What are the effects of Covid- 19 on professional football?

**An analysis of the influences of “ghost games” on home advantage**

**Master thesis Marketing Analytics Spring 2020**

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# Introduction

## Problem Indication

Football is the most popular sport in the world with millions of players across the Globe. According to a study conducted by (FIFA, 2006), the amount of active football players was 265 million (FIFA 2007). In other words, roughly 4 percent of total world population at that time was regularly playing football. The amount of fans is even more staggering, with 3.5 billion people tuning in for the FIFA World Cup Final in 2018 between France and Croatia (FIFA, 2019) for example.

Many of these fans were left without their favourite pastime for a considerable time when the Covid pandemic struck Europe and other parts of the world in March 2020. Due to strict measures and even complete lockdowns in several countries, almost all sports games were cancelled or postponed until further notice. After a few months of lockdown, the Bundesliga was the first major league to restart their competition to finish the remaining quarter of the games. On the 16th of May the Bundesliga recommenced with a packed schedule featuring 6 matches behind closed doors. Other major European leagues such as the Premier League, Serie A and La Liga followed soon and there was even some space in the packed playing calendar to finish the remaining knock-out matches of the Champions League and Europa League. Global social distancing measures following the Covid-19 pandemic introduced the phenomenon “Ghost Matches” in the football world during the restart. So called “Ghost Matches” are football matches without any spectators attending. Without the fans attendance the matches seemed mere training games, which gives rise to the question what sort of influences this could have on the the outcome of matches. Is home advantage still present in games without a crowd? Is referee behaviour different without fans? Do Away teams perform better under the new circumstances? We aim to answer these questions in this paper.

Due to its popularity, an abundant base of research on football and each of its aspects currently exists. The same holds for the possible advantage of the team playing at home, with several papers trying to disentangle the dynamics at play that could lead to home advantage. (e.g. Boyko, Boyko & Boyko ,2007; Pollard & Polla[rd, 2005](https://shapeamerica.tandfonline.com/doi/full/10.1080/02640410601038576?scroll=top&needAccess=true)). Examples of previous research topics include, does the crowd raise home team performance? Or is the performance of away teams significantly lower in hostile environments? (Goumas, 2014) find that home teams on average win more games, collect more points and score more goals than away. However, whether this is a result from deteriorating away performances, better home performance or a combination of both is not clear yet. Another factor involved in home advantage is the referee. A referee has a large influence on the outcome of the games(Boyko, Boyko & Boyko, 2007) Especially in a sport as football which has such a low scoring nature(Decroos, Bransen & Davis, 2019). A decisions to award a team a penalty in the 89th minute of the match with the score of 0-0 could completely change the match outcome. Or an early red card significantly alters the course of the match with both teams adjusting their tactics and strategy. (Neville and Holder, 1999 and Bokyo 2007) find that crowds could influence referee decisions subconsciously in favor of the home team. (Endrich & Gesche, 2020) quantify this in their paper where they find that away teams on average receive 0.3 cards less and home teams 0.5 cards more per match when there are no spectators.

Home advantage seems to be in decline however in general, find that home advantage has declined over time from(Peeters & van Ours, 2021). One of the major factors they prescribe this decline to is the bigger distance between fans and players, with most of the players coming from countries spread around the world, presumably less connected to the local fans who are used to supporting their local heroes. (Pollard 2006; Smith 2003).

Opinions on how and to what extent home advantage is shaped by crowd support are very mixed. In light of the uncertainty in the effect of crowd support, the current extraordinary circumstances thus provide a special occasion to increase our understanding of the relevance of crowd support and its influence on referee behaviour and player performance. Furthermore, the effect of moderating variables on team performance can be directly investigated. Examples of these could include the composition of teams in terms of foreign and local players, which could influence fan behaviour, and in turn influence team performance.

## Research Questions

This natural experiment translates into the following leading research questions:

* + 1. To what extent is referee behaviour shaped by crowd support?
    2. To what extent is home and away team performance significantly different as a consequence of “ghost games”?
    3. To what extent does referee bias influence team performance?

## Research Approach

Providing legitimate answers to the aforementioned research questions requires a combination of theoretical and empirical analysis. Firstly, we examine the current and historical literature to obtain information on the relationship between crowd attendance and team performance. This will serve as our basis on which we can conduct the right analytical approach to analyze our data. Historical data on football matches for the main football leagues is available starting from the year 2000 until the latest season 2020/2021. We decide to include the seasons 2018/19, 2019/20 and 2020/21 into our final analysis, this results in a roughly equal division of ghost games and non ghost games in our data. Furthermore, around 2018, the VAR got introduced in most of the matjor league in Europe, possibly changing our results on referee behaviour significantly.The datasets are automatically updated every week to provide recent and accurate data.

We then combine match data with a data set from Fivethirtyeight to incorporate expected goals as extra measures of performance and home advantage. This data set also contains team strength and match importance which we can include as control variables into the analysis. The data for our moderator variables, team age, amount of foreigners and stadium occupancy are collected manually from Transfermarkt.com. This website provides a vast amount of detailed statistics on players, clubs and leagues. After data collection and construction of the final datasets we first perform an exploratory factor analysis to find the relevant variables for our analysis and to construct latent measures of concepts that are difficult to capture in a single metric, such as referee bias and team performance. We then apply a regression model to the data in order to draw valid conclusions on the existence of home advantage.

## Academic Relevance

The batch of matches without fans provides an unique opportunity to delve deeper in the impact of crowds on football matches since there is an abundance in new data for matches played without crowds. Past papers often required advanced econometric techniques, relying on various assumptions, to be able to discern the extent to which a crowd influences home team advantage. The difficulties in assessing drivers of home advantage lies in confounding variables effects(2008). Which make it unclear how much of home advantage can be attributed to what factors since most of the factors of home advantage are connected to each other. However, in the current situation, suddenly there are substantial amounts of data on “ghost games” which can be used to directly compare matches with and without spectators, which reduces the number of assumptions to be made significantly.

A few papers on home advantage in times of covid-19 have been published already, including the work of (Fischer & Haucap, 2020;Deutscher & Winkelmann, 2020; Endrich & Gesche, 2020). They analyzed the home advantage during the covid-19 pandemic. However,each of these papers focused on German leagues in their analysis. We add to the current research by extending the preliminary research already completed to numerous other football leagues to obtain a comprehensive overview of the evolution of home advantage during the pandemic.

Another contribution of our paper is the extended availability of data with an entire season of games played behind closed doors available after the 2020/21 season. Papers from last year mostly only use data from the 2019/2020 season which was partly played under normal circumstances and partly played behind closed doors. By using the weekly updated datasets with the right timing we can incorporate the entirety of the 2020/21 season into our model.

Furthermore, we contribute to the current body of literature by constructing a comprehensive framework of the influence of crowd support on home advantage by using several mediating and moderating variables to assess how and to which extent crowd support influences home advantage. Additionally, by first performing a factor analysis, we try to use as much data as possible and combine different variables of team performance and referee bias to obtain more meaningful data on these measures. Concepts such as referee bias and team performance are difficult to capture in a single number. We use various aspects of referee decisions such as fouls, yellow cards and red cards. Team performance can be measured in numerous ways. Looking at outcome related variables such as points collected our goals scored can give insight into home advantage, however, secondary performance indicators such as shots, corners and expected goals(measure to compute quality of chances created in a match). We explore whether these multiple variables can be captured into overarching measures of team performance. Removing unnecessary indicators from the analysis.

## Managerial Relevance

Covid affects the footballing world in multiple ways. The absence of crowds plus the extra heavy loaded schedule increase uncertainty surrounding team and individual performance(Metelski & Kornakov, 2021). However, the influence works through on football clubs off the pitch. Team performance heavily influence team results. Team results in turn influence a clubs performance outside of the pitch in several ways. To name 2 examples, better results lead to better stock performance(Samagaio, Couto & Caiado, 2009) and increased market value for players(Müller, Simons & Weinmann, 2017). Similar findings are reported by (Galariotis, Germain & Zopounidis, 2018) and (He, Cachucho & Knobbe, 2015). as they find positive relationships between revenues,position in the league table and individual performance. Therefore, estimating the influence covid-19 has on team performance and football results will help football clubs evaluating the effect of the pandemic on their marketing, financial and on-field performance.

Knowledge on what variables exactly drive home advantage and team performance provides great insight for football clubs in how to optimize their clubs environment and team to improve the chances of performing well. (Fischer & Haucap 2020) for example see preliminary findings of a significant effect of crowd occupancy on home team performance. By comparing home advantage during covid-19 between the German Bundesliga and the 2nd and 3rd level of German football, they find that the home advantage has only changed significantly in the Bundesliga. Whereas in the 2nd Bundesliga and 3rd Liga home advantage did not change significantly during ghost games. They account this difference to the differences in occupancy rates between these competitions. Stadium occupancy can be influenced by managers through several channels. (Wetzel, Hattula, Hammerschmidt & van Heerde, 2018) show for example that football clubs possessing a stronger brand name can leverage this brand name to increase attendance, an effect which increases over time of the existence of the brand. Creating a stronger brand could increase higher attendance rates, higher matchday revenues and better team performance. Other variable that are under control of management and possibly related to team performance differences in home and away matches are the age of the squad players and the composition of the squad in terms of local and foreign players. Prior research conducted by (van de Ven, 2016) signal a small effect of age on team performance, with older teams performing slightly better away than younger teams. We aim to examine whether a football club branding their club to their supporters as an experienced squad with local players can increase the teams performance.

By examining the effect of variables such as crowd occupancy and team composition on home performance, we aim to provide marketeers direct tools to influence the performance of their clubs. Hypothetically speaking, knowing that improving the occupancy rates for their team increases team performance gives the marketing department a significant task in finding ways to attract more fans to the stadium. Perhaps,even a slight decrease in ticket price with the associated lower per customer revenue could actually turn out as a smart investment with better team performance and an upwards positive spiral both on and off the field. We believe the current literature is lacking in this area. Most of the papers available on this topic refrain from applying their findings to managerial recommendations for football clubs. We add to the current body of literature by examining how factors that are to a certain extent under control of management of football clubs could influence home advantage and team performance and thus provide extra tools on how football clubs can improve their on field performance. Which in turn improves off-field performance as well.

## Structure of the Thesis

This first chapter serves as a background chapter for the rest of the thesis in which we outlined the concept to be researched in combination with the academic and managerial relevance of the concept. In the second chapter we construct the theoretical framework that will represent the basis of the empirical analysis in the later sections. First we analyze the current literature to obtain an overview of what is currently known. In chapter 3, having laid out the theoretical framework, we thoroughly describe the data set and the variables we use to define the concepts that we want to analyze. Furthermore, based on our variable selection and data structure, we select the most suitable method of analysis to attain the desired results and answers to our research questions. In the fourth chapter we summarize the analysis and findings of the research in order to answer the empirical questions. Furthermore, we extend our model with several robustness checks to ensure that our findings are actually meaningful and not a result of flaws in our methodology or reasoning. Finally, in the fifth chapter, we generate conclusions and recommendations based on the findings of the study. We use this chapter to provide football club management with deeper insights into the drivers of their team performance at home, and how these can be influenced by management. Additionally, we discuss the limitations of this study and provide a guideline for possible future research in this area to improve our understanding of home advantage even further.

## Theoretical Background

## Literature Review

## 2.1.1 The role of home advantage in sports

Home advantage has been widely studied in sports literature. One of the first to formally document the existence of a certain home advantage in sports were (Schwartz & Barsky, 1977). They find that home advantage exists in varying degrees across different sports. Furthermore in their research they suggest that the major contributor to home advantage is social support, opposed to familiarity and fatigue for away teams. (Nevill & Holder, 1999) support this claim as they produce similar results in their analysis of home advantage in English and Scottish football matches. In a related study, (Carron & Agnew, 1994) examine crowd effects specifically to provide an overview of how crowds influence match outcomes. One of their main findings is a significant positive relationship between home advantage and crowd density. In other words, more crowd support leads to a stronger home performance relative to away performance and consequently a higher chance of a home win than an away win.

One of the landmark studies in the area of home advantage in sports is the research conducted by (Courneya & Carron, 1992). In their paper they provide a comprehensive literature review on home advantage in sports, their framework has been used extensively in subsequent studies. Their framework on home advantage revolves around location factors that influence players, coaches and officials(referee) psychologically. Correspondingly behaviour of players, coaches and officials is influenced by their psychological state, the change in behaviour in turn alters the performance of players, coaches and referees. The four main factors behind home advantage in their framework are crowd factors, learning(familiarity) factors, travel factors and rule factors(specific rules that favor home team in some sports). (Carron & Hausenblas, 1997) apply this framework to assess the occurrence of home advantage. They claim that home advantage is relatively stable across time and is generalizable across team/individual sports, gender and professional and amateur sports.

Despite the increased complexity of models and data used, (Carron, Longhead & Bray, 2005) find that the framework is still relevant in the evolving situation, assessing that the framework still serves as bases for a majority of the research conducted on home advantage in sports.

## 2.1.2 Causal factors of team performance in football

(Pollard, 2008) provides an excellent overview of the consensus of home advantage in football. Similar to the work of (Courneya & Carron, 1992) he drafts a framework of the major factors of which home advantages in football sterns from. Some of the more interesting findings according to his review include those of (Naeve & Wolfson, 2003 & 2004) as well as (Anderson, Neave & Wolfsson, 2007) who find hormonal differences between home and away team players in match build up, with higher levels of testosterone for players when playhing a home match versus playing an a way match. Similarly to hormonal reaction when defending territory. This hormonal change could then be attributed to increased performance on the pitch for the home team. (Pollard, 2006; Pollard & Seckin, 2007) further scrutinize the sense of territoriality and its effect on home and away performance and find indeed evidence of a possible influence on home advantage.

Another widely recognized possible component of home advantage us familiarity. Familiarity with specific home turf conditions such as altitude(Mc Sharry, 2007) and climate (Pollard, Da Silva & Nisio, 2008; Pollard & Seckin, 2007)could play a role in improved home team performance. In a similar fashion, artificial pitches seem to play a role in home advantage(Barnett & Hidditch, 1993).

The findings on the significance of travelling for home advantage are more ambiguous. (Pollard, da Silva & Nísio, 2008 ) find that travel distance seem to play a role albeit a minor one in conceiving of home advantage. Especially since their research is focusing on Brazil, where distances between teams can be very large. Distances that would impossibly exist in European countries. This is similar to what (Nevill&Holder) found in their research, where they found that distance only mattered when distance traveled was of such magnitude that different time zones would be crossed. (Goddard, 2006; Clarke & Norman, 1995) however, do seem to find a significant effect for travel distance on away team performance even with reasonably small distances between 0-200 miles.

One of the factors that the literature seems to have reached consensus on is the role of referee bias in home advantage. According to (Nevill, Balmer & Williams, 1999 ; Nevill, Balmer & Williams, 2002; Garicano, Palacios-Huerta & Prendergast, 2005) there exists consistently find evidence of a referee bias in favour of the home team probably due to social pressure from the crowd. In more recent research. (Endrich & Gesche, 2020) find that referees give less cards to home teams and more cards to away teams on average, which could be interpreted as a sign of referee bias in favour of the home side. However the exact source of this referee bias remains somewhat unclear. Research like ours on the incidence of referee bias in ghost games settings could provide useful in discerning whether or not crowd support plays a major role in referee decision making.

A final factor considered in the literature are tactical approaches to football matches as a driver of home advantage. There seems to be a difference in tactical approach between away and home teams according to (Pollard 1986; Pollard 2006). For instance a more cautious approach from the away side might induce dynamics such as the aforementioned territorial factors influencing home and away performance. However, evidence on the significance of tactical approaches in determining home advantage is not conclusive. (Carmichael & Thomas, 2005; Tucker, Mellalieu, James & Taylor,2005) and should therefore be examined further.

Somewhere where the literature appears to agree on is the difficulty of disentangling each of the various forces driving home advantage. Pollard(2008) cites that struggles concerning the unraveling of individual factors effect on home advantage sterns from the phenomenon that multiple psychological and physiological influences involved all interact with each other and possibly reinforce each others significance. For exactly this reason do “ghost games” provide such an unique opportunity to specifically study changes in home advantage under ghost games in order to disentangle crowd effects from other drivers of home advantage.

## 2.1.3 First insights covid-19 and home advantage

A few preliminary studies attempted to investigate the influence of crowd absence on home advantage by analyzing “ghost games” played in the German leagues after the restart of the season 2019-2020. For example (Thilp & Taller, 2020) find that home advantage has actually turned into a home disadvantage in case of “ghost games”. (Fischer & Haucap, 2020) also find that there seems to be a significant alteration in the strength of home advantage in the Bundesliga when crowd support is nonexistent. However, the German 2nd and 3rd leagues seem to be less affected by “ghost games” according to their analysis, due to lower occupancy rates on average in the lower tier leagues compared to the Bundesliga.

Early evidence thus seems to point to a significant drop in home advantage for teams without crowd support to back them in home games. And that the effect of crowd support is especially dependent on occupancy rates within a stadium, rather than absolute number of supporters. This makes sense as a large stadium only filled one thirdly seems less a motivating atmosphere than a small compact stadium completely filled with supporters close on the pitch.

In the following section, we will focus on the variables involved in crowd support, relevant for our analysis.

## Theoretic Framework

## 2.2.1 The impact of crowd absence on team performance

A home crowd can be a positive stimulus for home team players and can create an intimidating and hostile environment for the opposition (Ponzo & Scoppa, 2018). Every football fan will know about the famous European nights at Anfield where teams regarded superior in terms of quality found their Waterloo against an inspired Liverpool side backed by the roar of the crowd. Similarly in Belgium teams often loathe the away game against Standard Liege because of the extremely passionate home fans creating a very aggressive atmosphere. These sentiments in football are confirmed by (Carmichael & Thomas, 2005), who find that home advantage is significantly higher in compressed and intense atmospheres compared to more open and wide areas where crowds might be more distant from the pitch. For example an athletic track around stadiums might decrease the effect of supporters on team performance. Additionally, (Carron & Agnew, 1994) report a positive relationship between crowd density and home performance. In a situation of “ghost games”, crowd density will of course be 0. Additionally(Tilp & Thaller, 2020) hypothesize that awareness of the absence of crowd support could boost away team morale and increase confidence in retrieving a result. This could as outlined before by(Pollard 1986; Pollard 2006) alter tactical approaches and mentality of both home and away teams. Therefore, based on previous findings of similar studies, we expect home performance to suffer significantly in the new situation of “ghost games” and as a result we predict a sizeable drop in the probability of a home win, all other things being equal.

This leads us to generate the following hypothesis regarding the effect of crowd absence on home advantage.

*H1: Home Team Performance is negatively influenced by the absence of supporters, while the Away Team Performance is positively influenced by Away teams. The gaps in performance between Home and Away teams will become smaller in games played behind closed doors.*

The degree to which Crowd support will influence team performance will vary per team. Some teams always play well away from home while having difficulties at home. An example is Ajax in European competitions over the last few seasons, being unbeaten away from home for nearly 2 years while playing formidable sides, but barely beating any side in their own Johan-Cruijff Arena. Sources of these difference between could stern from tactics, playing style and playing mentality. However, also team composition seems to play a role. (van de Ven, 2016) finds that experienced sides with older players tend to perform better away from home than inexperienced sides. Possible reasons could include familiarity with the away venue and more experience with hostile crowds. As mentioned before in section 2.2, familiarity effects are considered to be one of the sources for home advantage(Pollard, 2008) Where certain key stadium attributes could help players locate themselves more precisely on the pitch and consequently make better decision on where and how hard to pass the ball or where to position themselves to get the bests hot on goal. Older players who have more experience, especially when that experience is within the same league will be more familiar with venues and could have similar advantages as home team players in visual cues when playing away. Another reason for increased away performance for older teams could be more experience with home crowds means less influenced by that same home crowd for example by developing coping strategies (Russell, 1983). This leads to the following hypothesis of the effect of age on the relationship between crowd support and team performance.

*H1b: Age negatively influences the impact of crowd support on team performance*

Another part of team composition is the share of foreign players within the squad. The manifestation of the Bosman rule in 1995, guaranteeing a free transfer for players who are out of contract had an immense impact on players relationships with clubs. Players more than ever are able to easily switch between clubs, dramatically decreasing the average tenure for football players at their clubs. Additionally, in the increasing globalized world, international transfers are increasingly common, leading to an influx of foreign players into squads of football clubs. (Adcroft, Teckman & Madichie, 2009) Foreign players who grew up in perhaps a completely different culture might have less sentiment with their employer and have less loyalty compared to a local boy who supports his boyhood club. This could imply that they might be less invested in the club and will have less incentive to give their all for their team, since they would switch to the other side easily if a better offer would come by. (Tilp&Taller, 2020*.)* cite increased global outlook of football clubs, both for recruiting fans and players, has lead to an increased gap between fans and players. Fans and players due to the increased differences in pay and origins live in completely different realities from each other. Fans do not recognize themselves in the extremely rich and foreign players who play for their local team, and the rich and foreign players would often happily switch clubs if a more attractive option comes by. We therefore hypothesize that teams with high shares of foreign players will have less difference in performance between home and away games, both to a lesser innate bond with the club and the decreased support of fans for the clubs they don’t recognize anymore. This leads to the following hypothesis.

*H1c: The share of foreigners negatively influences the impact of crowd support on team performance.*

Fischer & Haucap (2020) find that crowd occupancy differences where the main drivers of differing levels of home advantage post corona, with teams that are used to lower occupancy rates will be less influenced by the introduction of matches played in empty stadiums. If you play for 30.000 fans in a stadium where 100.000 fit, the atmosphere seems to be less intense and the stadium can appear to be almost empty. The switch to a completely empty stadium in this case might be less severe than a case where 15.000 very fanatic fans completely fill up a small stadium with stands close to the pitch and a fiery atmosphere. A completely empty stadium all of a sudden makes a very big change, even though the absolute decrease in supporters is lower compared to the first situation. Therefore we hypothesize the following.

*H1d: Stadium Occupancy will positively reinforce the effect of crowd support on team performance.*

## 2.2.2 The impact of crowd absence on referee bias

Previous studies found evidence that referee bias could be lower in matches without the influence of the home crowd. ((Endrich & Gesche, 2020; Nevill, Balmer & Williams, 2002; )Referees can be heavily influenced in their decision making by the heavy cheering of the crowd favoring the home team.(Unkelbach & Memmert , 2010). In similar fashion,(Neville & Holder, 1999; Bokyo, 2007) in their paper pose that crowds compel referee’s such that their decisions subconsciously favor the home team. (Endrich & Gesche, 2020) find that referees give more penalties to home teams, and more red and yellow cards to away teams. Therefore, in the case of “ghost games” we Again expect that referees will be less subject to social pressure of the crowd and consequently, less biased in decision making. This could benefit away teams in their chase to seize a result away from home. This leads to the following hypothesis on the effect of the absence of crowds on referee performance.

*H2: Crowd absence will positively influence referee decisions in favour of away teams, leading to a smaller or even negative gap in fouls, red cards and yellow cards between away and home teams.*

Similarly to the expected moderating effect of crowd occupancy on the direct relationship between crowd support and team performance, we expect crowd occupancy to influence the relationship between crowd support and referee bias. (Nevill, Balmer & Williams, 2002) demonstrated in an experimental setting the significant effect of crowd noise on referee decision making. Referees are more uncertain in their decisions when crowd noise is present compared to situation where there is silence only. Often more favoring the home team in a situation with crowd noise by being more lenient in fouls . Therefore we expect that a higher occupancy with more crowd noise will result in a stronger referee bias towards the home team.

*H2b: Crowd occupancy will influence the effect of crowd support on referee decisions We expect that the effect of crowd absence on referee bias for home teams is more pronounced for teams with a higher occupancy.*

In football, much more compared to other sports, one action can decide the entire game. A1-0 win with a single shot on goal is certainly attainable.Additionally, a red card can change a teams entire game plan, tactics and performance. Since individual moments can have such a big impact on outcome and performance in football, referees play a major role in football outcomes. Crucial decisions such as a controversial penalty or red card can significantly alter the course of a football game, and if the home team gets benefit of the doubt it could significantly increase the chances of home teams winning their games. Unkelbach & Memmert , 2010). (Sutter & Kocher, 2004; Garicano, Palacios-Huerta & Prendergast, 2005) suggest that referees tend to award more extra time at the end of the first and second half if the home team is behind. The infamous “Fergie time” illustrates this perfectly. During the tenure of Sir Alex Ferguson at the helm of Manchester United, his side often received longer extra time in home matches, which more than once led to a late escape for the home side.

*H3: Referee decisions significantly influence team performance, we expect that in a situation of ghost games, the effect of referee bias will be less pronounced, and thus will have less influence on team performance compared to pre-covid*

Of course there is a vast array of other variables that influence team performance. The most obvious being team quality, with better teams being able to perform at higher levels and produce better football. (Lago-Peñas & Lago-Ballesteros,2011)To ensure that team quality differences do not influence our model estimates, we incorporate the SPI metric for team strength into our model.This controls for the effect of team quality on team performance. The SPI metric also conveniently incorporates recent form into its calculation. Recent form can be a significant predictor of team performance, a slump of bad recent results can loom heavy on a teams morale and confidence(Magen, 1980). Which in turn could alter their performance as well as team strategies and tactics deployed within the field significantly. Finally, SPI supplies prior probabilities of winning, drawing and losing for each teams upcoming match based on the strength measures of both teams involved. Incorporating this prior probability, which has proven to be very accurate in predicting match outcomes in the past could serve as a very powerful extra control variable in our model.

Table 1 provides a schematic overview of the contribution of our study to the current body of literature in this area.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table 1 | Natural experiment covid-19 | Composite measure of Referee  Bias | Composite measures performance | Crowd Occupancy | Country aggregate | Team Age | Share of Foreigners |
| Boyko, Boyko, & Boyko, (2007) | 🗶 | 🗶 | 🗶 | ✓ | 🗶 | 🗶 | 🗶 |
| Pollard(2008) | 🗶 | 🗶 | 🗶 | 🗶 | ✓ | 🗶 | 🗶 |
| Schwartz & Barsky, 1977) | 🗶 | 🗶 | 🗶 | ✓ | ✓ | 🗶 | 🗶 |
| (Courneya & Carron, 1992). | 🗶 | 🗶 | 🗶 | 🗶 | ✓ | 🗶 | 🗶 |
| Inan, T. (2020) | ✓ | 🗶 | 🗶 | ✓ | ✓ | 🗶 | 🗶 |
| Nevill&Holder(1999) | ✓ | 🗶 | 🗶 | 🗶 | 🗶 | 🗶 | 🗶 |
| Pollard(2006) | 🗶 | 🗶 | 🗶 | 🗶 | ✓ | 🗶 | 🗶 |
| Tilp&Thaller (2020) | ✓ | 🗶 | 🗶 | 🗶 | 🗶 | 🗶 | 🗶 |
| Fischer & Haucap, (2020) | ✓ | 🗶 | 🗶 | ✓ | 🗶 | 🗶 | 🗶 |
| Mccarick et al(2020) | ✓ | 🗶 | ✓ | ✓ | ✓ | 🗶 | 🗶 |
| Endrich& Gesche, (2020). | ✓ | 🗶 | 🗶 | ✓ | 🗶 | 🗶 | 🗶 |
| This study | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## Conceptual Model

Table 2 shows the conceptual model we establish based on the current literature and hypotheses. This conceptual model will be used in later stages to build the correct model to analyze the data.

Table 2

Referee Bias

Crowd Support

Team Performance

Occupancy rate

Local vs foreign players

Player Age

## Data and Methodology

## Data collection

The website: <http://www.football-data.co.uk/data.php> has weekly updated datasets for all the important leagues around the world. The datasets include statistics on full-time and half-time results, amount of shots and shots on targets of both home and away teams as well as the number of yellow and red cards and corners for each team. For each of the major leagues in the worlds exists historical data available up to the season 1994/1995. All the datasets are split per season, per country and per league level in countries with multiple tiers. Our sample includes all the matches played from season 2018/19 onwards, since the VAR(…) got introduced around this time. Var has major implications for referee decision making, and especially in the realm of crowd supports influence on decision making by referees. For big decisions such as red-cards, the referee can be overruled by the video referee, often located outside of the stadium, and thus less influenced by crowd noise. We decided to analyze the 9 of the top 10 leagues in Europe, other leagues were limited in data availability and data convenience. The 9 leagues incorporated are the following: Dutch Eredivisie, German Bundesliga, Portuguese Primeira Liga, The Turkish Super Lig, Belgian Jupiler League, French Ligue 1, English Premier League, Spanish Primera Division.

For data on our 3 moderators: team age, proportion of foreigners playing for the team and crowd occupancy, we consulted the website of transfermarkt.com. This website provides a multitude of interesting statistics on numerous aspects of football, they provide data on player level, club level and league level. We manually collect the following variables: Firstly we take the average age of the players used by the team within the season to serve as a proxy for the age of players. Secondly, we use the share of minutes played by foreigners measurement for the extent of foreign influence within squads. Crowd occupancy data is gathered by using the average occupancy of each team over the course of the season. We aggregate our seasonal proxies for team age, foreigner share and occupancy rates into a large final data set for all games played in each of the 3 seasons by merging all the games based on team name. The datasets per season can then be bound into a single data set.

The most comprehensive index of team strength as far as we know is the SPI index used by : project538. Their SPI index is constructed by computing an offensive rating in the form of the number of goals expected to score against an average opponent on neutral terrain. This offensive rating is the combined with a defensive rating, the number of goals expected to concede by the team against an average opponent on neutral ground. The SPI is then the percentage of points that the team will take if the match against an average team on neutral ground is played. Such that the SPI takes a value of 90 when the defensive and offensive strength of the team is such that it would win in 90 percent of the matches against an average team. SPI’s github repository provides weekly updated data set on historical matches with SPI data, which can be merged with our previously constructed data set with historical match outcomes and team specific data. The Spi data set contains loads of information on match outcomes from virtually any league in the world. Measures of Expected goals, team strengths, prior winning probabilities and match importance. We first filtered the SPI data set by date to only include matches from 2018/19 onwards. Afterwards, by filtering for league names, we obtained a trimmed data set with only matches played in our 9 leagues of interest. After cleaning differing team names across the datasets, we merged the SPI data set and Match result data set to obtain a total sample of 8137 matches played between the beginning of the season 2018/19 and now.

## Variable operationalization

**SPI:** this variable is calculated by … and … and is an advanced metric of team strength of both the home and away teams. The metric incorporates recent results and the strength of the teams played previously. It therefore is also a measure of recent form, with a string of bad results against lesser rated teams lowering the rating of a team possibly.

**Age difference:**  this variable captures the differences in age between the home and away team, where a positive value implies the home team have an older squad on average than the away team, and a negative value implies the away team have older squad players.

**Importance of match:** This variable is calculated by … and …. and represents the importance of the match outcome on the league developments for both teams their perspective. There are 2 values, one value for the away team and one value for the home team

**Covid:** a dummy variable that indicates whether or not the game was played before or after the start of the covid-19 pandemic. A value of 1 represents matches that are played behind closed doors, with no spectators attending, whereas a 0 implies fans were present with no limits on number of spectators allowed to watch the match.

**Crowd occupancy:** The ratio of the number of attendants to the number of seats in the stadium. Due to data collection and computation limits, the crowd occupancy is calculated as the total number of attendants within a league divided by the average capacity for all teams in the league. For example a league where the clubs on average have a stadium capacity of 50.000 with 4.000.000 fans in total visiting 200 matches means an average attendance of ((4000000/200))/50.000 = 0.4.

**Expected goals:** Expected goals are measured as the expected goals that would have been made from a teams chances within a match, based on average player and average situation. It is a sum of the quality of chances created by a team. A shot for open goal with no opponent player in tackling distance has a very high xg chance since it will be converted into a goal almost all the time. A 40 yard shot that gets deflected by a defender on the way and flies in with luck has a low xg value, as such shots have a low probability of producing a goal. Expected goals metric thus takes out luck out of the performance of a team and can be seen as a good metric of match performance and match outcomes.

**Spread in fouls:** The number of fouls committed by the home team - the number of fouls committed by the away team. A positive number means the home team has committed more fouls than the away team in the specific match, and a negative number implies the away team committed more fouls. 0 implies an equal number of fouls for both teams. Based on a non biased referee and controlling for team dominance and team quality we expect the number of fouls for home and away teams to not be significantly different from each other.

**Spread in yellow cards :** The number of yellow cards for the home team - the number of yellow cards for the away team. A negative number can be interpreted as the away team receiving more yellow cards than the home team. A positive number means the number of yellow cards received by the home team exceeds those of the away team. 0 implies an equal number of yellow cards for home and away team. This could be 0 for both but also 1 or 2 or more for each side.

**Goals:** This variable denotes the number of goals scored by teams int he particular match.

**Percentage Points :** Home or away points as a fraction of total points obtained in the game. For Home teams calculating average points won at home divided by total points won. A value above 50 percent implies a home advantage as more points are collected on average at home than Away.

**Probability:** This measures the probability of each team to win the match, based on the team strength and match importance.

Table 3 variable operationalization

|  |  |  |
| --- | --- | --- |
| **Variable** | **Type** | **Explanation** |
| Covid | Nominal | 1 = during covid pandemic, 0 = before |
| Yellow card spread | Interval | 0 = equal number of yellow cars for home and away |
| Foul Spread | Interval | 0 = equal number of Fouls committed both teams |
| Percentage of points | Ratio | 0 = no points 1 = only home wins |
| Expected goals | Ratio | 0 = no chances created |
| Goals | Interval | 0 = no goals 1 = 1 goal etc. |
| Proportion Foreigners | Ratio | 0 = 0 percent 1 = 100 percent |
| Age difference | Ratio | 0 = no age difference |
| Occupancy rate | Ratio | 1 = sold out stadium, 0 = no spectators |
| SPI | Ratio | 0 = no strength , 100 = strongest possible |
| Importance | Ratio | 0 = non important 100 = extremely important |
| Probability | Ratio | 0 = no chance of win 1 = 100 percent change |

## Methods of analysis

We use a Latent moderated structural equation approach to assess the relationships between our variables within our model. Structural equation models consist of two main components, a structural component, where the relationships between variables can be examined. Like in our case the relationship between crowd support, referee bias and team performance. The measurement part exists to measure latent structures in the data, these latent structures are able to capture complex variable and measures, which would be hard to define to a single variable or metric. The measurement component is usually conducted through a confirmatory or exploratory factor analysis.

Game outcomes are not the only measure of team performance we look at. Soccer is a low scoring game in a sense that a single goal or single action can decide the entire outcome of a match. Luck with a team their only shot deflected in the goal and the opponent missing big chances can mean an outcome not congruent with how the match developed. To delve deeper into we use several metrics to quantify team performance on a deeper level than purely outcome based. Examples could be Expected Goals, a number that symbolizes the amount of goals normally would have been scored based on the amount and the quality of chances created by the team, thus removing luck and misfortune out of the analysis.

To analyze the role of referee bias on team performance we first need to examine whether crowd support is a significant predictor of referee bias. Our construct of referee bias is a factor score for multiple metrics of referee decision making, such as number of fouls and number of yellow and red cards. We also deem the spread(difference) between number of fouls, yellow cards and red cards between the home and away team to be relevant. Such that this spread would expected to be 0 when controlling for factors such as team strength but if a referee has a certain bias towards teams this number could be positive or negative, where a positive(negative) number implies a referee on average gives more(less) fouls;yellow or red cards to the home team. Indicating a bias against(in favour) of the home team. We believe that the factor analysis of several measures of referee decisions would be a valid strategy to integrate a latent construct of referee bias into our model.

Following our factor analysis, the measurement part of our model is structural we proceed with our regression model to examine the relationship between our dependent and independent variables. Since our model comprises of both moderating and mediating variables, a moderated mediation model is required to correctly analyze the effects of the various independent variables on our dependent variable team performance. Multiple models to measure moderated mediation exist currently. Examples include Path Analysis, Product Indicator analysis and Latent moderated Structural Equations. (Feng, Song, Zhangh, Zheng and Pan, 2020) find that Latent moderated Structural Equations outperforms Path Analysis and Product Indicator analysis in all settings studied. Therefore, we will proceed with a Latent moderated Structural Equations model to estimate our model.

## Descriptive statistics

Table 4 provides the descriptive statistics for the variables mentioned in section …

The data set contains match data for 8137 matches played in the 9 major leagues of Europe. The Ligue 1, Premier League, Primera Division, Turkcell Super Lig, Eredivisie, Serie A, Primeira Liga, Bundesliga and Jupiler Pro League. On average in the last 3 seasons, home teams won 56 percents of total points won by all teams. Similarly, the number of home points on average is 1.557 points per game collected on home, while the average number of away points equals 1.192. 2996 of the matches have been played behind closed doors and 5141 were played with spectators present.

Table 4

Descriptive Statistics

=====================================================================================

Statistic N Mean St. Dev. Min Pctl(25) Pctl(75) Max

-------------------------------------------------------------------------------------

FTHG 8,137 1.542 1.303 0 1 2 10

FTAG 8,137 1.250 1.179 0 0 2 13

occupancy 8,137 0.525 0.360 0.000 0.162 0.831 1.283

spi1 8,137 60.012 16.006 21.450 47.000 71.430 95.750

spi2 8,137 59.912 15.994 21.150 46.780 71.250 95.470

prob1 8,137 0.454 0.181 0.028 0.342 0.553 0.968

prob2 8,137 0.304 0.164 0.004 0.198 0.388 0.899

probtie 8,137 0.242 0.049 0.026 0.223 0.274 0.355

importance1 8,054 33.614 24.951 0.000 13.325 48.900 100.000

importance2 8,054 32.519 24.641 0.000 12.600 48.000 100.000

xg1 5,999 1.528 0.884 0.000 0.875 2.020 7.070

xg2 5,999 1.272 0.803 0.000 0.670 1.720 8.270

yel\_card\_spread 8,137 -0.185 1.747 -7 -1 1 7

age\_diff 8,137 0.0001 1.573 -5.000 -1.100 1.100 5.000

home\_win 8,137 0.436 0.496 0 0 1 1

away\_win 8,137 0.314 0.464 0 0 1 1

draw 8,137 0.251 0.433 0 0 1 1

home\_points 8,137 1.557 1.321 0 0 3 3

away\_points 8,137 1.192 1.286 0 0 3 3

home\_points\_percentage\_total 8,137 0.561 0.429 0 0 1 1

away\_points\_percentage\_total 8,137 0.439 0.429 0 0 1 1

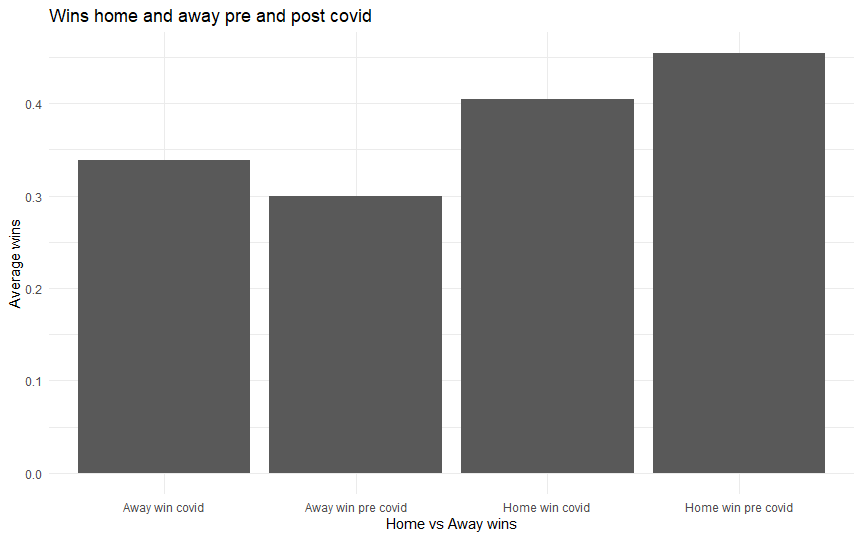
foul\_spread 8,135 -0.107 5.243 -24.000 -4.000 3.000 18.000

foreigners\_spread 8,137 -0.0001 0.213 -0.752 -0.139 0.139 0.752

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Table 4

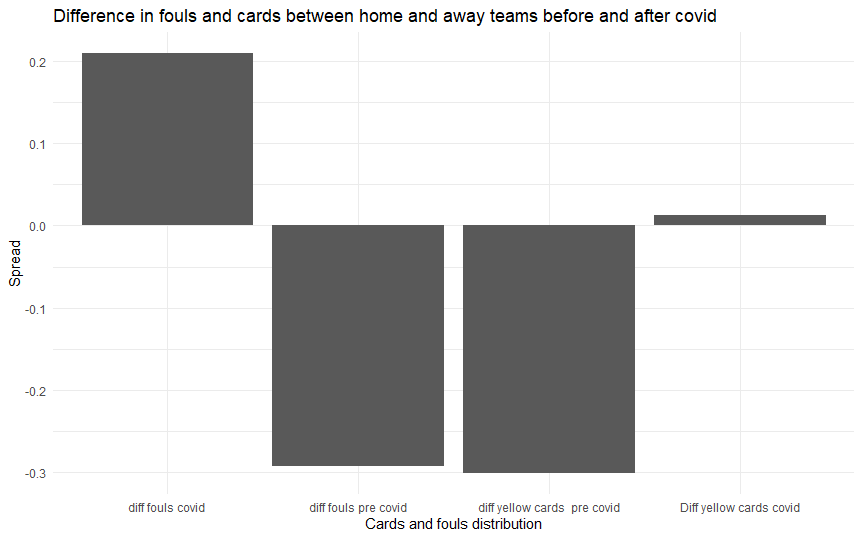


As we can observe from table 4, corona has impacted the performance of home and away teams. The percentage of wins at home has declined 5 percent from 45 percent pre covid to 40 percent post covid. Whereas the percentage away wins have rose from 30 to 34 percent. Also number of goals and points for home teams declined substantially. Number of goals scored per match on average by the home team stood at 1.58 pre-covid, whereas post-covid the average goals scored per match has fallen to 1.46 for home teams. Similarly for points, home teams collected 1.61 points per game on average when backed by their crowd, however, in the case of empty stadiums, this number has fallen to 1.47.

Away teams fare better in games behind closed doors compared to games with fans. Before the lockdown, away teams on average collected 1.14 points per game, scoring an average of 1.22 goals per game in the process. Since the lockdown, away teams have increased their points per game to 1.27, also increasing the amount of goals scored on average by 0.07 to 1.29 goals per game. There seems to be initial evidence of a decrease in home advantage following the exclusion of home fans.

Exploration of the data set seems to point at referees’ decision being influenced by the exclusion of supporters at football games in times of covid-19. Before the lockdown, referees would give on average 1.96 cards and 12.86 fouls against home teams per game , while giving 2.26 yellow cards and13.16 fouls against away teams. These numbers have changed to 12.92 and 1.98 respectively for away teams, where the amount of fouls given against the home team rose by 0.27 to 13.13 and the number of yellow cards rose by 0.03 to 1.99 yellow cards per game. This is also visible in the difference in yellow cards spread and foul spread. the difference between home and away teams is reduced. Where first referees gave more yellow cards and fouls to away team on average, after the lockdown this pattern reversed and referee gave more fouls and yellow cards to the Home team than to the away team.

Table 5



## Regression Equation

As mentioned in section 3.3, we deem a combination of exploratory factor analysis and regression analysis as most suitable method for analysis of our data set. We apply the Latent Moderated structural equations model to our framework to obtain the best estimates of coefficients. Including factor scores into a linear regression can introduce bias. Therefore, we decided to pursue a structured equation modeling approach. For our Latent moderated equation we estimate the following regression equation for our direct path. Modeling the relationship between crowd support and team performance. We test whether difference in crowd support had a significant effect on team performance, checking for the effects of our 3 moderators: occupancy, foreigners in squad and team age. Furthermore we add the control variables for league fixed effects, SPI team strength and form , match importance and the prior probabilities.

**Equation 1:** team\_performance= β0 + β1COVID-19+ β2SPI + β3foreigners\_used\*COVID-19 + β4team\_age\*COVID-19 + β5prob +β6league\_fixed\_effects + β7occupancy \* COVID-19 + β8importance

Our second equation involves the path between our independent variable crowd support and our mediating variable, referee bias. We examine the moderating effect of Occupancy on the relationship between crowd support and referee bias. Furthermore, we control for team quality, league fixed effects, prior probabilities and match importance.

**Equation 2:** referee\_bias: β0 + β1COVID-19 + β2SPI + β3COVID-19 \* Occupancy + β4league\_fixed\_effects + β5prob + β6importance

Our final step is to incorporate the mediator referee bias in the modelling of the relationship between our independent variable crowd support and dependent variable team performance, to investigate whether the effect of crowd support is different when referee bias is added into the model.

**Equation 3:** team\_performance= β0 + β1COVID-19+ β2SPI + β3foreigners\_used\*COVID-19 + β4team\_age\*COVID-19 + β5prob +β6league\_fixed\_effects + β7occupancy \* COVID-19 + β8importance + β9referee bias

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