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Impact of fans' presence on home team's performance in the English football

Student Name: Thomas Grosset
Student ID: 600279

Supervisor: Prof. Dr. Ir. Jan van Ours
Second Assessor: Dr. Max Coveney

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The views stated in this thesis are those of the author and not necessarily those of the supervisor, second assessor, Erasmus School of Economics or Erasmus University Rotterdam.

PREFACE AND ACKNOWLEDGEMENTS

This research represents the top of my Bachelors' studies at the Erasmus School of Economics, where I studied Economics and Business Economics for three years. The journey of writing this thesis has been both challenging and rewarding, providing me with insights into the impact of fans' presence on home team performance in English football.

The inspiration for this research came from my passion for football and a curiosity about how external factors, such as crowd presence (myself being a fervent fan of LOSC Lille), influence game outcomes. I was also inspired by the Sports Economics elective course I studied in November-December 2023. The unique circumstances of the COVID-19 pandemic offered an opportunity to study fans' importance on a real-world context.

Throughout this research, I received support and guidance from many people. This preface is the opportunity to acknowledge and express my gratitude to those who have contributed to the completion of this work.

I would like to express my deepest gratitude to my supervisor, Prof. Dr. Ir. Jan van Ours, for his constant support, his feedback, and expert guidance throughout the entire process of writing this thesis. From the research proposal to the final version of my work, his comments have been instrumental in the development and refinement of my research.

I am also thankful to the Erasmus School of Economics for providing me with the resources and an adapted environment for academic research. The knowledge and skills I have acquired here have been foundational to my research and overall academic development.

I also want to thank Dr. Thomas Peeters, for having taught alongside with Jan van Ours, the course in Sport Economics, which revealed in me the wish to work in the sport industry later, and to pursue a master's after which I will be able to work for sports organizations.

Abstract

This paper aims to research the impact of fans' presence on the home team's performance. Using 630 games played across 3 seasons of the English Premier League, I conduct a regression to observe and quantify the impact of fans' presence, the referees' impact and the importance of the market value of home and away teams, on match outcomes. I collected data about games played with full attendance, and games played behind closed doors, to build the treatment and control groups of my analysis. The treatment group only includes games that took place during the COVID-19 pandemic, hence, without fans. I find that home teams perform significantly better with fans, with on average 0.133 more goals scored. It is also confirmed by higher win percentages, more points won per game, fewer fouls committed, more shots and more shots on target, while away teams perform better without fans. My findings challenge existing literature when dealing with yellow cards awarded to home teams, and confirm existing findings for yellow cards received by away teams. This study contributes a league-specific perspective on how fans affect team performance, particularly in the unique context of the English Premier League.

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Chapter 1: Introduction

The debut of archaeology as a formal discipline began in the 19th century, marked by excavations and the scientific study of ancient artefacts and sites. Cave paintings were discovered in the Bayankhongor Province of Mongolia dating of the Neolithic Age (c. 7000 BCE) representing a wrestling match in front of other people. This discovery highlights the entertaining character of sports, already 9,000 years ago.

People started including sports in their daily routines. It quickly became essential in people's lives. Our ancestors started competing professionally in sports, with the first edition of the Olympic Games in 776 BC. It has proven to be very important both economically and entertainingly. Competition started attracting people to stadiums, to watch games. Every city started making clubs, with their local fans. For instance, London is the city in the world with the highest number of professional clubs with 17 teams competing at high levels of English football. The creation of clubs helped locally bring people together, uniting crowds behind a team, and giving it the motivation to win.

Football clubs were first created during the 15th century though football in its current form was designed in the 1850's in England. Football was initially played by public school teams and turned later to be played by teams of workers. The biggest change in football history has been the introduction of players' wages and money incentives to join teams. This period induced the professionalization of the activity. Paying players was not only initiated to achieve better win rates but also because in the 1880s, fans started to pay for game tickets.

This new era was transformative for football clubs. In the 1890's, they started building stadiums with stands to host fans. With 39,414 spectators, Goodison Park, built in 1892, was the biggest football stadium in the world, later dethroned by Wembley in 1923, with a standing capacity of 125,000 people.

By building bigger stadiums, club owners understood the importance of fans. Over the economic aspect a greater attendance can bring to a club, the support of fans can be of great help in achieving victory for players. Through chants and anthems, fans give a boost of energy and confidence, helping players push beyond their limits and perform at their best. In modern football, this is often referred to as "Home Advantage". Home advantage is commonly understood as the tendency for home teams to perform much better when playing at home, than away. This can be explained by various factors, which I will discuss, using existing literature.

The growth of football and its professionalisation show how important competition formats are for clubs. Different formats, such as round-robin and knock-out tournaments, affect the way competitions play out. Peeters and van Ours (2020) look at how playing at home affects the result of a tournament. They explained that football, in its current format, is played with competitions structured in different ways. The majority of these tournaments are round-robin competitions, in which a team plays every other team twice: once at home and once away. Others are knock-out tournaments, which may include two-leg games at home and away or matches at neutral grounds. In these formats, home advantage cancels out.

Understanding home advantage in football is important. I will study its characteristics and see if the Covid period induced any significant changes on match outcomes and statistics. Indeed, the recent pandemic has changed our lives in different ways, with most sports having to adapt. It had a profound impact on the English Premier League (EPL) during the 2019/20 and 2020/21 seasons. When the 2019/20 season stopped because of the global crisis, the Premier League worked with other football organisations and the UK government to make sure that when it resumed, it was safe. “Project Restart” started a gradual return to training. Small-group sessions began on 19 May 2020, followed by contact training on 27 May. Matches were played Behind Closed Doors (BCD) from 17 June 2020. All staff members had to take part in risk assessments and regular tests. The 2020/21 season started similarly with most matches played without fans. However, the following season 2021/22 saw the return of full-capacity crowds supported by significant matchday protocols, introduced as a top priority for everyone's safety. These adaptations reflected the League's efforts to maintain football while ensuring health and safety during the pandemic, while other championships like the EREDIVISIE did not play the last games of the 2019/2020 season. This situation offered a great chance to look at how fans affect home team performance, focusing on the EPL. COVID-19 indeed provided a natural experiment for such an analysis. In this research, I will benefit the natural experiment to separate the data in two groups:

- The control group: with match data about all games played with fans;
- The treatment group: with match data about all games played behind closed doors.

The purpose of this setting is to consider the absence of fans as the treatment, or the major difference with the control group. I choose this treatment as football is usually played with a crowd, therefore making most of the games the control group, and the games played during the pandemic the treatment group.

The aim of this paper is to investigate whether home team fans' presence influence their team's performance positively. I will examine some factors such as attendance and market values of both teams that can potentially influence the outcome of football matches using 630 different games over three seasons in the English Premier League (EPL).

The central research question of this research is :

How did the absence of fans affect home team performance in the English Premier League across different periods of the COVID-19 pandemic?

This research seeks to understand how the absence of fans influenced game results, goals scored, and overall match dynamics in the EPL. Behind closed doors, players reported feeling non-supported, and the silencing atmosphere in the stadium impacted a lot on the games. Based on match situations, clubs diffused an artificial atmosphere in the stadiums' speakers to try hiding the absence of crowd noise. The home team could therefore hear chants and cheers when attacking, and booing when the opposing team attacked.

The data collected and analyzed is for the season 2019/2020 where there was full attendance in the stadiums. All matches for this period, and before the 17th of June 2020, represent the control group. The treatment group includes all games played from the 17th of June 2020, until the end of the 2020/2021 season. As above-mentioned, the season 2020/2021 was played BCD, I use games played with no fans as a treatment group. Games of the 2021/2022 season are added to the control group.

To understand this research, I must first look at previous studies on similar topics. Then, I will use numbers and data for the quantitative section, trying to quantify fans' impact. Finally, I will discuss the results, bring a final answer to my central research question, and make suggestions for future research.

Chapter 2: Literature Review

Home advantage

The theory of home advantage can be explained by the basic idea that underlies the effect of fan presence on home team performance. Home advantage is the fact that teams tend to perform better and win more often when playing at their venue than when playing away from home. In most sporting contests, teams always play at home or in their opponents' venue upon the scheduling. Home advantage is famous in a broad range of sports. Several causes have been implied, such as crowd support, knowing the venue of play better, and sometimes even less fatigue in travelling for the home team. When these causes work together, the performance of the home team increases, thus increasing win rates. Researchers of home advantage in football compare win percentages of home and away teams, analyze the number of chances created between them, and establish score differences between them. As put forward by Seçkin and Pollard (2008), home advantage does indeed exist in football. In their research, they focus on the Turkish Super League, and find that home advantage is evidenced by the fact that home teams accrued 61% of the total points at home, similar to findings reported across other sports and leagues worldwide. Home advantage as a concept has numerous components and implications; thus an understanding of how it is affected by, for example, the presence or absence of fans can help one analyze how different factors interact to influence team performance and outcomes in sports contests.

Referee Decision-Making/ Changes in Referee Behavior

The role of referees' decisions cannot be overlooked when determining the effects that fans have on home team performance. The importance of home advantage can reveal itself through biased decisions that referees make toward the home team, and the reasons for this bias are plenty. For instance, Garicano and Palacios-Huerta (2005) showed that there exists social pressure from the crowd that has resulted in a systematic bias of referees' favoritism for the home team. Their review of 750 games in the Spanish first football division between the 1994-95 and the 1998-99 seasons showed that referees would add more additional minutes when the home team is led by one goal at the 90th minute, compared to cases where the home team was two goals behind or winning by a single goal. This is supported by the findings of Unkelbach and Memmert (2010) that crowd noise can be used as a valid cue to the referees' judgments, which strengthens home advantage. Another research, by Boyko, Boyko, and Boyko (2007) identified significant differences in home advantage, within the English Premier League, to be

the result of subjectively officiated decisions by specific individuals as referees and clearly, crowd presence plays a vital role. Nevill, Balmer, and Williams (2002) went a step further to show that the pressure of crowd noise added uncertainty on the part of the referees, which makes them susceptible to bias by reciprocating the support shown for the home team, the referees consequently award significantly fewer fouls to the away teams. On the other hand, the findings of this study cannot be held as universal characteristics of referees since if they are widely generalizable, then football can be said not to be fair since it would suffer from potential scandals in each of its games. Page and Page (2010) advised that referees were more vulnerable to the crowd's pressure, the susceptibility appeared to be reflected in another probable contributory factor to the home advantage phenomenon: individual differences in the referees. Similarly, Pettersson-Lidbom and Priks (2010) discovered such findings in Italian soccer: there was a case of home bias by referees due to social pressure when spectators were present. These studies collectively suggest the effect of referee decision-making on home advantage, shaped by the presence and pressure of the crowd. It shows in what ways the fundamental nature of the home advantage can be revealed across sports contests. This part of the literature, and especially Nevill, Balmer, and Williams' findings (2002) yield the first hypothesis of this research:

Hypothesis (H1): *There is no difference in the number of yellow cards, awarded to the home and away teams for games played with and without crowd.*

Player Performance and Psychological Effects

The psychological effect on players of the lack of fans is an area that has been the ground of many researches and, therefore, evidence of factors behind home advantage. Ferraresi and Gucciardi (2021), found out that home teams were more likely to miss penalty kicks when played in front of empty stands, a likelihood that was a decreased for away teams also under similar settings. This phenomenon was most robust in circumstances in which the audience was large, pre-pandemic, highlighting the importance of a good-sized supporting cast in the performance of skill tasks such as penalty kicks. Going deeper into the psychological aspects, Neave and Wolfson (2003) noted that salivary testosterone levels in soccer players were significantly elevated before home matches versus away matches, peaking for contests against a better rival. These results imply that testosterone contributes more significantly to home advantage in team sports than mood-related factors. Nevertheless, Ven (2011) argued on the controversial ground of the claim that crowd support is not a sufficient precondition. He

mentioned two critical variables for home advantage: venue familiarity and travel fatigue. This holistic view aligns with prevailing literature suggesting that home advantage is multifunctional, including psychological and physiological functions along with situational variables. Altogether, the findings enhance our understanding of the intricate relationship between psychological determinants and player performance concerning home advantage, emphasizing the essential inclusion of other determinants like crowd support, venue familiarity, and travel fatigue.

Stadium familiarity and travel fatigue

As just mentioned, other reasons for home advantage are the home team's familiarity with its venue and the travel fatigue experienced by Away teams. Courneya and Carron (1992), later reviewed by Schwartz, Barsky (1977) and Edwards (1979) wrote about the latter "It is already known and has been demonstrated in numerous studies that a home team almost always outperforms the away team in all types of sports". Further validation of this idea is found in other studies by Clarke, and Norman (1995). In their research, it was observed that there existed a linear relationship between the distance separating club grounds and home advantage. Hence, this further proves that travel fatigue significantly impairs performance of the away team. Their findings suggest that the home advantage can become relatively significant when the away team needs to travel longer distances, which may indicate travel fatigue as one mechanism behind this. A variable directly related to venue familiarity is considered in more detail by Pollard (2002) in his study. The findings from his research reveal that home advantage diminishes markedly when teams change stadiums, even if they remain in the same city. Familiarity with the playing venue accounts for about 25% of the home advantage according to him. This is not unique in football. It applies to basically all other sports. Pollard commented that a more minor home disadvantage exists between the first and last games at the new ground because of the slight familiarity of players and fans with the new environment, including the pitch, stands, and general atmosphere. These findings show that both travel fatigue and venue familiarity significantly affect how well the home team can perform. The literature indicates that teams perform well under homely conditions and become tired from travelling, thus explaining our understanding of the factors responsible for home advantage in sports contests.

A first way to study home advantage is to consider the COVID-19 period to judge fans impact and its effect on referee behaviour towards away teams.

The covid findings

Some researchers already took a look into the COVID-19 period, to study Home advantage. Research has shown over and over that the presence of the crowd has an important impact on player performance and the decisions made by the referee. Again, COVID-19 provided an opportunity that was likely to have never existed again for football to investigate how crowds impact games. The absence of crowds has proved that the impact made by the crowd was more significant than the initial thought. Missing crowds hugely impacted the judgment calls that referees make. Endrich and Gesche (2020) pointed out that in Bundesliga games, home bias was reduced as evidenced by the fact that a few numbers of yellow cards were given to the home team by referees compared to the away team for a 'ghost match.' They also found similar results for faults whistled. Reade, Schreyer, and Singleton (2021) cite a significant reduction of yellows given to the visitors in empty stadiums as a clear indication of the extent of referees' bias diminishing when crowd pressure is not at play. McCarrick et al. (2021) conducted their study also in European football leagues, with games played in the absence of spectators found to reduce home advantage significantly. Most of the drop resulted from the poor performance at home by the home teams, which allows them to be attacked, and create fewer chances. This result highlights the importance of fans providing support to inspire the players to go beyond their limits. Sors et al. (2020) observed home advantage to decline in matches also played behind closed doors. They also concluded a reduction in referee bias for these games. Following this, various studies have demonstrated that during games played behind closed doors, the home advantage was either lost or significantly reduced. The most recent of such is that by Van Ours (2024), who observed how empty stadiums in the Netherlands became possible ways of losing the home advantages since the home-playing teams scored fewer goals. Another example took place in the Egyptian Premier League. Home advantage was completely nullified or even disadvantaged by fans' absence due to extreme violence cases during prior matches, as revealed by Singleton et al., Reade, and Schreyer (2023). The findings of research related to COVID-19 strengthen current theories of home advantage because they outline a clear, direct impact of crowd's presence on performance and referees' decisions. It also assists, with especially Van Ours' findings (2024) in the drawing of the second hypothesis of this research:

Hypothesis (H2): *The absence of fans leads to a reduction in the number of goals scored by home teams.*

Another way to study home advantage is under same-stadium derbies. Analyzing under this setting will allow cancelling out travel fatigue and stadium familiarity as factors influencing teams performances.

Same-Stadium Derbies

Research into same-stadium derbies is especially relevant because it can strip out the impact of travel fatigue and venue familiarity, thus putting greater emphasis on crowd support and psychological pressure as drivers of home advantage. Ponzio and Scoppa (2014) looked at same-stadium derbies and showed that a large part of this home advantage came from crowd support. Their study was further able to show that a higher crowd support team won more often and that the travel fatigue difference was not significantly different, nor was the familiarity of playing in the stadium. This is precisely what many authors have already expounded regarding home advantage; crowd support remains a crucial added advantage factor. The examination by Pollard and Seckin (2008) took their analysis towards football derbies in Istanbul. Their research also concluded that home teams won far less in derbies than other games. The said abnormalities were not a result of stadium recognition but of the fact that derby matches tend to be highly competitive, with standards set at a very high level by both participating teams, among many other external factors. Such findings indicate that the unique context of derbies can help offset the usual benefits associated with playing at home in terms of crowd support and venue familiarity. Integrating such findings with existing literature shows that while crowd support is an integral part of home advantage, its influence can be pretty nuanced by the context of the match. The psychological benefits of having the audience and familiarity within the same stadium during such derbies are likely to have been cancelled out by the psychological pressure and the quality of teams. This complexity adds depth to our understanding of home advantage, whereby it is not a uniform phenomenon but can vary significantly depending on specific match conditions.

Variations Across Leagues and Conditions

The loss of crowd support affects home advantage, but this impact is highly dependent on the league and situation. For instance, research has shown that the effect is smaller in Portugal's Primeira Liga compared to other leagues. Peeters and Van Ours (2020) researched in English professional football in the period from 1974 to 2018 at different levels. The main finding of their work was that while the home advantage varied drastically from one division to another, there still was quite a bit of absolute home advantage. However, this advantage showed a trend

of decreasing over time, suggesting that various other factors might increasingly counteract the effect of a crowd. Schwarz (2011) on the other hand, specifically studied the German Bundesliga and discovered balanced tendencies in crowd-incited penalty decisions. His study found that supporters influenced judges, leading to a disproportionate balance of matches in which each side received one penalty from the two available. The strength of fans as a determinant differs across leagues and settings, these findings shed light on the growing body of research on home advantage. While the overall home advantage in English football has gone down over the years, possibly for reasons including professionalization, the effect of attendance on referees' decisions on matters such as the Bundesliga seems clear. This complexity illustrates the intricate nature of home advantage indicating that its components such as crowd support, psychological pressure and referee bias can vary significantly concerning league culture and match specifics.

Chapter 3: Data

3.1: Data set

The data for this research is retrieved from the EPL for games during the 2019/2020, 2020/2021 and 2021/2022 seasons. The main data source for the research is football-data.co.uk, on which I collected all match statistics and game results. I include market values of both home and away teams per season. The data for teams market values per season was retrieved from Transfermarkt.com. The Referee data was collected using the WhoScored.Com dataset on referees officiating in EPL.

The dataset comprises 630 matches played over three seasons in the English Premier League (EPL). Usually, 380 games are played every season by 20 teams in EPL, meaning that the original dataset was made of 1140 games.

Teams that took part in all three seasons are the following: Arsenal, Aston Villa, Brighton & Hove Albion, Chelsea, Crystal Palace, Everton, Leicester City, Liverpool, Manchester City, Manchester United, Newcastle United, Southampton, Tottenham Hotspur, West Ham United, and Wolverhampton Wanderers. The EPL is competitive, with promotion and relegation affecting the league's composition each season. However, to increase the reliability of my research, I included only the teams that played over the 3 seasons in EPL. I made this choice

to be able to compare the three seasons and to make sure I had the same teams. Therefore, I dropped all match data for the following teams: Norwich City, Watford, Bournemouth, Burnley, Leeds United, West Bromwich Albion, and Fulham.

A total of 630 matches were therefore played by 15 different teams, with 25 referees officiating the matches. 371 games were played with full attendance, against 259 matches played behind closed doors. The main difference for games before or after and during the COVID-19 pandemic is reflected in the dummy variable "fans." Hence, for all games that were played before and after the massive spread of COVID-19, the value is set to 1, while during the pandemic, it is set to 0. The average attendance for the games played in the two seasons with full attendance was approximately 26,593 attendees per match.

3.2: Descriptive Statistics

My analysis offers guidance on the impact of home-field advantage by comparing match statistics with and without fans. I found that the home team win percentage was 45.01% for games with fans compared to 38.61% for games without fans, indicating a statistically significant decrease of 6.40% in win percentage when home players stop benefiting from the support of their fans. Conversely, the away team win percentage increased by 6.84%, rising from 31.00% with fans to 37.84% without fans, which is also statistically significant. The average points per game for the home team were 1.59 with fans and 1.39 without fans, showing a significant difference of 0.20 points in favor of games with fans. For away teams, the average points per game increased from 1.17 with fans to 1.37 without fans, a difference of 0.20 points, which is statistically significant. Regarding goals scored, home teams scored on average 0.133 goals more in games with fans, and this difference is statistically significant. Away teams scored 0.083 goals less when playing with full attendance, but this difference is not statistically significant. Home teams had significantly more shots on target per game with fans, with a mean difference of 0.347 shots. Away teams also had more shots on target per game with fans, with a mean difference of 0.254 shots, which is statistically significant. The total number of shots for home teams was significantly higher with fans, with a mean difference of 1.383 shots. In contrast, away teams had a non-significant mean difference of 0.187 shots more per game with fans.

For disciplinary actions, home teams received significantly more yellow cards per game with fans, with a mean difference of 0.137 cards. Away teams received significantly fewer yellow

cards per game without fans, with a mean difference of 0.279 cards, which is highly significant. Home teams committed significantly more fouls without fans, with a mean difference of -1.233 fouls. Away teams had a non-significant mean difference of 0.007 fouls more per game with fans.

In summary, these statistics indicate significant differences in match outcomes and team performance when fans are present compared to when they are absent. Home teams generally perform better with fans, as indicated by higher win percentages, more points won per game, fewer fouls, more shots, and more shots on target, while away teams perform better without fans.

Table 1. Match statistics of EPL games over 2019/2020, 2020,2021 and 2021/2022 seasons.

	With fans	Without fans	Mean differences
Home team win %	45.01	38.61	6.400*
Away team win %	31.00	37.84	-6.840*
Mean home points/match	1.59	1.39	0.200*
Mean away points/match	1.17	1.37	-0.201**
Mean attendance	26,681.48	0	26,681.48
Home goals/match	1.58	1.44	0.133*
Away goals/match	1.27	1.35	-0.083
Home shots on target/match	4.74	4.39	0.347**
Away shots on target/match	4.19	3.93	0.254*
Home shots/match	13.64	12.26	1.383***
Away shots/match	11.53	11.34	0.187
Home yellows/match	1.68	1.54	0.137*
Away yellows/match	1.85	1.57	0.279***
Home fouls/match	10.22	11.45	-1.233***
Away fouls/match	10.60	10.60	0.007
Observations	371	259	112

Notes: Column 1 reveals statistics for games played with spectators (before and after Covid-19). Column 2 is without spectators (during Covid-19 pandemic). Column 3 shows the mean differences between the two samples. All tests performed for this table are t-tests, and the significance levels are as follows: ***p<.01, ** p<.05, * p<.1. Same number of teams across all seasons (15).

3.3: Methodology

To develop an understanding of fans' impact, I run an OLS regression. In the context of this research, the primary interest of this method lies in understanding how various factors, particularly spectator attendance, influence outcomes such as the number of points won per game, the number of goals scored, the goal difference and the number of yellow cards received by both teams. OLS regression is a suitable and robust method for analyzing continuous dependent variables because it models the marginal effect of the independent variables on the dependent variable. The OLS regression method assumes a linear relationship between the dependent and independent variables, providing a straightforward estimation of how changes in explanatory variables impact the dependent variable. This method is particularly useful when the outcome variable is continuous, allowing for the interpretation of the marginal effects of each independent variable. Thus, using OLS regression in my study allows for the precise estimation of how attendance and other factors influence the performance of the home team, capturing the direct impact of these variables on the dependent variable.

In my research, I use OLS regression to analyze continuous dependent variables, with a particular focus on the market values of both home and away teams, which are expressed in millions of euros.

Additionally, I transformed the attendance variable by using its natural logarithm. The transformation is detailed in the Appendix. This adjustment helps in stabilizing the variance and reducing heteroscedasticity, ensuring more reliable and consistent regression estimates. This transformation has many advantages. First, log transformation captures diminishing returns, where the impact of an increase in attendance, for example from 60,000 to 70,000, is smaller than from 10,000 to 20,000. This is important in reflecting how marginal changes in large crowds might affect game dynamics less. Second, it helps normalize skewed attendance data, as attendance figures vary widely across stadiums, from smaller venues like Selhurst Park to large ones like Old Trafford. Additionally, it allows for easier interpretation of the results in terms of percentage changes, making the coefficients more meaningful when explaining the relationship between attendance and game statistics. By employing these transformations, my model benefits from improved linearity, reduced skewness, and enhanced interpretability of the coefficients. These methodological choices contribute to more robust and valid regression results, offering clearer insights into how market values, attendance and referees influence game outcomes.

The dependent variable (Y) is Home Advantage. In my model, I will include several variables. The independent variables included in the regression model are **Fans**, a dummy variable indicating the presence of fans (1 if fans are present, 0 if not), and the natural logarithm of the number of fans present in the stadium, measured by the variable **LNATT**, being the transformed **Attendance** variable. Using attendance as an independent variable in this research was motivated by the findings of Bryson et al. (2021), who found using a similar method, that the absence of a crowd does not lead to a change in the scoreline, but reduces by one-third, the number of yellow cards attributed to the away team. Therefore, I will control for Attendance, to see if I find similar results.

I also include a referee controlling variable. This choice is motivated by the study of Schward (2011), who studied the bias, a referee suffers from, when he already attributed a penalty to a team in a football game, leading him to attribute another penalty more easily in the same game. The variable **Ref** will therefore account for this bias and is defined as the average number of penalties awarded per game, over the whole career of the referee, officiating in EPL only. In appendix, I include a summary table of the referee statistics. The choice to include a referee controlling variable is also motivated by the study of Page and Page (2010), who found that bias leading to home advantage was subject to individual differences across referees. Their study reveals the importance of controlling for referee bias.

Finally, I include two variables, **MvH** (market value of home team) and **MvA** (market value of away team) measuring the market value of the teams, retrieved per season, from Transfermarkt.com. These variables are expressed in millions of euros, and left raw, without any transformation. The choice to include the market values of teams in their raw form was motivated by the study of Gerhards and Mutz (2016) which found that the market value of a team was by far the most important predictor of success. However, they write “ The lower the degree of financial inequality in a league, the lower the impact of the market value on teams’ performance”. This statement is relevant for the EPL since Carreras and Garcia (2018) researched the degree of financial inequality in the league. They studied the new TV deals, which significantly increase TV revenue, and are expected to exacerbate competitive imbalance within the league. The study provides evidence that absolute financial differences between clubs, as opposed to relative differences, better explain game outcomes and overall standings. As the new TV deals increase financial inequality in absolute terms, the competitive balance in the EPL is predicted to worsen. This means that richer clubs will likely become more dominant, thereby making the competition more imbalanced. Therefore, this finding further motivated my choice to control the market values of teams and their impact on match outcomes.

These variables become interesting to see if lower market value teams can compete with the dominant teams of the championship, and to see if the crowd can help lower value teams, to compete.

Some of the dependent variables are therefore match statistics, such as Home and Away teams' goals scored per game (**HG/AG**), Recalling my second hypothesis ***Hypothesis (H2): The absence of fans leads to a reduction in the number of goals scored by home teams.*** The number of Yellow cards received by both teams per game (**HY/AY**), the Goal Difference (**GD**), the number of points won per game (**HP/AP**).

The Equation is as follows:

$$Y_{hijkt} = B_1LNATT_{hijkt} + B_2Fans_{hijkt} + B_3Ref_j + B_4MvH_{ht} + B_5MvA_{it} + \epsilon_{hijkt}$$

- h represents the home team.
- i represents the away team.
- j represents the match.
- k represents the specific type of match statistic.
- t represents the time period (season).

Chapter 4: Results

I evaluated the impact of fan presence on various football game outcomes through a regression analysis. For my model, I run a regression of the transformed Attendance, the fans dummy, the referee and market values variables, on different match statistics and outcomes. The LNATT variable, is used to study the impact of a 1-percent increase in attendance on match statistics and outcomes.

The coefficient for Attendance is significant in the regressions on yellows received by Home and Away teams, and in the regressions on points earned per game by both teams. It is not found to be statistically significant for the regressions on goals scored by both teams, nor on the goal difference.

When looking at the effect an increase of 1% in Attendance has, I find that it only impacts significantly the number of yellows received by both teams. Indeed, my results are challenging existing findings. A 1% increase tends to increase by 0.471% the number of yellows received by home teams, and to decrease by 0.383% the number of yellows received my away teams.

In other regressions, the Attendance variable is not statistically significant.

The fans dummy is very straightforward in its interpretation. As earlier said, it takes a value of 1 when the game is played in front of fans. The coefficients are interpretable as marginal effects. Like for the Attendance variable, the coefficients are only significant on the regressions on the number of yellows received by both teams. However, for this independent variable, the results are more in line with existing findings. I find that playing in front of fans decreases the number of yellows received by home teams by 4.890, on average, and increases by 4.351, the number received by away teams.

The Referee variable is more tricky to understand. Being measured as the average number of penalties given per match over the career of the referee. Its marginal effect is therefore understood as an increase of one penalty per game in the referee's career average, resulting in 2.296 more yellows attributed to Home teams, and 1.328 more yellows to away teams. Both these significant coefficients suggest that referees who tend to award more penalties on average are also likely to issue more yellow cards during a match, reflecting a bias where referees with a history of awarding more penalties may also be stricter in enforcing other rules, leading to more yellow cards. The coefficients are again not significant on the other regressions.

Market values coefficients are more straightforward in their interpretation. A 1-unit increase refers to an increase of 1 million euros in a team's market value. Surprisingly, the coefficients are very small and significant in all models but the regression on the number of yellow cards received by away teams. I find an increase by 0.001 in goals scored by home teams and points won per game by home team. I also find a 0.002 increase in goal difference per match and in the number of points earned per game by home team. Conversely, I find that an increase in the market value of home teams decrease by 0.001 the number of goals scored and points won per game by the away teams, while also decreasing the number of yellows received by home teams by the same coefficient. This result is also supporting existing findings and common sense of player's market values. Research by Kologlu et al. (2018) suggests that fouls can negatively impact a player's market value, as they might be seen as a liability for the team. An increase in a player's market value is often supported by better performances, and means in my model that a home team with a greater market value is associated with fewer yellows received. This could be explained by greater talent defensively, or more experienced players, doing fewer fouls and therefore receiving less yellow cards.

To understand better the meaning of the results, I explain one in the following example. If for instance a team increases its market value by 150 million euros, either by buying talented players, or by revealing talents formed in the club, the impact then becomes more important, and the number of points won by home teams increases by 0.150.

The same applies to the market value of away teams, with more goals scored for them and fewer for home teams (0.001 for both), and a smaller goal difference (-0.002 for every million increase), and finally a positive impact on points earned per game by away teams. However, the coefficients for the regression on yellows received by both teams are found not to be statistically significant.

Table 2. OLS Regression Results for Various Match Outcomes and Statistics.

	HG	AG	HY	AY	GD	HP	AP
LNATT	0.334 (0.207)	-0.286 (0.209)	0.471** (0.219)	-0.383* (0.229)	0.049 (0.310)	0.149 (0.228)	-0.076 (0.221)
Fans	-3.479 (2.196)	-3.119 (2.242)	-4.890** (2.329)	4.351* (2.438)	-0.360 (3.306)	-1.432 (2.429)	0.630 (2.355)
Ref	0.967 (0.818)	0.701 (0.697)	2.296*** (0.767)	1.328* (0.790)	0.265 (1.135)	0.007 (0.876)	0.497 (0.865)
MvH	0.001*** (0.000)	-0.001*** (0.000)	-0.001** (0.000)	0.000 (0.000)	0.002*** (0.000)	0.001*** (0.000)	-0.001*** (0.000)
MvA	-0.001*** (0.000)	0.001*** (0.000)	0.000 (0.000)	0.000 (0.000)	-0.002*** (0.000)	-0.001*** (0.000)	0.001*** (0.000)
Intercept	1.089*** (0.253)	1.018*** (0.234)	0.982*** (0.247)	1.115*** (0.249)	0.071 (0.358)	1.387*** (0.280)	1.158*** (0.273)
R-squared	0.1168	0.1103	0.0299	0.0214	0.1834	0.1427	0.1423

Notes: the significance levels are as follows: *** $p < .01$, ** $p < .05$, * $p < .1$. Standard errors are indicated in the parentheses. The number of observations is the same for all regressions: 630.

Chapter 5: Conclusion and suggestions for further research

5.1: Conclusion

The 2021 pandemic showed how much home advantage depends on crowds. Without them, players' performance matters more. My results depict several significant changes in matches outcomes, depending on fans' presence. Games played with fans represent 59% of my sample. I find significant increases in coefficients for the number of shots and shots on target per game, for Home teams, while playing with supporters. I also find that away teams tend to receive 0.279 more yellow cards in games played with fans, than in games played behind the COVID-

19 pandemic. This finding supports existing literature about referees' bias towards home teams in games with fans. I also find that home teams commit more fouls in games played in empty stadiums. However, my research finds that home teams received more yellows in games with fans, challenging existing literature about home advantage. When looking at Table 1 and 2, my results further challenge the existing findings about yellows received by home Teams. With a greater attendance by 1%, contributing to more yellow cards received by home teams, my findings go against the common understanding of referee bias favouring home teams and home team's performance. I find that the increased presence of fans leads to an increase by 0.471% of yellows received, and a decrease by 0.383%. This later decrease challenges as well the existing literature about Home Advantage, while in principle, an increase in attendance would lead to an increase in the number of yellows received by away teams, because of increase pressure on the referee and worsening of the away team's performance.

Some results also support existing literature. By finding that the presence of fans, in contrast to an increase in attendance, leads to more yellows received by away teams and fewer yellows received by home teams. My coefficients are quite large, respectively, 4.351 and -4.890, indicating an important increase and decrease in the number of yellows received.

My findings about yellow cards allow me to draw a conclusion on my first hypothesis, namely: *There is no difference in the number of yellow cards, awarded to the home and away teams for games played with and without crowd.* From Table 2, I am able to reject this first hypothesis, given the significance of my coefficients for the fans dummy in both regressions on the number of yellows received by both teams. There is indeed a difference in the number of yellow cards awarded to both teams for games played with or without fans. Table 1 further validates this rejection, with a mean difference of 0.137 for home teams and 0.279 for away teams. My findings for instance challenge the findings of Nevill, Balmer, and Williams (2002), that find that fans' presence leads to fewer fouls being awarded against home teams, with more yellows being awarded to home teams when playing with fans.

Though using market values of teams has already been done in other research, my study differs from the existing literature by focusing on the EPL. Using three full seasons, comparing the presence, absence and the subsequent return of fans in the stadiums to explore their impact on match statistics. Within my sample, I find that an increase in a team's market value is often beneficial for its goals scored, points earned, and tends to increase the number of yellows received by the opponent while reducing the number of yellows it receives. These results are again pretty straightforward when thinking of one player's valuation, and in-line with the existing literature.

I can also confirm the results of Van Ours (2024) and McCarrick et al. (2021), given the significance of the mean difference for goals scored by home teams in Table 1. I therefore accept my second hypothesis, that fans' absence lead to a decrease in the number of goals scored by home teams.

Another of my findings is that, when looking at Table 1, the presence of fans increases the number of shots and the number of shots on target for away teams which is challenging the findings of Wunderlich et al. (2021), who found that because of psychological pressure, away teams tend to have fewer offensive opportunities such as corner kicks and shots as a result of fans presence. This study suggests that fans have a big impact on the performance of football teams.

My study further differs from previous literature in many other aspects. The context of this research is unique because it only focuses on the EPL (the most competitive league in the world) and considers the seasons before, during and after the pandemic. Existing literature does not focus on these periods to obtain results. Existing research typically compares the COVID season with only one season before or after it. Other existing research studies home advantage across much longer periods, including tens of seasons, and also research the effect of home advantage across multiple division levels and countries. I therefore offer a league-specific insight that contributes to a more nuanced understanding of fans' impact.

In terms of methodology, my study uses OLS regression, while other research use probit models, instrumental variables and fixed effects models. Though my study is close to the one by Bryson et al. (2021) by using Attendance and Fans dummy, it incorporates market values of both teams and a referee variable.

Other research includes variables such as the wage payroll of clubs to account for team quality, instead of the market value of clubs. I decided to only focus on specific match outcomes, fan presence, attendance, referees bias, and market values, providing a more targeted analysis of the immediate impact of these control variables on match statistics.

5.2 Suggestions for further research

Despite the robust findings and insights provided by this study, several limitations should be acknowledged. Concerning this research, I realized that some parts of the research could be strengthened to improve the overall reliability of the results. By restricting the dataset to three seasons, to ensure balanced sample sizes, the analysis might not capture the full variability of matches across different seasons and conditions, potentially limiting the generalizability of the findings. This approach could potentially exclude data that provide additional insights into the

impact of fans on match outcomes. This then leads to the fact that the results might not fully represent the broader population of football matches in the EPL. A suggestion would be to consider more seasons in my study.

Other questions and hypotheses must also be evaluated to have a complete overview of the home advantage phenomenon. This is because I study changes in home team's performance. However, the home advantage can also be influenced by other factors as mentioned in the literature review, such as familiarity with the playing field and travel fatigue for away teams. These aspects were not separately analysed in this study. Extending this research to other divisions of English football must also be interesting, as done by Peeters and Van Ours. It could help expand the results to other levels of football and see, if in lower divisions, when attendance is lower and facilities, are less developed, similar findings are found. Finally, there may be other unobserved variables that influence match outcomes, such as player injuries, weather conditions, or tactical changes made by the teams. These factors could not be fully accounted for in the analysis and may affect the results of our research.

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Appendix

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Table of Descriptive statistics of all the dataset variables.

Variable	Mean	Min	Max
Home_goals	1.52	0.00	9.00
Away_goals	1.31	0.00	9.00
Goaldiff	0.21	-9.00	9.00
Home_shots	13.07	1.00	31.00
Away_shots	11.45	1.00	31.00
Home_shots_on_target	4.60	0.00	14.00
Away_shots_on_target	4.08	0.00	15.00
Home_fouls_comitted	10.72	0.00	23.00
Away_fouls_comitted	10.60	1.00	25.00
Home_yellow	1.62	0.00	6.00
Away_yellow	1.73	0.00	6.00
Attendance	26,738.71	0.00	73393.00
Fans	0.59	0.00	1.00
MVH	514.71	126.50	1112.00
MVA	515.56	126.50	1112.00
Ref	0.28	0.18	0.71
LNATT	6.29	0.00	11.20

Notes: Table 1 gives mean statistics of all variables, with no distinction of treatment or control group. All variables have the same number of observations, Obs= 630.

Table of Premier League average match attendance for seasons 19/20 and 21/22.

Rank	Club	Average	LNATT	Average	LNATT
		19/20	19/20	21/22	21/22
1	Manchester United	73,393	11.204	73,150	11.200
2	Arsenal FC	60,279	11.007	59,776	10.998
3	West Ham United FC	59,925	11.001	58,894	10.983
4	Tottenham Hotspur FC	59,384	10.992	56,428	10.941
5	Manchester City FC	54,219	10.901	52,774	10.874
6	Liverpool FC	53,143	10.881	53,027	10.879
7	Newcastle United FC	48,248	10.784	51,487	10.849
8	Aston Villa FC	41,661	10.637	41,681	10.638
9	Chelsea FC	40,563	10.611	37,810	10.540
10	Everton FC	39,150	10.575	38,845	10.570
11	Leicester City FC	32,061	10.375	32,061	10.375
12	Wolverhampton Wanderers FC	31,360	10.353	30,741	10.333
13	Brighton & Hove Albion FC	30,358	10.321	30,988	10.341
14	Southampton FC	29,675	10.298	29,889	10.305
15	Crystal Palace FC	25,060	10.129	24,282	10.097

Attendance statistics retrieved from <http://www.european-football-statistics.co.uk/attn.htm>.

Table of Market Values per season.

Teams	2019/2020	2020/2021	2021/2022
Arsenal	582.75	591.75	548.30
Aston Villa	126.50	217.55	397.80
Brighton & Hove Albion FC	203.95	194.90	297.10
Chelsea	850.65	727.80	955.50
Crystal Palace	215.40	173.25	181.65
Everton	479.75	429.65	505.90
Leicester city	379.53	428.55	493.30
Liverpool	1,110.00	993.95	924.00
Manchester City	1,170.00	1,060.00	1,110.00
Manchester United	801.10	655.98	764.55
Newcastle United	207.50	244.58	239.70
Southampton	303.10	208.30	268.10
Tottenham Hotspur	882.00	701.00	665.00
West Ham United	356.25	294.15	274.55
Wolverhampton Wolves	301.25	298.00	377.35

Data retrieved from Transfermarkt.com. All market values are in millions of euros and are taken on the first of July of each season.

Table of referees statistics:

Referee	Average penalties per game awarded over the career
A Madley	0.18
A Marriner	0.22
A Taylor	0.30
C Kavanagh	0.29
C Pawson	0.37
D Coote	0.31
D England	0.33
G Scott	0.25
J Brooks	0.31
J Gillett	0.28
J Moss	0.30
K Friend	0.26
L Mason	0.26
M Atkinson	0.23
M Dean	0.33
M Oliver	0.32
M Salisbury	0.71
O Langford	0.30
P Bankes	0.24
P Tierney	0.21
R Jones	0.37
S Attwell	0.22
S Hooper	0.20
S Scott	0.30
T Harrington	0.37

Notes: 25 referees officiated during the 630 games, across the 3 seasons. Data retrieved from WhoScored.Com.