

# The Problem with the Empty Stands at the NBA Bubble

## Abstract

Due to COVID-19, the National Basketball Association decided to continue the 2019-20 season without fans. Our study wondered whether fanatics had any real impact on the game, which could then mean this year's champion would not have won under normal circumstances. Also, if we find evidence that fanatics have direct impact on games, then that means NBA front offices should start to work harder on how they market their games, how they handle promotions and how they keep the fans happy. We hypothesized that if there exists home court advantage in the NBA, then an increase in fans attending will benefit the home team and harm the visitors.

We made a dataset with all game scores and fanatics in attendance from the beginning of the 2015-16 season to the 2020 NBA hiatus. First, we used an ANOVA test to confirm that the points per game average for home teams is significantly higher than the points per game average for away teams. Then, we used ANOVA tests again to compare the mean points per game across different attendance groups: sellouts, high, medium, and low attendance. We used different subsets of the NBA (conferences, divisions, and individual teams) and examined home games and away games separately.

Our results suggest that teams benefit from an increase in attendance as the home team but are not hurt by it as the away team. This is evidenced by the fact that the ANOVA tests mostly provided significant results for home teams, while away teams had similar points per game averages regardless of the attendance group. We also found evidence to the importance of fully selling out your arena. Lastly, some of our results hint at the obvious: bad teams will lose to good teams, regardless of the number of fanatics cheering for them.

With these findings in mind, it is interesting to think about the 2019-20 NBA season results and how they may have been different under normal circumstances. Front offices should feel motivated by these results and make sure the arena is at full capacity next time fans are allowed at games. There are different ways to get fans in your building like promotions or a good halftime show, and we encourage teams to figure out what works best for their audience.

## Introduction

The NBA's format has remained unchanged for decades now: teams try to win as many games as possible during the regular season. As a reward for their success during the regular season, teams have home court advantage every time they play a post-season series against a team with a lower record. Home court advantage refers to the advantage a team has if most of the games in a series are played in their home court. Every time the post-season starts, home court advantage is one of the most talked about elements of each series. This will not be the case this year, though. The NBA looks to have all teams play in Walt Disney World Resort. Naturally, the basketball community wonders how this change will affect the season.

Many studies have already found evidence of home court advantage. Schwartz and Barsky (1977) found that home court advantage exists across various sports, but the effect was most pronounced in basketball and hockey. A study to get to the bottom of why home teams have an advantage in National Basketball Association games (Entine and Small, 2008) found that travel and back-to-backs explains part of the effect, but the bulk of it is explained by something else.

Smith and Groetzinger (2010) studied home court advantage in Major League Baseball games and found that attendance was positively correlated to runs for the home team, while attendance percentage increased the likelihood of a home team win. The effect of attendance has also been studied in English Premier League football games (Boyko, Boyko and Boyko, 2007) and it was found that crowd size was positively correlated to a positive goal differential (differential is defined as number of events for home team minus number of events for away team). They also found that crowd size was negatively correlated to yellow cards for the home team and red card differential, while crowd density was correlated with an increase in yellow cards for the away team and had a positive correlation with penalty differential. However, the effects of attendance in National Basketball Association games has been a topic of debate. Kotecki (2014) found that log of attendance increased the chances of the home team winning, but La (2014) found that attendance was not significantly related to score differential or home wins, and only had a small significant effect on free throw percentage for the visiting team.

Our approach to testing whether attendance benefits the home team is very similar to an observation made by Schwartz and Barsky (1977). They found that in Major League Baseball games observed, the home team won 48% of games with low attendance, but 57% of games with large attendance. In their study, they said they would have preferred to study the effects of crowd size in a closed arena. They also were unable to prove that there existed a statistically significant difference. Our study will address these limitations by taking basketball data, a sport played inside a building, dividing the games into attendance groups, and using ANOVA to make sure the differences are not due to random chance.

## Hypothesis

Our study is divided into two hypotheses:

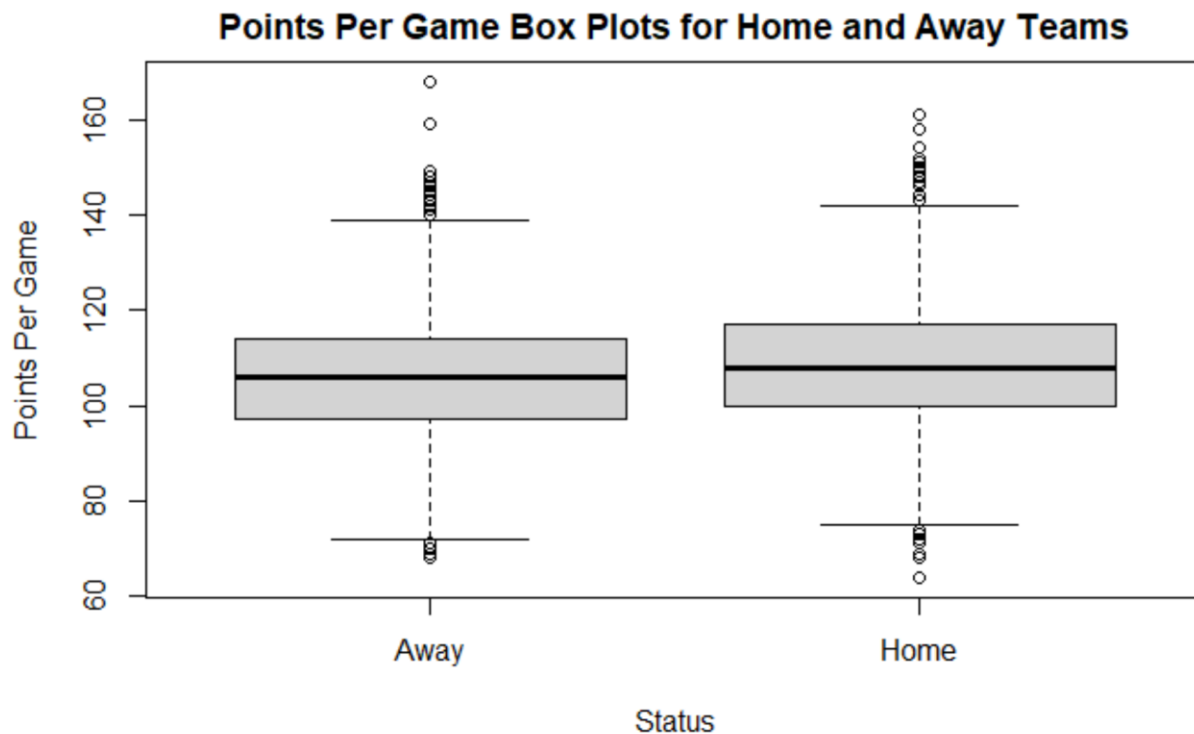
1. We hypothesize that the home team averages a significantly greater amount of points than the visiting team.

2. If home court advantage does exist, then an increase in crowd size positively affects the home team, while negatively affecting the away team.

## Data

### First Hypothesis

We are using a dataset that contains all NBA regular season games from the past five seasons, up to the 2020 hiatus (Basketball Reference). Note that NBA Global games are not included in this dataset. There are only two variables: Total Points and Status (Home or Away). There is a total of 11,754 observations. The box plots in **Figure 1** illustrate our data.



**Figure 1:** Box plots for points scored by the Home and Away teams.

**Figure 1** shows that Home teams and Away teams have a very similar range. The Away team has higher outliers, but in general the Home team has a slight edge. We will test whether the difference is significant.

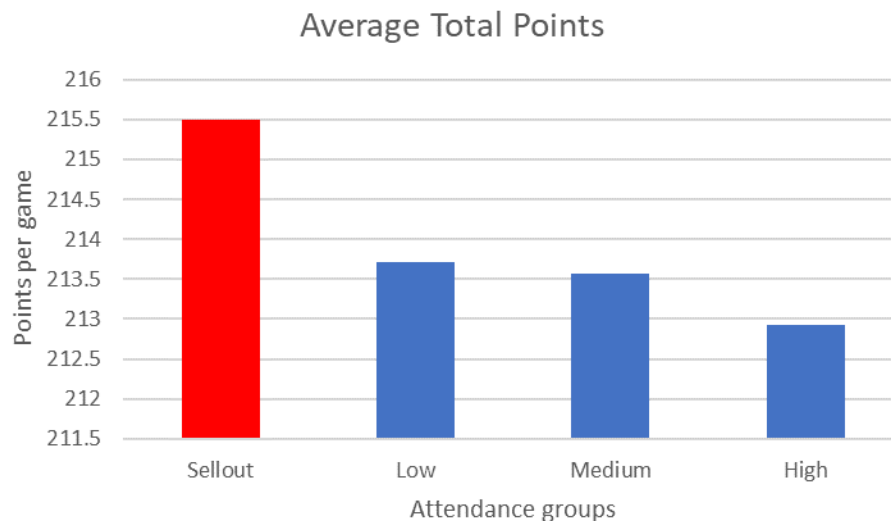
### Second Hypothesis

We are using a dataset that contains all NBA regular season games from the past five seasons, up to the 2020 hiatus (Basketball Reference, ESPN). Note that NBA Global games are not included in this dataset. The dataset contains the following variables:

- Home team
- Away team
- Points scored by home team
- Points scored by away team

- Total points (Points scored by home team plus points scored by away team)
- Attendance
- Capacity percentage
- Capacity Percentage group (100% or more: Sellout, 99%-95%: High, 94%-86%: Medium, 85% or less: Low)

There is a total of 5,877 observations. **Figure 2** illustrates the mean amount of total points scored in a game, divided by the four capacity percentage groups.



**Figure 2:** Average total points scored in a game, grouped by attendance group.

**Figure 2** demonstrates that, although the average points per game for the “Low”, “Medium” and “High” attendance groups are very similar, the average points per game for the “Sellout” attendance group is distinguishingly different from the rest.

## Results

### First Hypothesis

We will first use an ANOVA test to make sure home court advantage exists in our dataset.

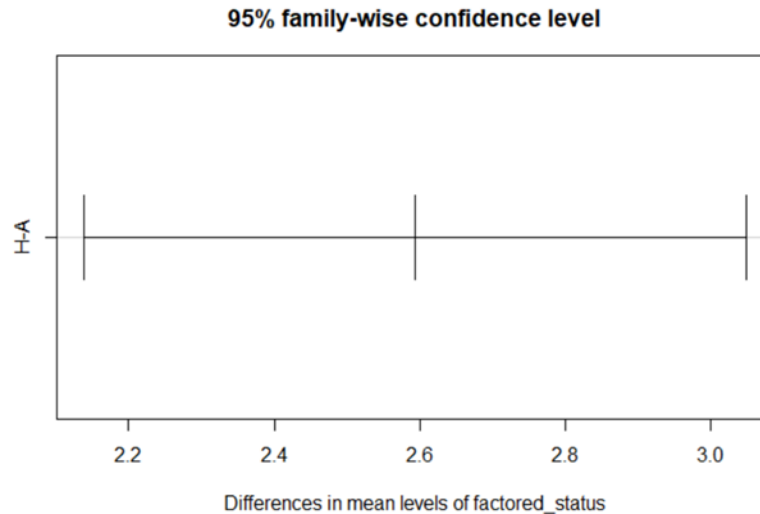
**Figure 3** shows the ANOVA test results, while the Tukey plot in **Figure 4** illustrates the differences in points per game averages between the home and visiting teams.

```

              Df  Sum Sq Mean Sq F value Pr(>F)
factored_status    1   19757    19757   124.7 <2e-16 ***
Residuals      11752  1862240      158
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

**Figure 3:** ANOVA test results.



**Figure 4:** Our model's Tukey mean-difference plot.

As for the test, the results in **Figure 3** shows there **is** a difference in mean points scored for the home team and mean points scored for the away team, since the p-value is less than  $2 \times 10^{-16}$ . The Tukey mean-difference plot in **Figure 4** shows home teams average around 2.6 more points than away teams, which is enough to decide a basketball game. **Figure 4** also helps us verify that the difference is in fact significant, because the confidence interval does not include 0. Next, we want to try to figure out how much of this advantage can be explained by our attendance groups.

### Second Hypothesis

We ran ANOVA tests for the whole NBA, the two NBA conferences, the six NBA divisions and thirty NBA teams. We made these subsets twice: once considering subset as the home team, and another time considering the subset as the visitors. We hypothesized that at home, the teams will perform better as attendance increases, but that as the away team, they will perform worse as attendance increases.

Category	Subset	Home (p-value < )	Away (p-value <)
NBA	NBA	<b>3.00E-10</b>	0.266
Conference	Eastern	<b>0.0015</b>	<b>0.0177</b>
	Western	<b>4.34E-06</b>	0.563
Divisions	Atlantic	<b>5.05E-08</b>	0.666
	Northwest	<b>2.25E-04</b>	0.793
	Southeast	<b>2.48E-02</b>	0.103
	Southwest	<b>3.61E-03</b>	0.757
Teams*	Charlotte Hornets	<b>2.10E-02</b>	<b>0.0376</b>
	Milwaukee Bucks	<b>1.39E-10</b>	0.32
	Philadelphia 76ers	<b>8.98E-13</b>	0.477
	Phoenix Suns	<b>3.60E-02</b>	0.459
	Sacramento Kings	<b>3.06E-02</b>	0.318
	Utah Jazz	<b>3.36E-03</b>	0.2

**Table 1:** P-values from significant results in ANOVA tests done with the database. (\*Models made from team-specific subsets had less than 30 observations and should be analyzed with precaution)

We can see from **Table 1** that there does not seem to be any geographical trend in the subsets. There are exactly three teams from each conference and two divisions from each conference with significant ANOVA tests results. This means that it is unlikely that one geographical region is more affected by the attendance than another region.

We can also tell from **Table 1** that most of the significant tests involved the home team. The NBA as a whole seems to only exhibit a difference in points per game across attendance groups when considering home teams and only one of the two conferences exhibited the phenomenon while considering away teams. In fact, of six divisions, only four had a significant test result, all of which had to do with the home team. Furthermore, from thirty teams, only six exhibited significant test results (albeit with worrying diagnostics) and only one of those exhibited significant test results from a test done on their mean points scored as the visitors. Hence, we found little evidence to believe that visiting teams perform worse as attendance increases.

Lastly, we can see Tukey plots analyzed in **Table 2**. This shows the direction of the differences found to be significant.

Test with Significant Result	Tukey Plot Observations
NBA Home	"Sellout" is significantly greater than "High" (2.01), "Medium" (2.40) and "Low" (2.27).
Eastern Home	"Sellout" is significantly greater than "Medium" (2.21) and "Low" (1.59).
Eastern Away	No significance.
Western Home	"Sellout" is significantly greater than "High" (2.65), "Medium" (2.31) and "Low" (2.51).
Atlantic Home	"Sellout" is significantly greater than "Low" (6.47).
Northwest Home	"Sellout" is significantly greater than "High" (4.46), "Medium" (3.92) and "Low" (2.64).
Southeast Home	"Low" is significantly greater than "Medium" (3.02).
Southwest Home	"Sellout" is significantly greater than "High" (3.06) and "Low" (4.13).
Charlotte Hornets Home	"Low" is significantly greater than "Sellout" (6.15).
Charlotte Hornets Away	No significance.
Milwaukee Bucks Home	"Sellout" is significantly greater than "Medium" (13.12) and "Low" (12.77).
Philadelphia 76ers Home	"Sellout" is significantly greater than "Medium" (8.98) and "Low" (15.01).
Phoenix Suns Home	No significance.
Sacramento Kings Home	No significance.
Utah Jazz Home	"Sellout" significantly greater than "High" (9.40).

**Table 2:** Tukey plot results from models with significant test results. The number in parenthesis is the difference in points per game average between the two groups.

The results in **Table 2** show the importance of selling out your games. In nine of the fifteen results shown, the “Sellout” percent group was the only group that held a significant advantage over any other group, and sometimes over multiple groups. In accordance with the bar plot we saw earlier, we fail to see games with “High” attendance have a significantly greater mean points per game than games with “Medium” or “Low” attendance and games with “Medium” attendance have a significantly greater mean points per game than games with “Low” attendance. Surprisingly, there are also two instances where the games with “Low” attendance had a significantly higher mean points per game than other groups.

In addition to these observations, we also noticed that the difference in mean points per game found significant are all above 2 points per game. This means that attendance could actually impact the outcome of a game. The effect seems to be stronger for the Western Home subset than for the Eastern Home subset in terms of conferences, while the Atlantic Home and Northwest Home subsets seem to benefit the most from sellout crowds division-wise.

## Conclusion

In our study, only one of our two hypotheses was entirely correct. We found that home teams average around 2.6 more points per game than away teams. We also found that home teams score approximately 2 points more when the game is sold out compared to the other attendance groups. However, we found little to suggest that visitors benefit from less fanatics attending. This effect may be explained by various factors, such as the idea that while a morale boost or referee bias might help get an extra trip to the free throw line or a loose ball, it is also true that NBA players are professionals that know how to handle pressure from the fans. For this reason, the home team exhibits an advantage whenever the audience increases, but the away team does not necessarily exhibit a disadvantage.

Finally, we found the rather counterintuitive result: Charlotte and the Southeast Division benefited from “Low” attendance, as shown in **Table 2**. I have a hypothesis that explains these

results. When bad teams are visited by good teams, there will be a bigger audience since the fans want to see the good team. Since the visitor is better, the home team will score less points, resulting in a small mean points per game. However, when that same home team plays against a worst opponent than the one described before, people will not be attracted to the game and will not attend. It is this lurking variable, opponent quality, and not attendance, that we see reflected in our study. Because the visitor is worse than the home team, the home team will score more points even if there are less fans in attendance. To support this hypothesis, we look at this year's standings up until the 2020 hiatus. The Southeast division, who exhibited this phenomenon of playing better with less fans on their home court, only have one team over .500 and include the Charlotte Hornets, who themselves exhibited said phenomenon.

Further studies should look more into team quality, possibly by adding to the dataset the seed of both teams playing each game. In this research, we could not control for team quality, and it follows that good teams attract more fans, so we cannot be sure that an increase in attendance causes an advantage for the home team. Lastly, a bigger dataset, possibly one covering the last ten or more years, will address the problem of insufficient observations in the smaller subsets.

Overall, these findings are important because it hints at the idea that selling out games helps home teams. It is especially interesting how just having "high" attendance did not do much for most subsets. If NBA front offices really want to help their teams, they must find a way to promote the games and make sure they are sold out. It is also fun to think about how different the 2020 NBA Playoffs would have been if home court advantage was a factor, but ultimately our findings with the Southeast division subset show that above else, team quality remains the most important predictor of success.

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