Effects of the COVID-19 Pandemic on Home Advantage in Professional Hockey and Basketball

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Section I: Introduction

Home advantage is an established phenomenon in many, if not all, sports. It is considered by teams, players, fans, and analysts alike to play a significant role in the outcome of games and playoff series. Therefore, it is of great importance to all teams to have as many games as possible occur at their home venue, especially games with higher stakes such as those that may determine progression to a subsequent playoff round. In order to maintain fairness, leagues schedule their regular seasons so that all teams play an equal number of home and away games. Leaving aside the possibility that the magnitude of home advantage is different for each team, this system should ensure that, even if there is an advantage to playing at home, one team does not benefit more than another team. Many professional leagues, including the National Basketball Association (NBA) and the National Hockey League (NHL), structure their playoffs in a different way than their regular seasons, namely that there is a deliberate imbalance between the amount of home games that different teams play. Teams that perform better during the regular season are awarded a higher seed going into the playoffs and with this comes the ability to have more games played at home. Both the NHL and the NBA have four playoff rounds to determine their champion, and in each round each team plays a best-of-seven series against another team. The team with the higher seed in the matchup hosts four of the seven games, including the seventh and deciding game if it is necessary. There are multiple potential reasons for why playing at home provides an advantage for teams, and these can include familiarity with the playing area, the support of their home fans, less fatigue from not having to travel, possible referee bias and, in some sports, certain rule factors that favour the home team.

Due to the COVID-19 pandemic, many professional sports leagues, including the NBA and the NHL, were put on hiatus for several months during their regular seasons. When they

were able to resume play, they cut much of the remaining regular season short and transitioned quickly to the playoff rounds. Games were played in isolated, neutral locations that were decided in advance. Restricted access to the playing bubble meant that players were not able to travel, and all games were played in one arena with no fans allowed to attend in person. The NBA played all games at Disneyworld in Orlando, Florida and the NHL initially split their teams into two separate bubbles in Edmonton, Alberta and Toronto, Ontario, before moving to a single bubble in Edmonton for the final two playoff rounds. However, all games still had a designated home team that was decided in accordance with all existing rules, such as the higher seed being the home team more often. This unique situation has created conditions in which home advantage can be studied in a natural experiment. Using regressions run on data from game records for both sports' playoffs, this paper will attempt to answer whether there is a significant difference between team outcomes across various categories when playing at home in normal seasons, compared to playing at home in this pandemic-affected season in which many typical characteristics of playing at home are absent.

This paper will proceed with Section II reviewing relevant previous literature on the study of home advantage in sport. Section III will summarize the data and Section IV will discuss the empirical strategy used to run the regressions. Section V will present the regression results, Section VI will discuss their interpretation regarding home advantage, and Section VII will provide concluding remarks and discuss the potential for future work.

Section II: Literature Review

Previous studies of home advantage in sports have identified the most likely causes of the effect to be learning, travel, rule, and crowd factors (Nevill & Holder, 1999). Rule factors, where official game rules benefit home teams in some way, and learning factors, which are advantages

gained by the home team for familiarity with the venue of the game, have been shown to provide minimal benefit (Nevill & Holder, 1999). Travel factors were found to contribute to home advantage, but crowd size (up to a threshold) was found to be the largest contributor (Nevill & Holder, 1999). Possible explanations for these findings are that home crowds can boost performance of the home team or that crowds can influence referees to favour home teams. In their book *Scorecasting*, Moskowitz and Wertheim (2011) concluded that there was little evidence to support crowds having a significant impact on players, but there was evidence to support crowds' effect on referees. Referee decisions, particularly those made in crucial moments in the game and requiring more subjective judgement, were found to go in favour of home teams between two and four times more often than away teams. The effect on referees is determined to most likely be due to psychological factors caused by the influence of home crowds of which referees themselves are not aware (Moskowitz & Wertheim, 2011). Further evidence to support the effect of crowd influence on referees has been found in a study of European football (soccer) in which referees watching games with regular crowds called 15.5% fewer fouls on Home teams compared to those watching the games in silence (Nevill et al., 2002).

Additional support for crowds being the primary factor determining home advantage has been found by studying European football matches taking place in the 2019/20 season amidst the COVID-19 pandemic (Respiratory Therapeutics Week, 2020). Due to its recency, this study has not yet been peer-reviewed, but its findings show home teams' chance to win significantly decreased in the pandemic playing conditions. This is proposed to be the result of missing crowds, and potentially their effect on referee bias, because European football has been holding matches in teams' regular stadiums, meaning that travel and familiarity factors should not have

changed compared to the normal, pre-pandemic conditions (Respiratory Therapeutics Week, 2020). However, a previous study comparing home advantage across different sports, as well as between college and professional levels, found that soccer (European football) was the only sport where crowd size seemed to have an effect (Pollard & Gomez, 2015). Therefore, the findings regarding the effect of the COVID-19 pandemic on European football may not necessarily translate to the NBA and NHL studied here. The Pollard & Gomez (2015) study also reported inconclusive results on the impact of travel fatigue on home advantage. However, Moskowitz and Wertheim (2011) show evidence to support travel factors negatively impacting away teams in the NBA when they have also played a game on the previous day. Given that games are typically not scheduled in this way during the playoffs, it is feasible to hypothesize that this effect may be lessened or completely absent in studies of playoff games.

Another approach to studying home advantage is the teamwork theory (Jones, 2017), which states that the concept of home advantage is more appropriately thought of as a disadvantage for the away team, meaning that the factors causing the advantage are acting primarily on the away team rather than on the home team. This paper also produced results that support home advantage (away disadvantage by their formulation) being correlated with total team distance travelled during a game. Greater distance covered per game resulted in a greater disadvantage for the away team (Jones, 2017).

Section III: Data Summary

The data used in this paper is all publicly available NBA and NHL game box scores, obtained from the official league websites, and the ESPN NBA website. The data contains all games from each league's playoffs from the past three seasons, 2017-18, 2018-19, & 2019-2020. The first two playoff seasons, 2017-18 & 2018-19, were played in normal pre-pandemic

conditions in teams' regular home locations and thus have been labelled *Normal Season* in the analysis. The 2019-20 playoff season was played in neutral locations during the pandemic and thus has been labelled *Pandemic Season* in the analysis.

The data was formatted so that the unit of observation was one game for each team. Since there are two teams playing in each game, this means that there are two entries in the data for each game. A dummy variable was then created to represent whether the team was home or away for that game. I entitled this variable *Home* and it took a value of one if the team was the designated home team and a value of zero if not. Other variables collected in the dataset that are used in this analysis are *Wins* which is another dummy variable that takes a value of one if the team won the game, and a zero if they lost, *Points (NBA) / Goals (NHL)* which represents how many points/goals were scored by that team in that game, and *Fouls (NBA) / Penalties (NHL)* which represents how many fouls/penalties the team was called for in that game. As the main NHL dataset did not include penalty data, it was obtained separately and combined with the other dataset. One additional variable was used in the NBA analysis, *Free Throw,* which represents that team's free throw percentage in that game. All playoff games that took place in the three-season time period are included in the analysis, which resulted in a total of 494 observations for the NBA and 602 observations for the NHL.

Table 1: NBA Summary Statistics

	Mean (sd)	
	Away	Home
Chance to Win	0.417	0.583
	(0.494)	(0.494)
Points Scored	105.4	109.1
	(12.03)	(12.30)
Personal Fouls	21.81	21.31
	(3.981)	(3.600)

Free Throw Percentage	77.48	78.16
	(10.58)	(9.381)
Year	0.336	0.336
	(0.473)	(0.473)
Observations	247	247

Table 2: NHL Summary Statistics

	Mean (sd)	
	Away	Home
Chance to Win	0.522	0.478
	(0.500)	(0.500)
Goals Scored	2.824	2.791
	(1.598)	(1.762)
Penalties Taken	4.382	4.066
	(2.342)	(2.172)
Year	0.432	0.432
	(0.496)	(0.496)
Observations	301	301

Tables 1 & 2 provide summary statistics, split for home and away teams, for the data from both the NBA and NHL across all games and teams within the sample. Since all data is included, no initial difference can be observed between normal and pandemic conditions. Instead, these tables show the average difference between home and away teams across all seasons. From Table 1, we see that NBA home teams perform better in all categories, particularly in winning games where they enjoy nearly a 17% better chance to win than away teams. While home teams are better in other categories as well, the margin is much smaller. Conversely, the NHL data from Table 2 shows that home teams do not even seem to have any advantage over away teams. However, to determine the effect of the pandemic, we must further sort the data by home & away and by season.

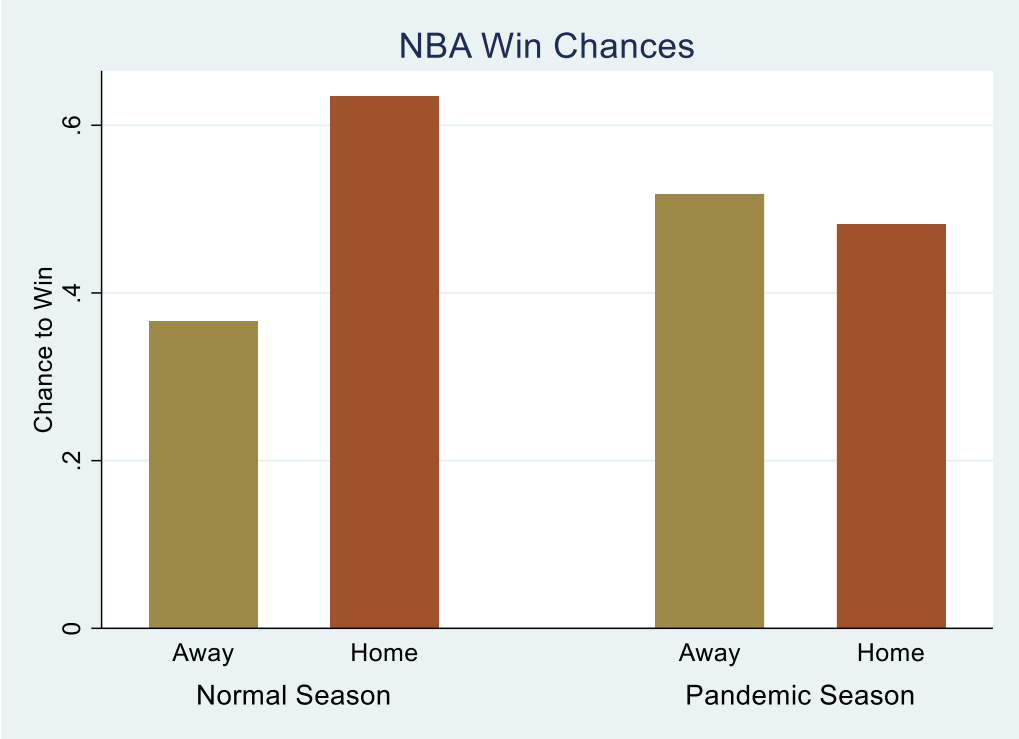

Figure 1: Chance to win for Home and Away in the NBA in the Normal Seasons compared to the Pandemic Season

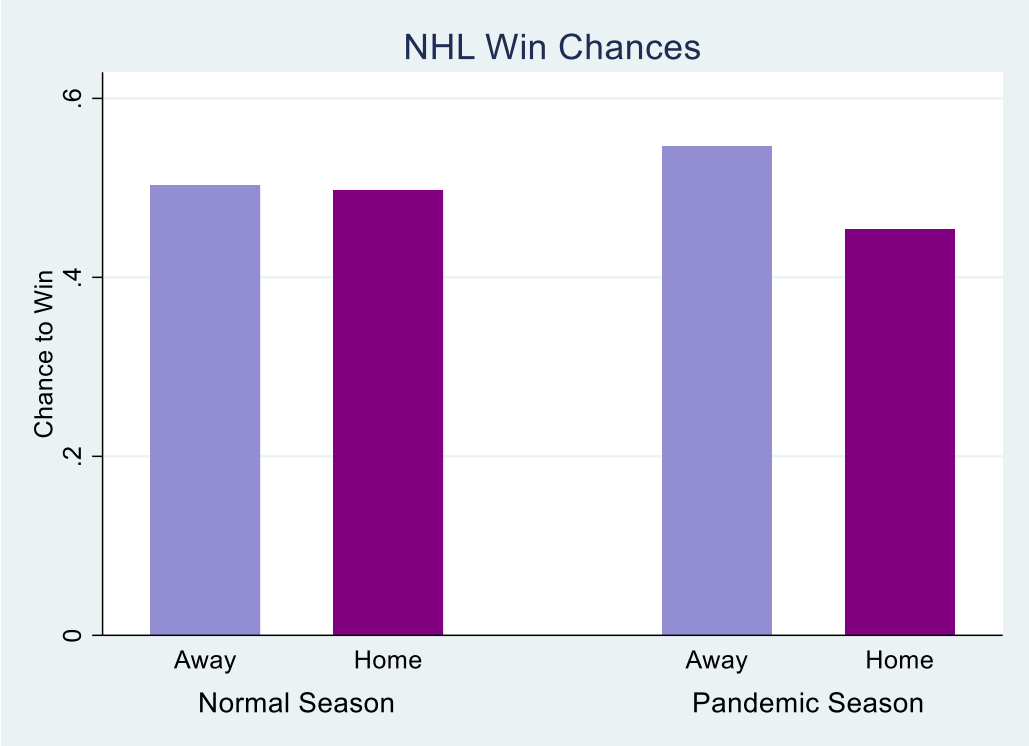

Figure 2: Chance to win for Home and Away NHL teams in the Normal Seasons compared to the Pandemic Season

Figures 1 & 2 highlight initial differences in chance to win for home and away teams when the pandemic season is isolated from the others. Here we see from Figure 1 that the pandemic appears to have had a significant impact on home teams in the NBA. They had a large advantage in chance to win in normal years but that completely disappears for the pandemic season, which even shows a slight advantage for the away team. In Figure 2, we see that NHL home teams did not have any advantage in winning games in normal seasons and while the effect of the pandemic trends in the same direction as the NBA (with the away teams' performance increasing), it doesn't appear to have as significant an impact, likely due to the away team having an already strong initial chance to win. However, while this gives an idea that the pandemic may have had a larger impact on NBA home teams, this is only highlighting a potential difference. In order to determine the true effect on chance to win, and all other variables, a regression model will be used.

Section IV: Empirical Strategy

This paper uses an empirical strategy where each outcome variable is regressed on the *Home* and *Year* dummy variables interacted together. The regression equation is:

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 (X_1 X_2) + \varepsilon$$

Y_i represents each of the outcome, or dependent, variables described above that were studied in the analysis. These include, chance to win, points/goals per game, fouls/penalties per game, and free throw percentage. Seven regressions were run in total, four for the NBA and three for the NHL, so the Y_i is the outcome variable in each of these regressions. X_1 is the *Home* dummy variable and X_2 is the *Year* dummy variable. The $(X_1 X_2)$ term then represents the interaction between the *Home* and *Year* variables. The interpretation of the coefficients is as follows: the constant term α represents the average value of the outcome variable for away teams

in normal seasons, β_1 represents the average effect on the outcome variable from being a home team in a normal season, β_2 represents the average effect on the outcome variable from playing in the pandemic season for away teams, and β_3 represents the average effect on the outcome variable from being the home team and playing in the pandemic season.

Section V: Results

Table 3: NBA Regression Results

	(1) Chance to Win	(2) Points per game	(3) Personal Fouls	(4) Free Throw Percentage
Home & Normal Season	0.268***	5.049***	-0.518	0.307
	(0.0534)	(1.305)	(0.415)	(1.130)
Away & Pandemic Season	0.152*	5.511***	0.268	1.244
	(0.0668)	(1.592)	(0.536)	(1.354)
Home & Pandemic Season	-0.304**	-4.049	0.0484	1.114
	(0.0944)	(2.335)	(0.731)	(1.852)
Constant	0.366***	103.5***	21.72***	77.06***
	(0.0378)	(0.915)	(0.312)	(0.867)
N	494	494	494	494

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 shows the regression results for all outcome variables in the NBA analysis. The results in column 1 indicate that away teams had a 36.6% chance to win games in normal years, which increased 15.2% during the pandemic year. Home teams had a 63.4% chance to win games in normal seasons, but we see that being the home team in the pandemic season had a statistically significant negative impact on chance to win. From the results we can calculate that home teams had a $0.366 + 0.268 + 0.152 - 0.304 = 0.483$ or 48.3% chance to win games played during the pandemic season, meaning that their chance to win dropped 15.2% (which we

see mirrored in the increased chance to for away teams to win). In column 2 the results show that home teams scored on average 5 points per game more than away teams in normal years, while away teams scored on average 5.5 points per game more in the pandemic season than in normal seasons. However, while it appears that home teams did score less points per game in the pandemic season than in normal seasons, this result was not statistically significant and the 95% confidence interval included the value of 0, so this conclusion is not definitive. In columns 3 and 4, results for fouls per game and free throw percentage show very minimal impact from playing in the pandemic season, none of which are statistically significant. Furthermore, these variables show that the home team did not have an advantage in these categories even before the pandemic season.

Table 4: NHL Regression Results

	(1) Chance to Win	(2) Goals Scored
Home & Normal Season	-0.00585	0.193
	(0.0543)	(0.186)
Away & Pandemic Season	0.0432	0.120
	(0.0582)	(0.187)
Home & Pandemic Season	-0.0865	-0.524
	(0.0824)	(0.274)
Constant	0.503***	2.772***
	(0.0384)	(0.121)
N	602	602

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4 shows the regression results for the chance to win and goals per game outcome variables in the NHL analysis. Surprisingly, the results in column 1 show that in normal seasons the chance to win was about equal at 50% for both home and away teams, so no clear home advantage was present. It is also shown that the effects of playing in the pandemic season for both home and away teams is small and not statistically significant. All coefficients in this regression include 0 in the 95% confidence interval, so we cannot conclude that the pandemic season had any effect on chance to win whatsoever. Column 2 shows similar results for goals scored. No clear home advantage is present in the data in normal seasons, and the effects of the pandemic season on both home and away teams is minimal and again not statistically significant.

Table 5: NHL Penalties Regression Results

	(1) Penalties Taken
Home & Normal Season	-0.585*
	(0.251)
Away & Pandemic Season	-0.0632
	(0.271)
Home & Pandemic Season	0.623
	(0.367)
Constant	4.409***
	(0.184)
N	602

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5 shows the regression results for the penalties per game outcome variable in the NHL analysis. This variable was obtained from a separate dataset than the other NHL outcome variables. Identical time periods and games were covered but as there was no way to link the datasets directly, the regression for penalties per game was run individually. Column 1 shows that away teams in normal seasons were called for an average of 4.41 penalties per game, while

home teams were called for 0.59 less penalties per game in normal seasons. The data also suggests that away teams were called for slightly less penalties when playing in the pandemic season, and home teams were called for more, however these two effects are not statistically significant. 95% confidence intervals for the effect of the pandemic season on both home and away teams included 0, and so we cannot definitively say that home teams' penalty advantage was gone in the pandemic season.

Table 6: NBA Attendance

Team	Average pre-pandemic attendance	Home win % normal	Home win % pandemic	Difference in win %
BKN	15249	0	0	0
BOS	18624	0.8	0.375	-0.425
DEN	17796	0.625	0.556	-0.069
HOU	17979	0.75	0.667	-0.083
IND	16432	0.4	0	-0.4
LAC	17172	0	0.429	0.429
MIA	19636	0	0.6	0.6
MIL	17158	0.818	0.333	-0.485
OKC	18203	0.6	1	0.4
ORL	17727	0	0	0
PHI	20385	0.636	0	-0.636
POR	19447	0.5	0	-0.5
TOR	19832	0.667	0.333	-0.333
UTA	18114	0.571	0.667	0.095

Table 7: Attendance and Win % Correlation

	Pre-Pandemic Attendance
Difference in Win %	-0.167

* p<0.05, ** p<0.01, *** p<0.001

Tables 6 & 7 show analysis that was done regarding the heterogeneity among teams in the NBA. This analysis was not conducted for the NHL. Of all teams in the NBA data set, 14 were identified to have had games played in both the normal and pandemic seasons. Win percentage was calculated for each team over all their home games in normal seasons and then again for the pandemic season. The difference in win percentage between the normal and the pandemic season was calculated and was tested for correlation with each teams' average game attendance in normal seasons. The results show that the correlation between these two variables is minimal and not significant.

Section VI: Discussion

The overall results show that home advantage was greater in the NBA in normal seasons and was also more heavily impacted by the pandemic. Initially, it seems counterintuitive that the NHL would not show any advantage at all for the home team, even in normal seasons. This is especially true because in addition to the base factors thought to create home advantage such as crowd support, potential officiating bias, or travel factors, hockey also has a rule advantage for home teams. During stoppages in play, when teams often change their lineup of players currently on the ice, home teams get the benefit of being able to do so last, and thus can control the matchup of players to their advantage. However, results show that this and all additional factors do not seem to have an impact. These results suggest that the NBA possesses qualities the NHL does not have that are more influenced by playing at home. In the NBA, while the initial intuitive hypothesis of the pandemic season negatively affecting home advantage appears true regarding chance to win, an interesting question is raised as to why the impact was not present in all performance outcomes. The results suggest that even when a home advantage is present, it does not provide an increase in performance across-the-board. The difference in the effect of the

pandemic on home advantage between the leagues suggests that rule factors and, contrary to much previous research, crowds and officiating bias are not significant factors. Further support for crowd size not being a major factor comes from the heterogeneity analysis of NBA teams. Pre-pandemic average crowd size is shown to have a very weak correlation with the difference in home win percentage between normal and pandemic seasons for each team. One caveat with this analysis is that since only one season has been played in pandemic conditions, sample sizes for individual teams are quite small. Roster changes between seasons likely also played a role in the variation in win percentage, rather than the only effect being the pandemic playing conditions. Additionally, NBA and NHL teams draw similar sized crowds and many even share arenas, meaning the reduction in crowd size is similar for both leagues. As mentioned above, if rule factors were significant, it is likely that the NHL would show a larger home advantage than the NBA. Therefore, another factor not directly measured in this analysis must be determining a significant amount of home advantage. One possibility for this factor is team travel and fatigue level. While difficult to directly measure, this factor is indirectly captured in the data as the pandemic season was played in a single location that eliminated travel for all teams. No travel requirements may explain why the results show more evidence of improved away team performance rather than worsened home team performance, as seen in the NBA points per game data. Furthermore, since basketball teams have a greater reliance on a smaller number of players who play a larger percentage of the minutes of the game, is it feasible that fatigue may have a greater impact on performance for teams in the NBA than in the NHL. This may explain the discrepancy in the effect of the pandemic between the leagues. However, it is also possible that the pandemic did have a significant effect on all factors contributing to existing home advantages

in the NBA, but for the NHL, home advantage was already absent and so could not be negatively affected, resulting in the overall effect of the pandemic conditions being minimal.

Section VII: Conclusion

The pandemic conditions of the 2019-20 season had varied effects on home team performance across the NBA and the NHL. While the NBA saw a significant negative impact on home teams' chances to win, the impact was absent in the NHL data. In both leagues, the results showed the pandemic conditions to have no significant impact on fouls, penalties, or free throw percentage. Home advantage has been widely studied in sports, but this paper used the unique natural experiment created by teams playing in neutral, isolated conditions to study home advantage in a way that was not previously possible. This analysis has great potential for improvement and extension, especially if games will continue to be played in neutral locations next season. This is currently unclear, but it has been suggested that teams may return to their regular home arenas (and thus travel between them) but still not have crowds in attendance. This would present an opportunity to conduct similar analysis and compare results with this paper to potentially isolate effects such as location familiarity and travel fatigue to see if they impact home advantage. Furthermore, data from regular season games may produce different results as it would include all teams in the league. The regular season schedule also means teams play games more often which may increase the effects of travel fatigue. The specific analysis in this paper would benefit from more data from games played in identical conditions to this year's pandemic bubble in order to provide more definitive conclusions on its impact on home advantage. Finally, the analysis would also benefit from an extension to include other professional sports, such as professional baseball or football, to see how their results compare with the NBA and the NHL.

Section VIII: References

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