which for the same logic as explained above puts them in far greater control of the game. Clearly, the three point swing can drastically change probability of winning for a team down the stretch of a game. Since, home teams picked up an additional two-points per game on average vs. five for away teams, the three additional points from two-point shooting appear to be the driving factor of away teams closing the gap with home teams.

There are a few possibilities that might create this increase in two-point shooting percentage. One could be the possible removal of officiating bias in favor of the home team during the bubble. As we saw in Price et al.[10], home bias is normally stronger in high attendance games. Thus, with no attendance at games, it's reasonable to say officiating bias was smaller than normal. Away teams in the bubble may have benefited from more fouls called on drives to the basket. On drives to the basket there can often be a lot of contact with no clear foul, these calls are then up to the ref's discretion. Typically, refs may be more reluctant to blow the whistle against the home team, in front of their crowd, on this type of play. The NBA only records an attempted shot when a foul is called on the shot if the shot is made. So, when away teams are fouled, but it is not called because it's often at the ref's discretion to make the call, they'll likely miss and be credited the miss. However, in the bubble, if fouls are called more fairly, the missed shots from uncalled fouls are removed and two-point shooting would increase. This wouldn't affect three-point shooting because those fouls are clearer and less up to the ref's discretion. Another possibility, without the crowd noise inhibiting their offense, away teams were able to more easily run their offensive sets that generate easy two-point looks at the rim. Also, away teams being generally more confident without opposing fans present, may have been more inclined to attack the basket and get an easy look close to the rim. It's hard to say for sure what causes the increase in away two-point shooting, but these are all possibilities. It may also be a combination of all of these.

Separating the effects of the home-court advantage into home effects and away effects allowed for some interesting new insights. Previously, we knew that on average home teams outperformed away teams. It was less clear whether it was from positive effects on the home team or negative effects on the road team or perhaps a bit of both. The biggest takeaway from this study is the main source of home-court-advantage is the negative effects playing on the road away teams face. In 2020 there wasn't any evidence of regression for home team performance, based on the performance measures used, despite being stripped of home-court advantage. Yet, home teams lost about 12% more of games in the 2020 playoffs than the typical average. This was because of the improvement of away teams. No longer having to face the struggle of traveling, pressure from opposing fans, or playing on an unfamiliar court, teams saw an improvement in their play and an increase in winning. The improvement of away teams confirms a proposition from Greer[6] that the positive social impact of crowds benefiting home teams may be a result of inhibiting away teams.

It's worth noting that much of this paper discusses the effects from an offensive point of view, focusing on a team's ability to score. However, one of the main factors that affects an offense's ability to score is the opposing defense. It's possible that home-court advantage mainly functions as an extra defender for home teams, which is how it negatively impacts away scoring. There is not much home fans can do to help their team on offense, except being quiet so players can easily communicate and focus. However, when on defense, fans can act as a ""sixth defender"" supporting their team by cheering loudly and making it harder on the offense. Also, as seen in the study Price et al.[10], fans can create turnovers by pressuring officials to make calls in their favor. This would explain how away teams were able to improve offensively in the bubble. Home teams did not have the regular help from the noise of fans that hinders the away team's offensive efforts. This would also explain why home team offense didn't show significant change in the bubble, the in-game offensive environment was largely unaltered for home teams since the bubble provided the same quiet environment they're used to at home while on offense. I still believe home-court advantage is better categorized as a negative effect on away team offense, since it's more likely noise from fans lowers level of play of away offense rather than raises the level of play of home defense. This will be further discussed below. An interesting finding is all shooting and scoring numbers for both home and away teams did make at least small increases. Although, these increases were not all significant these increases are exactly what is reported in Carron et al.[9] when they explain how evidence suggests that teams perform better with the absence of fans. This is important because it coincides with our conclusion

that home-court advantage mostly plays into games by negatively impacting away teams by acting as an extra defender. If fans cause overall performance to drop, then home-court advantage must come from a bigger drop in away performance than the drop in home performance. This is why away teams were able to close the gap with home teams with home-court advantage removed. Future studies may want to use the 2020 NBA bubble and compare vs previous years using other performance measures. For example, turnovers, steals, assist, rebounds, and many more game statistics. There are plenty of other possibilities besides just shooting efficiency to pick through looking for more possible sources of added points for away teams. This will further help explain what is lost in the performance of away teams when they travel to opposing arenas. This study is only the beginning of possibilities for studies using the 2020 NBA bubble as a case study for home-court advantage. Although, the study is limited by a one time sample, it seems unlikely that these conditions will ever be repeated. It may not be possible to have a follow-up study using the same measures with a different sample. Otherwise, that type of study could help strengthen the conclusion in this paper. Also, you could answer more questions with a larger sample size. For example, testing the strength of home-court advantage relative to specific teams, like the Denver Nuggets and Utah Jazz who we know from other literature may have a stronger home-court advantage. The sample size of home games for the individual teams in the bubble was far too small to try and address this question, the Jazz and Nuggets only had 3 and 9 home games, respectively.

REFERENCES
1. M. J. Lopez, G. J. Matthews, and B. S. Baumer, "How often does the best team win? A unified approach to understanding randomness in North American sport," *The Annals of Applied Statistics*, vol. 12, no. 4, pp. 2483–2516, 2018.
2. S. Aschburner, "How Orlando's neutral site will impact teams, referees and games," 2020, https://www.nba.com/article/2020/06/22/season-restart-home-court-advantage-no-more.
3. J. Kotecki, "Estimating the effect of home court advantage on wins in the NBA," *The Park Place Economist*, vol. 22, no. 1, pp. 49–57, 2014.
4. Z. Cao, J. Price, and D. F. Stone, "Performance under pressure in the NBA," *Journal of Sports Economics*, vol. 12, no. 3, pp. 231–252, 2011.
5. A. R. Harris and P. J. Roebber, "NBA team home advantage: Identifying key factors using an artificial neural network," *PLOS ONE*, vol. 14, no. 7, pp. 1–9, 2019.
6. D. L. Greer, "Spectator booing and the home advantage: A study of social influence in the basketball arena," *Journal of Sport and Exercise Psychology*, vol. 46, no. 3, pp. 252–261, 1983.
7. M. B. Jones, "Home advantage in the NBA as a game-long process," *Journal of Quantitative Analysis in Sports*, vol. 3, no. 4, pp. 10–13, 2007.
8. K. S. Courneya and A. V. Carron, "The home advantage in sport competitions: A literature review," *Journal of Sport and Exercise Psychology*, vol. 14, no. 1, pp. 13–27, 1992.
9. A. V. Carron, T. M. Loughhead, and S. R. Bray, "The home advantage in sport competitions: Courneya and Carron's (1992) conceptual framework a decade later," *Journal of Sports Sciences*, vol. 23, no. 4, pp. 395–407, 2005.
10. J. Price, M. Remer, and D. F. Stone, "Subperfect game: Profitable biases of NBA referees," *Journal of Economics and Management Strategy*, vol. 21, no. 1, pp. 271–300, 2012.
11. D. A. Harville and M. H. Smith, "The home-court advantage: How large is it, and does it vary from team to team?" *The American Statistician*, vol. 48, no. 1, pp. 22–28, 1994.
12. C. J. Boudreaux, S. D. Sanders, and B. Walia, "A natural experiment to determine the crowd effect upon home court advantage," *Journal of Sports Economics*, vol. 18, no. 7, pp. 737–749, 2017.
13. R Core Team, *R: A Language and Environment for Statistical Computing*, R Foundation for Statistical Computing, Vienna, Austria, 2020. [Online]. Available: https://www.R-project.org/

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PRESS SUMMARY

The purpose of this study was to examine the 2020 NBA playoffs, which were played inside of a bubble in Disney World because of the COVID-19 pandemic. The hope was to generate new insights about the effects of home-court advantage because the bubble created an unprecedented neutral playing field for the NBA. For the first time the effects of home-court advantage on home and away teams could be easily separated and studied individually, typically studies can only compare them relative to each other. This study is focused on team scoring totals and team shooting percentage on two-pointers, three-pointers, and free throws. Comparing these measures for home teams and away teams in 2020 vs. 2017–2019 shows that the 2020 playoffs favored away teams more than usual, particularly with two-point shooting and total scoring. The implication of these findings is home-court advantage seems to be the result of negative effects on away team, not positive effects on home-team.