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TEAM PERFORMANCE AND AUDIENCE: EXPERIMENTAL EVIDENCE FROM THE FOOTBALL SECTOR

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JEL Classification: J2, D8, M54

Keywords: team performance, home advantage, choking, lockdown, natural experiment

Team performance and audience: experimental evidence from the football sector[1]

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Abstract

We exploit the natural experimental setting provided by the Covid-19 lockdown to analyse how performance is affected by a friendly audience. Specifically, we use data on all football matches in the top-level competitions across France, Germany, Italy, Spain, and the United Kingdom over the 2019/2020 season. We compare the difference between the number of points gained by teams playing at home and teams competing away before the Covid-19 outbreak, when supporters could attend any match, with the same difference after the lockdown, when all matches took place behind closed doors. We find that the performance of the home team is halved when stadiums are empty, with this effect being more marked for teams whose attendance rate was very high and for those that do not have international experience. Taken together, these results may play a key role in the design of the future workplace as 'smart working'—an organisational model where the perception of being observed is less pronounced—is becoming increasingly important.

Keywords: team performance, home advantage, choking, lockdown, natural experiment

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1. Introduction

To control the reproduction rate of Covid-19 and tame it to below one, countries have announced measures that restrict the movements of individuals and impose social distancing. Following these strategies, a new organisational model of work known as 'smart working' is becoming increasingly important. Along these lines, workers are allowed to work outside their workplace, with a flexible time schedule, and with fewer interactions (at least physically) with other colleagues and supervisors, thereby reducing the level of pressure and stress (Angelici and Profeta, 2020).

While such a new model unequivocally calls for the creation of new jobs (Dingel and Neiman, 2020), it also poses the key question of whether the performance of workers will be affected. In this respect, knowledge about how professionals perform under pressure conditions is highly relevant not only for the design of incentives schemes but also—and primarily—for the design of the future workplace. This is the issue this paper explores. More specifically, the objective of this paper is to understand whether the performance of workers who feel they are being fully observed is different compared to when they do not feel observed. This is achieved by exploiting a randomized natural experiment in football competitions. In general, professional sports provide an excellent opportunity to study how performance is influenced by an audience (Böheim et al., 2020) as they allow overcoming two typical limitations of the real-life setting: *(i)* complexity and *(ii)* ambiguity and unobservability of outcomes (Apesteguia and Palacios-Huerta, 2010; Harb-Wu and Krumer, 2019).

There are many examples of professions in which individuals have to perform in front of an audience, and it is quite intuitive to believe that performing in front of a supportive crowd increases motivation as succeeding in front of a familiar group of people may be more satisfying and thus enhance performance (De Varo, 2006). Economists and social scientists call this phenomenon the *home advantage*, that is, borrowing from Courneya and Carron (1991), the tendency for home teams in (sport) competitions to win more than half of games played under a balanced home and away scheduled.[4]

[4] Home advantage has been observed in countless sports: hockey (Agnew and Carron, 1994; Bray, 1999; Pace and Carron, 1992), soccer (Clarke and Norman, 1995; Nevill et al., 1996; Pollard and Gomez, 2009), basketball (Harville and Smith, 1994; Jones, 2007), baseball (Courneya and Carron, 1992), and skeleton (Chun and Park, 2020).

Nevertheless, while an audience might increase a performer's will to succeed, on the other hand, the fear of not meeting expectations might become dominant. In this case, it is likely that the higher level of pressure induced by a friendly audience is associated with low performance, leading to the so-called 'choking under pressure' effect (Baumeister, 1984). Psychological research has shown, indeed, that increased motivation beyond an optimal level may harm performance. This is well-represented by the Yerkes–Dodson law, which describes the relationship between pressure and performance as an inverted U shape: performance increases with physiological or mental arousal, but only up to a point, after which—when levels of arousal become too high—performance decreases (Yerkes and Dodson, 1908). In practice, individuals are said to have choked when their performance under high pressure is inferior to their performance under low pressure, and pressure conditions are found to be higher in front of supportive than unsupportive audiences. As a result, the outcome observed when performing at home could be negatively influenced by the presence of a friendly audience (Wallace at al., 2005).

The empirical literature has then developed, documenting the presence of the choking under pressure effect. Harb-Wu and Krumer (2019) and Hickman and Metz (2015) find evidence of athletes choking in home competitions in the presence of a supportive crowd in biathlon and golf events, respectively. In a similar vein, Cohen-Zada et al. (2017) and Paserman (2010) show that professional tennis players choke more at the most important junctures of a match. Choking under pressure has been also detected in basketball competitions. Along these lines, Böheim at al., (2018), Cao et al. (2011), and Toma (2017) analyse performance under pressure through the success of free throws in top-level professional basketball, finding a sizeable and strong negative choking effect. Likewise, Epting et al. (2011) suggest that undergraduate basketball players, who play without the financial incentives of professional players, perform differently in free throwing when exposed to supportive, discouraging, or neutral audiences. As for football, the evidence is mixed. On the one hand, Dohmen (2008) shows that professional football players are more likely to choke on a penalty kick when the match takes place on the home turf. On the other hand, Braga and Guillén (2012), by relying on data from the Brazilian Soccer Championships in 2006, find no effect of pressure on performance.

Although these studies, despite mainly being suggestive and primarily focusing on a single event and/or country, shed light on the presence of either home advantage or the choking under pressure effect, evidence of a causal relationship in real tournament settings is very

scarce.[5] As stated by Harb-Wu and Krumer (2019), 'in general, studying the effect of competing in front of a supportive audience on absolute performance in real-life settings is not a trivial task, because nature rarely creates situations that make it possible' (Harb-Wu and Krumer 2019, p. 260). For this reason, they call for more causal evidence in different environments, which 'may shed additional light on the relationship between a supportive audience and absolute performance'.

We complement the existing literature on the home-field advantage vs the choke under pressure effect by employing a novel identification strategy on a sample of teams from the major European football leagues, which allows a credible and reliable causal effect to be estimated. Specifically, we use information on all football teams in the top-level competitions across France (Ligue 1), Germany (Bundesliga), Italy (Serie A), Spain (Liga), and the United Kingdom (Premier League) over the 2019/2020 season to study whether and to what extent supporters influence the performance of teams competing at home as opposed to away. To do so, we take advantage of an unusual opportunity provided by the post-lockdown, which forced all matches to take place behind closed doors.

Within this real-life situation, the treated and control groups are determined via explicit randomization, both cross-sectionally and across time. First, the mechanism used to determine which team plays its first match of the season at home and who plays away is random, as it is decided by a lottery. Second, each European league was on a different round of its season when the Covid-19 outbreak hit. Therefore, when countries allowed football events to resume, for a single team the number of matches still to be played behind closed doors at home and away was as good as randomly assigned.

Such an exogenous change offers a unique framework to test the theory of home advantage against home choke as it allows us to compare the difference between the number of points obtained by teams playing at home and teams competing away before Covid-19, when supporters could attend any match, with the same difference after the lockdown, when all matches took place behind closed doors. From a theoretical perspective, if home advantage holds, the difference between the utility (number of points) in the case of a strong performance and that of a poor performance should be much more pronounced when performing in front of a supportive crowd (namely, when playing at home before the

[5] In contrast, there is a vast amount evidence from laboratory experiments on the relationship between pressure to perform and audience. See, amongst others, Otten (2009), Georganas et al. (2015), Neave and Wolfson (2004), and Uziel (2007).

pandemic) than when performing in front of a neutral one (that is, when playing at home behind closed doors, after the Covid-19 outbreak). The opposite holds if, instead, the choke under pressure mechanism prevails.

We find that a home team after the lockdown—when playing behind closed-doors—gets 0.223 fewer points compared to what it would have gained in the absence of the lockdown. This is a sizable effect corresponding to roughly a 14% decrease with respect to the points achieved by home teams before the pandemic, on average (1.59). In practice, while before the Covid-19 outbreak home teams obtained, on average, 0.430 more points as compared to visiting teams, after the lockdown such a difference reduces to 0.201; that is, the home-field advantage is halved when stadiums are empty. Finally, a more in-depth analysis suggests that the home advantage is likely to be driven by *i)* crowd effects and *ii)* psychological factors.

While contributing to the existing literature aimed at understanding how performance is influenced under pressure conditions, our article is most closely related to the contributions of Pettersson-Lidbom and Priks (2010) and Reade et al. (2020). Although these impressive studies exploit other extraordinary circumstances in which teams were forced to play behind closed doors, our work is different along two dimensions. First, we use as our outcome variable the number of points gained by each team rather than team-discipline (Pettersson-Lidbom and Priks, 2010) or the single probability of winning/drawing or losing (Reade et al., 2020). Second, in their analysis, the number of matches that had to be played in empty stadiums is a rather rare event (around 2.5% of observations in the Pettersson-Lidbom and Priks sample and 0.47% in that of Read et al., 2020), thus preventing systematic and comprehensive (causal) evidence to be collected. In contrast, since we exploit the pandemic event, which forced teams around Europe to play behind closed doors for a sizable portion of their tournaments, we can exploit continuous exogenous variation for a longer period of time. Along these lines, such a feature provided by the return to play after the Covid-19 outbreak has also been acknowledged by Read et al. (2020), who indeed claim that studying how and to what extent the home advantage has changed since Covid-19 is 'better suited to future research, when more professional leagues have returned to action and more matches have been played, exploiting variation between countries and over time'. A very recent work by Scoppa (2020) evaluates the impact of crowd support on the performances of teams and referees in a similar setting, adopting Covid-19 pandemic as an exogenous shock. However, by adopting a difference-in-differences (DiD) research design we differ along several dimensions: (*i*) we fully exploit the panel structure of data to remove the unobservables that

are fixed over time; (*ii*) we identify the causal effect of the treatment on the outcome, under the validity of common trend assumption; (*iii*) we conduct common DiD falsification tests, such as the placebo test, and *(iv)* we try to explain the mechanism of our findings.

By documenting that home advantage is guided by crowd and psychological effects, we also contribute to emerging literature that seeks to explain the drivers of the home advantage (Boudreaux et al., 2017; Buraimo et al., 2012; Ponzo and Scoppa, 2018; Pollard, 2006, 2008; Wolfsoon et al., 2005).

The remainder of this work is structured as follows. Section 2 describes the institutional context and illustrates the data. Section 3 presents the econometric strategy, while the main findings and robustness tests are discussed in Section 4. Section 5 investigates the sources of the observed home effect, and Section 6 offers some concluding remarks.

2. Football leagues, data, and testable hypotheses

For the purposes of this study, we extracted data on full home and away tables for the main five leagues of Europe (France, Germany, Italy, Spain, and the United Kingdom) for the 2019/2020 season from the public repository developed by Football Data.[6] In each of these countries, all teams play with each other the same number of times at home and away, constituting a suitable framework for an unbiased calculation of home advantage (Pollard, 2006). The mechanism used to determine which team plays its first match of the season either at home or away is decided by a lottery. As a consequence, the probability of starting the league playing at home or away is even, similarly to the flip of a coin.

In Germany, the league is composed of 18 teams (34 matches), whereas in the other countries observed in our sample there are 20 teams (38 matches). Matches usually take place between August and April/June. As for the point system, all countries have adopted the Fédération Internationale de Football Association (FIFA) approach, that is, three points are given for a win and one for a draw (tie). The sum of the points obtained in each game determines the final ranking. As far as other characteristics are concerned, three players can be replaced during the match, and since 2018 a video assistant referee (VAR) has been used to support the decisions made by the head referee.

[6] Publicly available for download at http://www.football-data.co.uk/data.php. Download completed on August 3rd 2020.

Since the spread of Covid-19, many matches have been rescheduled, and in France, it was announced on April 28th 2020 that the league would resume. In Spain, the competition was suspended in March (27th round), started again on June 8th, and eventually concluded on July 19th. In a similar vein, the season in Germany was suspended in the 26th round, re-started in May, and ended on June 27th.[7] In Italy, some matches (4) of the 25th round, which took place at the end of February, were postponed for reasons unrelated to Covid-19 and, therefore, were the first played when the league re-opened. In the following round (26th), many matches were played behind closed doors, based on a last-minute decision.[8] Then, the competition was stopped and resumed again in June, until August 2nd. Lastly, in the United Kingdom, the Premier League was interrupted after the 29th round and started again on June 17th, running until July 26th. Nevertheless, 3 matches of the 28th round were postponed for reasons not related to the pandemic, resulting in those being the first ones played in June.

Following these numbers, we can observe 1,725 distinct matches between home and away teams, leading to 3,450 team-related observations, of which 828 are related to games played behind closed doors (24%). After the 2019/2020 season resumed, new rules were introduced by FIFA and were standardised in each country. Among them, the most relevant are that (*i*) all matches had to be played behind closed doors and that (*ii*) clubs could make five substitutions instead of three in a 3-slot window. Additional rules on safety and security, although very marginal, have been applied by national federations.

As was already alluded to, the Covid-19 outbreak provides a suitable and unique framework to empirically test whether the home advantage prevails over the home choke effect. In particular, the following can be tested:

Hypothesis 1—Home advantage. The difference between the utility (number of points) in the case of a strong performance and that of a poor performance is expected to be more pronounced when performing in front of a supportive crowd (namely, when playing at home before the pandemic) than when performing in front of a neutral one (that is, when playing at home behind closed doors after the Covid-19 outbreak).

Hypothesis 2—Home choke. The difference between the utility (number of points) in the case of a strong performance and that of a poor performance is expected to be more pronounced

[7] One single match of the 24th round was postponed for reasons unrelated to the Covid-19 outbreak and, as a consequence of the pandemic, was rescheduled for June 2020.

[8] See https://www.eurosport.com/football/serie-a/2019-2020/spal-beat-parma-behind-closed-doors-despite-sports-minister-s-call-to-suspend-serie-a_sto7697681/story.shtml.

when performing in front of a neutral atmosphere (that is, when playing at home behind closed doors during the Covid-19 outbreak) rather than a supportive crowd (namely, when playing at home before the pandemic).

As our main variable of interest, similarly to Ponzo and Scoppa (2016), Braga (2012), Pollard (2006), and Scoppa (2020), we adopt the number of points achieved by teams in each league (*points*). We use this variable because it is objective, comparable across European competitions, directly comes as a result of the match, and captures, in more general terms, the performance of the team. In addition, to account for the differences in the quality of opposing teams, we gather information on the quota paid by bookmakers in the case of victory of each team in every match (*Quota*). This variable was also extracted from Football Data and is obtained as the market maximum home win odds across seven relevant bookmakers.[9] The nice feature of this variable is that it captures the relative 'strength' of one team compared to another: the higher its value, the lower the probability that the given team wins.[10]

Before moving to the empirical investigation, as a preliminary piece of evidence, it is worth noting that within the 2019–2020 season but before the pandemic, the average number of points obtained by home teams (1.593) is higher than that of away teams (1.159), with a difference equal to 0.435. After the Covid-19 outbreak, when teams are forced to play behind closed doors, the same difference reduces to 0.196. It then follows that the difference in the differences (–0.239 = 0.196 – 0.435) is statistically significant at the 5% level, suggesting that the football lockdown drastically reduced the 'home advantage'.

3. Empirical strategy

Since we are interested in analysing the role of supporters in explaining the performance of teams competing at home as opposed to away, we define a team playing at home as treated and a team playing away as a control. We then exploit the staggered time in the countries' decision to permit football events to take place behind closed doors. The exogenous change allows us to compare the difference between the number of points gained by teams playing at home and visiting teams before the pandemic, when supporters could attend any match, with the same difference after the Covid-19 outbreak, when football matches took place behind closed doors.

[9] Including Bet365, Bet&Win, Gamebookers, Interwetten, Pinnacle, VC Bet, and William Hill.
[10] Summary statistcs are shown in Table A1 of the Online Appendix.

The difference in differences (DiD) model estimated in this study is specified as follows:

$$Points_{tr} = \alpha + \beta Home_{tr} + \lambda Post_r + \gamma Home_{tr} \times Post_r + f_t + f_r + u_{tr},$$

where $Points_{tr}$ is the number of points gained by team *t* in round *r* as a consequence of a win or a draw. $Home_{tr}$ is a dummy variable that takes on the value of one if team *t* plays at home in round *r*, and zero otherwise; $Post_r$ is a binary variable that is equal to one for all matches that, as a consequence of the Covid-19 pandemic, were played behind closed doors, and zero otherwise; f_t are team fixed effects that control for unobserved heterogeneity in the capacity to obtain points between teams, such as the quality of players and of the manger; f_r are round fixed effects that capture shocks common to every team; and u_{tr} is the error term, clustered at the team level.

It is important to note at the outset that in this estimating framework, the coefficient β accounts for the impact of being the home team on the amount of achieved points before the Covid-19 outbreak, while γ captures the differential effect, with respect to β, of being the home team when playing behind closed doors. It then follows that the estimate of the combination of $\beta + \gamma$ accounts for the difference in the points achieved between home and away teams after the lockdown.

Following Section 2 and the hypotheses derived there, recasted here in terms of the estimated Eq. (1), the following is expected.

Hypothesis 1—Home advantage. $\beta > 0$ and $\gamma < 0$. That is, if a supportive crowd matters, home teams should get more points before the pandemic, while after it—when playing behind closed doors—we should observe a negative differential effect, thereby reducing or offsetting any advantage of playing at home ($\beta + \gamma \geq 0 \; and \leq \; \beta$).

Hypothesis 2—Home choke. $\beta \leq 0$ and $\gamma > 0$. In this case as well, if a supportive crowd matters, home teams should get fewer points (or at least, a not significant statistical effect is expected to be found), while after the lockdown—when playing behind closed-doors—we should observe a positive differential effect, thereby offsetting any disadvantage of playing in front of supporters ($\beta + \gamma \leq 0 \; and \geq \; \beta$).

A few more empirical choices merit further explanation. First, as previously mentioned, the initial allocation of which teams play at home or away is primarily decided by a lottery; hence, the definition of treated and control groups can be reasonably considered as randomly

assigned. In a similar vein, each of the analysed European leagues was in a different round of its own season when hit by the Covid-19 outbreak. Therefore, when countries allowed football events to take place behind closed doors, for a single team, the number of matches still to be played behind closed doors at home and away was as good as randomly assigned. Furthermore, since the "shock" occurred during mid-season, when typical football factors such as team composition, mangers and strategies have already been defined, the effect of the post-lockdown can be truly isolated. Nevertheless, it might be the case that some teams, as a consequence of the pandemic, played behind closed doors but without all post-lockdown rules being implemented yet. This would lead to a differential treatment effect, which in turn could affect the estimates. While there are very few similar cases—all occurring in Italy—we try to mitigate this potential concern by running separate estimates with and without these teams. Lastly, one might argue that there could be some other unobservable characteristics related to the specific month in which a match is played or linked to some additional measures undertaken by single countries in relation to the pandemic that might determine the capacity of earning points when playing away. For this reason, in further specifications we augment model (1) by including (*i*) an interaction of team-by-month fixed effects; (*ii*) an interaction of country-by-round fixed effects; and (*iii*) a complete set of team-specific linear time trends to control for any potential temporal pattern independent of the treatment status.

4. Findings

The first round of results is shown in Table 1, columns 1 through 6. Each column corresponds to different specifications of Equation (1). The baseline specification, which includes team and round fixed effects, is reported in column (1). The model in column (2) controls for the quota payed by bookmakers, $Quota_{tr}$. Column (3) accounts only for teams that played behind closed doors with common 'Covid-safe' rules. As was already alluded to, six matches of the 26th round of the Italian Serie A were played behind closed doors, but not with all of the new rules. This was a last-minute decision from the Italian national authorities, and after these matches, the league was suspended. While these matches were played behind closed doors, like all games after the lockdown, in principle the rules and conditions of playing might not have been the same. Hence, we group these twelve teams for the 26th round and we replicate the regressions of column (2) by removing them. Column (4) takes into account any specific rule introduced by a single country to mitigate against the spread of Covid-19, such as the different intensity in the number of matches in a week, by including a set of country-by-round fixed effects. Column (5) includes monthly fixed effects and team-by-month fixed effects,

with the aim of capturing any sort of seasonality effect related to team performance. Lastly, since a key identifying assumption of the DiD approach is that the temporal development of each team would have been the same in the absence of any treatment, in column (6) we control for any potential temporal pattern independent of the treatment status by including a complete set of team-specific linear time trends.

The results in Table 1 show that the coefficient associated with $Home_{tr}$ is positive and statistically significant, thus indicating that before the lockdown, when matches were open to supporters, the number of points gained by home teams was higher compared to visiting ones. Central to the issue at hand is, however, the coefficient of $Home_{tr} \times Post_r$, which captures the differential effect of playing at home after the lockdown with respect to playing away. The coefficient turns out to be negative, remarkably similar in magnitude (ranging from -0.192 to -0.223), and statistically robust along all specifications. It is also interesting to point out that the comparison of the estimates in columns (3) and (4) indicates that the exclusion of the twelve teams hardly changes any of the results as the coefficients of $Home_{tr} \times Post_r$ are substantially identical (-0.222 and -0.222, respectively).

In terms of point estimates, following column 1 it emerges that a home team playing behind closed doors gets 0.223 fewer points compared to what it would have gained in the absence of the lockdown and hence with supportive fans. This is a sizable effect roughly corresponding to a 14% decrease with respect to the points achieved by home teams, on average (1.59). The key question, therefore, is whether or not the home-advantage effect still holds when teams are forced to play behind closed doors. To answer this question, we use the estimated coefficients of Eq. (1) to compute the combination of $Home_{tr}$+ $Home_{tr} \times Post_r$, which accounts for the difference in the points achieved between home and away teams after the lockdown. Turning now to our results, and by relying on column 1 estimates, we find that such a difference yields a significant but less marked effect; that is, after the lockdown, home teams get 0.207 more points as compared to visiting ones, which corresponds to a reduction of around 50%.[11] Put differently, the home-field advantage halves when stadiums are empty. These results hold independently of the chosen specification, thus supporting Hypothesis 1.

INSERT HERE TABLE 1

[11] The coefficient is obtained by following the estimated coefficients of col. 1, Table 1; namely, 0.207 = 0.430 – 0.223, with p-value = 0.050. Only in col. 1 does the linear combination lead to an estimation that is positive, albeit marginally insignificant.

5. Robustness checks

In this section, the validity of the previous results is confirmed by a battery of robustness checks that are intended to address possible issues related to the research design and which could bias the baseline estimates. First, a traditional event study is carried out. Then, some falsification tests are conducted, and lastly, several sensitivity checks are performed.

5.1 Event study

The existence of a common trend is the key identifying assumption for DiD estimates to be unbiased. In the framework of this analysis, the assumption implies that in the absence of the lockdown, the difference in the amount of points achieved by visiting teams as compared to home teams would have been the same. While this is not testable, an event-study analysis can shed some light on the validity of the research design.

Specifically, following Autor (2003), the interactions of the time dummies and the treatment indicator for pre-treatment periods are added to the baseline specification of Eq. (1). If the trends in gained points between treated and control teams are the same, then the interactions should not be statistically significant, i.e. the DiD coefficient is not significantly different in the pre-treatment period. An attractive feature of this test is that the interaction of the time dummies after the pandemic with the treatment indicator is informative and can show whether the effect changes over time. In detail, the specification is estimated as

$$Points_{tr} = \alpha + \sum_{\pi=-29}^{-2} \gamma_\pi (Home_{tr} \times Post_\pi) + \sum_{\tau=0}^{13} \gamma_\tau (Home_{tr} \times Post_\tau) + f_t + f_r + u_{tr}. \quad (2)$$

This specification allows for the testing of the presence of parallel trends in the pre-treatment period, namely, whether the coefficients associated with the lead (γ, with π going from -29 to -2) are not statistically different from zero.[12] Nevertheless, a key aspect here is the choice of the omitted round. First, since teams play with each other at home and away the same number of times, the choice of a specific round implies observing only half of the teams as treated (those playing at home). Second, it might be the case that in a specific round there is an

[12] For example, in Italy matches played behind closed doors started in the 25th round, and in Spain this was in the 28th round. Accordingly, since the time-span of the analysis covers the entire 2019/2020 season, which presents a different length depending on the country where the tournament is played (Italy, for example, has 38 rounds, while Germany has 34), for Italy it is possible to compute the pre-treatment period for 25 rounds, while its post-treatment period ranges from the 26th to the 38th round (and thus for a total of 13 rounds). In contrast, for Spain, it is possible to compute a pre-treatment period of 27 rounds, while the post-treatment period can be computed for 11 rounds.

extraordinary situation in which all teams playing at home lose. Were this the case, using that specific round as baseline would bias all of the pre-lockdown coefficients. Put differently, since the outcome of a football competition is not always predictable, the choice of the baseline is relevant. Therefore, to overcome these issues, we estimate Eq. (2) by omitting in one case the round just before the lockdown and in the other case the two rounds before it. In this way, we can see the presence of parallel trends by considering teams who played at home in the round just before the lockdown as treated and the rest as the control group, while in the second specification, where we use as baseline the matches two rounds before the lockdown, the ones that were in the control group become treated and those that were in the treated group become controls. If matches are not influenced by extraordinary circumstances, we should observe similar pre-trend patterns in both specifications. In addition, to ensure that the pre-trends are not driven by the specific rounds chosen, we replicate the same strategy with other pairs-rounds before the lockdown.

The estimates and their 90% confidence intervals are plotted in Figure 5. In panel A, we report the specification where we use the round before the pandemic as baseline, whereas the estimates using the two rounds before are outlined in Panel B. According to the results, there is no systematic difference in the points gained by playing at home during the pre-treatment period as compared to visiting teams, whether we rely on estimates of Panel A or Panel B. There are only a few exceptions in some rounds where a more marked (positive) effect was detected. In this case, it is very likely that such significant effects are triggered by some strong teams playing away (home), and all winning all of their games, which is something that we explore more in depth in the following sections.[13]

Taken together, these results seem to validate the research design, as there is no evidence against the presence of a common trend between treated and control units before the Covid-19 outbreak.

INSERT HERE FIGURE 1

5.2 Placebo test

A common way to conduct a placebo test in the context of DiD analysis is to focus on the span prior to the shock, that is, to simulate what would have happened to the number of points achieved by home teams if a fake round with teams forced to play behind closed doors

[13] Results do not change if we use other pairs of rounds. These findings are available upon request.

were used. Specifically, we replicate the main analysis by assuming that the Covid-19 outbreak occurred from the 3rd round up to the 24th, with a window of 3 rounds.[14] That is, we create eight (*Fake*)*Post* dummy variables, one for each of the fake rounds, and we interact them with the treatment indicator.

Were the coefficient associated with $Home_{tr} \times (Fake)Post_r$ negative and significant, it would suggest that before the true round where matches started to be played behind closed doors (after the Covid-19 outbreak), home teams were already losing points as compared to visiting ones, thus casting doubt on the validity of the previous results.

Reassuringly, the effect of the placebo exercise does not lead to any statistically significant effect on the number of points as the γ coefficient turns out to be indistinguishable from zero in all specifications (Table 2, columns 1 through 8).

INSERT HERE TABLE 2

5.3 Dream teams (outliers)

As already anticipated in Section 5.1, the effect analysed thus far may be driven by outlying teams. Along these lines, it might be the case that the higher number of points lost by home teams is due to the presence of more prestigious and strong teams, or *dream teams*, such as Real Madrid, Barcelona, Bayer Munich, Juventus, Manchester City, Liverpool, etc., for which the probability of winning is high regardless of the Covid-19 outbreak. Were this the case, the effect could not properly be generalised as it would simply be driven by these teams.

To test for this, we gather information on all teams that, in the 2018/2019 season, were eligible to participate in the following 2019/2020 edition of the Champions League[15] (notably, the most prestigious club football competition in Europe), and then we estimate Equation (1) dropping one of these dream teams at time. Figure 2 provides a visual overview of the relevance of each team. If a deviation from the main trend is observed, this signals that the dropped team plays a pivotal role in driving the estimates of the baseline specification.

[14] The choice of round 24 is motivated by the fact that matches in some countries started to be played behind closed doors in the 25th round

[15] Only the clubs obtaining the highest ranks in the previous year's national league (i.e. 1st to 4th in Germany, Italy, Spain, and the United Kingdom and from 1st to 3rd in France) qualify for the following year's Champions League.

Reassuringly, the value of the impact is rather constant, and it does not seem to suffer from notable changes when single teams are excluded.

To sum up, the analyses carried out in this section have strengthened the evidence of a home-field advantage. In addition, the results indicate that it is very likely that such an effect is due to the shock caused by Covid-19, and hence of playing behind closed doors, as no other plausible explanation that clearly holds as an argument against a causal interpretation of this relationship is found.

INSERT HERE FIGURE 2

6. Channels: the role of crowd support and psychological factors

So far, we have shown that the home advantage declines when fans are absent and that the crowd channel seems to be the most plausible explanation behind this effect.

Nevertheless, there are other alternative explanations that might drive our results. Besides crowd effects, travel, familiarity, rules, and psychological motivation are factors recognized in the literature that can explain the home-advantage effect (Pollard, 2008).[16] At the same time, some of these alternative explanations are not affected by the pandemic, and therefore, it is hard to believe that they might play a role in explaining our results. For example, familiarity with the stadium (e.g. the size of the pitch, altitude) should remain the same after the lockdown. Since away teams continue to travel, the Covid-19 outbreak should have not had any impact on travel fatigue. In a similar vein, the changes in the rules due to Covid-19 apply to all teams and hence are expected to affect both home and visiting teams in the same way. In turn, if these factors are not likely to be influenced by the pandemic, they can be accounted for via the inclusion of team and year fixed effects, as well as their different combinations with country fixed effects.

As was already alluded to, a seemingly obvious candidate to explain these results is crowding effects. In the presence of full home attendance of the stadium, it has been shown that the size, the intensity of support, and the pressure induced by fans are factors able to influence mood states or even the attention level of athletes, coaches, and referees, affecting

[16] Additional factors include referee bias, which is a consequence of crowd support (Nevill at al., 2002), and territoriality, which refers to the heightened sense of territoriality of teams from countries often isolated and with a history of conflict (Pollard, 2006). The latter is not expected to change as a consequence of the pandemic and thus can be controlled for by including team fixed effects.

performance and thus explaining the home-advantage phenomenon (Wolfson et al., 2005). Furthermore, such an effect should be more marked for medium-/low-rank teams, which are composed of players who are likely to be more psychologically influenced by stressful situations, that is, any changes in the environment with which they are familiar (Pollard and Gomez, 2014; Waters and Lovell, 2002).

Therefore, if these elements are at stake, one would observe a more pronounced effect (*i*) in stadiums that were very crowded before the pandemic and (*ii*) for teams unfamiliar with playing under stressful situations.

Crowd effects

In order to explicitly account for the crowd effect, we collected information on stadium attendance and stadium capacity before the pandemic for each team. We create our crowd indicator by taking the average attendance rate, and we split the sample in two according to whether the attendance rate of the home team is above or below its median. We then estimate Eq. (1) on these two subsamples. Hence, if crowd effects matter, one would expect the performance of home teams to be better when playing in stadiums that were characterised by a high rate of attendance before the pandemic.

Shown in columns 1 and 2 of Table 3 (Panel A), the coefficient of $Home_{tr}$ is positive and statistically significant at the 5% level in both subsamples. Consistent with the home-advantage effect, it is slightly larger in the subsample with a high attendance rate (0.451) as compared to the low-attendance subsample (0.411). Turning now to the interaction term, $Home_{tr} \times Post_{r}$, it is found to be negative (-0.272) and statistically significant at the 10% level in the subsample with a high attendance rate, while the same coefficient turns out to be statistically indistinguishable from zero for the subsample with a low attendance rate, suggesting that playing behind closed doors only affects the performance of teams that used to play in front of very a crowded stadium.

What all of this seems to reveal is that the observed home advantage is likely to be driven by crowd effects, thus indicating that the size of the audience could affect the performance of players.

International experience

Psychological factors are very difficult to identify and, when possible, this is primarily done by means of case studies of players or experiments (see the review of home advantage in football conducted from a psychological and physiological viewpoint by Neave and Wolfson, 2004). Without the benefit of running experiments, we can provide (at least suggestive) evidence of the importance of psychological factors by relying on the role played by participating in international competitions. Teams involved in international competitions (i.e. Champions Leagues, Europa League[17]) are usually formed by players and managers who are more likely to cope well with stressful situations (Lastella et al., 2019), e.g. long-distance travel, strong presence of home supporters, playing in different stadiums outside the country, and speaking a different language.

Therefore, we use the sample-split idea used previously to further divide the sample in two according to whether or not a team played (at least) one game either in the Champions League or in the Europa League during the 2019/2020 season. Teams that are involved in international competitions are expected to be better prepared to cope with environmental changes such as the one induced by the pandemic and, therefore, are those for which the impact of switching to play behind closed doors should be less marked.

The results of this analysis are reported in Table 3 (Panel B) and support the prediction that the performance of these teams has not been affected by the unusual changes induced by the Covid-19 outbreak, while for the other teams, the lack of spectators has led to a poorer performance. Indeed, in column 1, which presents the results for the sample of teams involved in international competitions, the coefficient of $Home_{tr} \times Post_{r}$ is around zero (0.054) and not statistically significant. In contrast, in the group of teams not engaged in international competition (col. 2), the same coefficient is negative (0.356) and statistically significant at the 1% level.

These findings suggest that when the level of stress induced by playing under unusual conditions is high, teams that are less accustomed to dealing with this type of stress are those whose performance worsens. Taken together, these findings indicate that psychological pressure influences the performance of players (Dohmen, 2008; Apesteguia and Palacios-Huerta, 2010).

[17] The second-tier competition of European club football, just below the UEFA Champions League.

INSERT HERE TABLE 3

7. Conclusion

In this paper, we have provided causal evidence consistent with the theory of home-field advantage as compared to home choke. To induce a source of plausible exogenous variation, we exploited that fact that teams in the five main national leagues of Europe, as a consequence of the pandemic, had to play behind closed doors for a sizable fraction of the 2019/2020 season.

The unprecedented nature of this event has allowed us to compare the performance, taken here to be the number of points obtained, of home and visiting teams before (open doors) and after (closed doors) the lockdown. Our findings indicate that a home team, after the lockdown period—when playing behind closed doors—obtained 0.223 fewer points compared to what it would have gained in the absence of the pandemic. This effect corresponds to roughly a 14% decrease with respect to the points achieved, on average, by visiting teams. More interestingly, we found that playing behind closed doors after Covid-19 halved the home advantage. All results survived a battery of robustness tests.

Further investigations suggest that this behaviour holds when the attendance rate before Covid-19 was very high and for teams that do not have international experience, thus indicating that both crowd effects and pressure factors are likely to be the determinants of the observed home-advantage effect.

While these findings might help shed light on the impact of audiences on performance, they also have some limitations that should be noted. To begin with, our results are obtained from football and more specifically, using figures from the major division (Ligue 1, Serie A, Premier League, Liga, and Bundesliga) of each of the main five leagues of Europe, where only the 'top' teams in each country participate. It is then possible that these results would differ in other environments. Second, different from other studies (Dohmen, 2008; Harb-Wu and Krumer, 2019), in our setting individuals performed together. In this respect, the final outcome observed is the result of the performance of the team as a whole, but it might be the case that a supportive audience impacts each player on a team differently. This leaves room for future research to analyse how a change in audience affects the individual performances of players.

Despite these limitations, the evidence that teams are likely to perform better in front of a supportive audience calls for extra attention in these times of pandemic. The finding, which is consistent with the hypothesis that positive public expectations or a friendly environment induce individuals to enhance their performance, has implications for workplace design. Along these lines, the empirical results seem to suggest that, for example, workers who feel they are not being observed by bosses, colleagues, or spectators may perform worse than they otherwise would. This may become more salient in the wake of the Covid-19 outbreak, with smart working becoming the 'new reality'. Under this new organisational model of work, indeed, the perception of workers of not being fully observed might increase, thus affecting performance.

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Table 1: Baseline results

Dep. Variables	Points					
	(1)	(2)	(3)	(4)	(5)	(6)
Home	0.430***	0.295***	0.430***	0.430***	0.429***	0.429***
	(0.048)	(0.050)	(0.048)	(0.049)	(0.049)	(0.049)
Post	0.110	0.109	0.096	0.149	0.013	0.105
	(0.137)	(0.134)	(0.144)	(0.310)	(0.818)	(0.152)
Home × Post	-0.223**	-0.192*	-0.222*	-0.222*	-0.217*	-0.222*
	(0.112)	(0.110)	(0.112)	(0.114)	(0.113)	(0.114)
Quota		-0.061***				
		(0.007)				
Home + Home × Post	0.207**	0.103	0.208**	0.207**	0.212**	0.207**
	(0.100)	(0.099)	(0.101)	(0.102)	(0.101)	(0.101)
Observations	3,450	3,450	3,438	3,450	3,450	3,450
R-squared	0.135	0.162	0.136	0.137	0.321	0.159
Round FE	Yes	Yes	Yes	Yes	Yes	Yes
Team FE	Yes	Yes	Yes	Yes	Yes	Yes
Control	No	Yes	No	No	No	No
Country × Round FE	No	No	No	Yes	No	No
Team × Month FE	No	No	No	No	Yes	No
Team specific linear trend	No	No	No	No	No	Yes
Mixed round	No	No	Yes	No	No	No

Note: Football season 2019-2020. *Home* is a dummy variable that takes the value one if the team plays in its own stadium at round *r*, *Post* is a dummy variable that takes on the value one if the match is played with closed doors (after the beginning of the lockdown), *Home x Post* is an interaction term being equal to one if for each team playing in its own stadium after the beginning of the lockdown. Standard errors, clustered at the team level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 2: Fake treatment results

Dep. Variable	Points							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home	0.179	0.339***	0.371***	0.460***	0.450***	0.427***	0.407***	0.408***
	(0.167)	(0.124)	(0.087)	(0.073)	(0.064)	(0.056)	(0.056)	(0.053)
Home × Fake Post (3rd round)	0.270							
	(0.175)							
Home × Fake Post (6th round)		0.111						
		(0.135)						
Home × Fake Post (9th round)			0.083					
			(0.095)					
Home × Fake Post (12th round)				-0.053				
				(0.090)				
Home × Fake Post (15th round)					-0.045			
					(0.084)			
Home × Fake Post (18th round)						0.004		
						(0.092)		
Home × Fake Post (21st round)							0.086	
							(0.113)	
Home × Fake Post (24th round)								0.148
								(0.131)
Observations	2,622	2,622	2,622	2,622	2,622	2,622	2,622	2,622
R-squared	0.031	0.030	0.030	0.030	0.030	0.030	0.030	0.030
Round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Team FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Football season 2019-2020. *Home* is a dummy variable that takes the value one if the team plays in its own stadium at round *r*, *Fake Post (r round)* are dummy variables that takes on the value one *r* rounds before the first match is played with closed doors (after the beginning of the lockdown), *Home x Post (r round)* is the interaction term between *Home* and *Fake Post (r round)*. Standard errors, clustered at the team level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 3: Heterogenous effects

Panel A	**Audience Rate**	
	Low	High
Dep. Variable: Points	(1)	(2)
Home	0.411***	0.451***
	(0.076)	(0.058)
Post	0.130	0.139
	(0.193)	(0.200)
Home × Post	-0.144	-0.272*
	(0.150)	(0.155)
Observations	1,696	1,754
R-squared	0.113	0.162
Round FE	Yes	Yes
Team FE	Yes	Yes
Panel B	**International Experience**	
	No	Yes
Dep. Variable: Points	(1)	(2)
Home	0.449***	0.408***
	(0.059)	(0.087)
Post	0.081	0.188
	(0.169)	(0.229)
Home × Post	-0.356***	0.054
	(0.130)	(0.217)
Observations	2,248	1,202
R-squared	0.080	0.150
Round FE	Yes	Yes
Team FE	Yes	Yes

Note: Football season 2019-2020. *Home* is a dummy variable that takes the value one if the team plays in its own stadium at round *r*, *Post* is a dummy variable that takes on the value one if the match is played with closed doors (after the beginning of the lockdown), *Home x Post* is an interaction term being equal to one if for each team playing in its own stadium after the beginning of the lockdown. Standard errors, clustered at the team level, are shown in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Figure 1: Common trend assumption

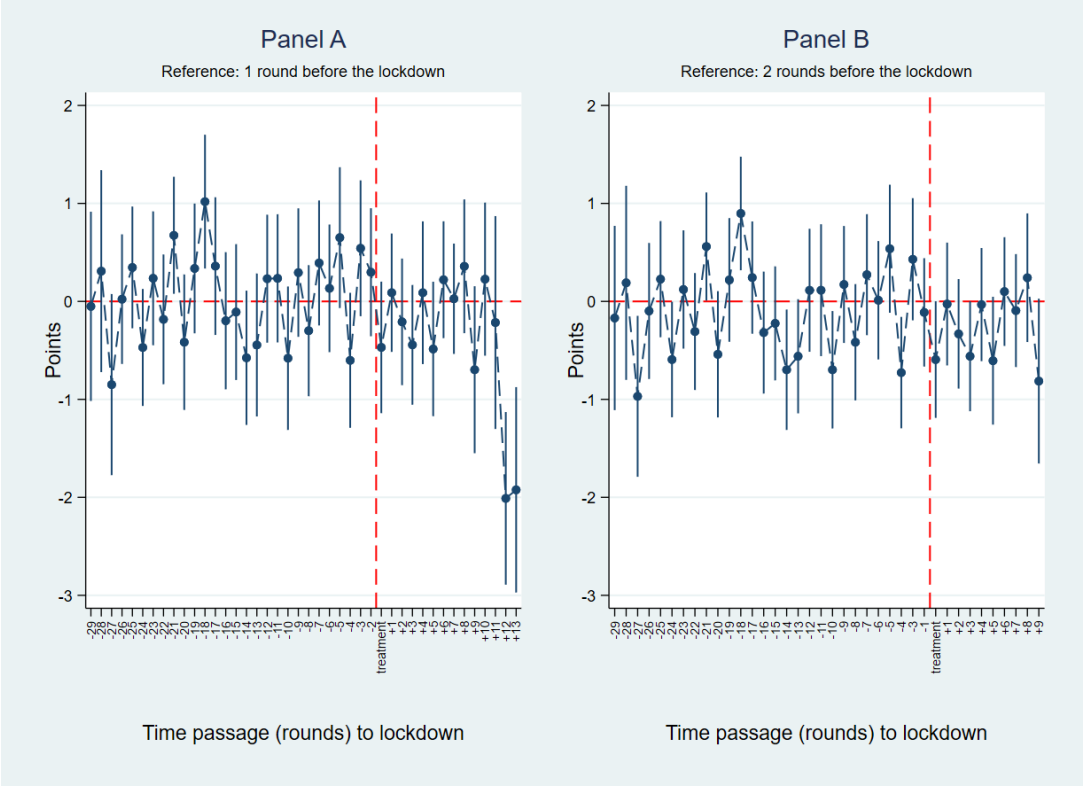

Figure 2: Team excluded

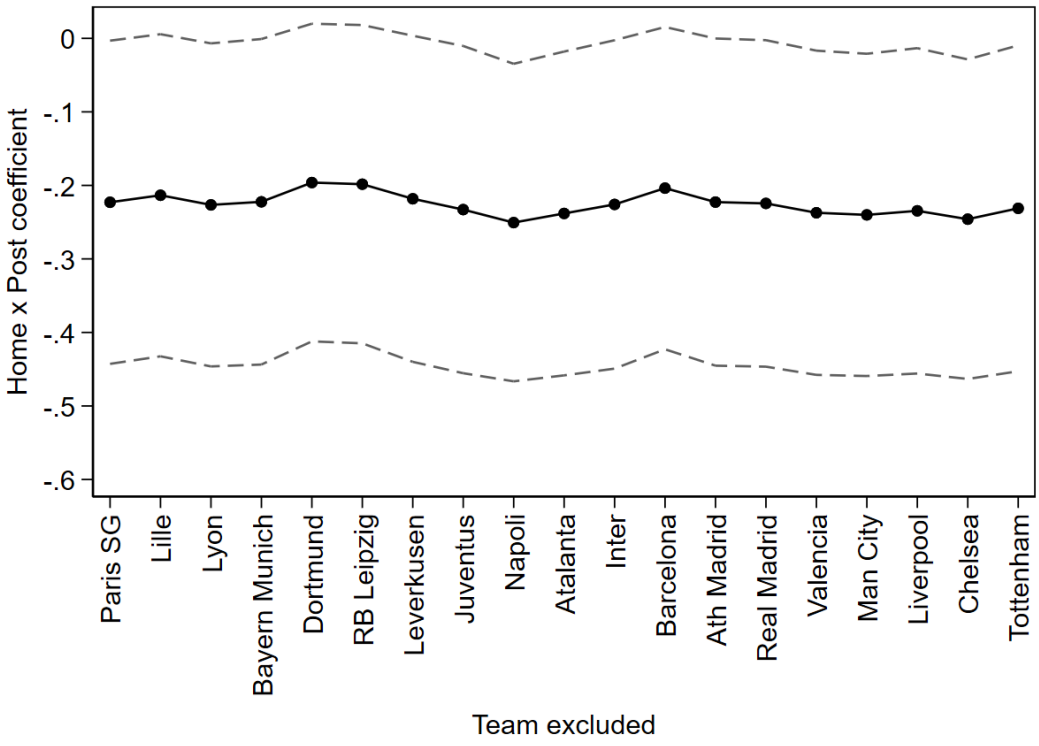

Table A1: Summary statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Points	3,450	1.377	1.322	0	3
Home	3,450	0.500	0.500	0	1
Post	3,450	0.240	0.427	0	1
Quota	3,450	4.016	0.041	1.080	56.000
Audience dummy	3,450	0.508	0.500	0	1
International experience dummy	3,450	0.348	0.477	0	1