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Midweek Effect on Performance:

Evidence from the German Soccer Bundesliga

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Abstract

The home advantage phenomenon is a well-established feature in sports competitions. In this paper, we examine data from 1,908 soccer matches played in the German Bundesliga during the seasons from 2007-08 to 2015-16. Using a very rich data set, our econometric analysis that is based on matching methods reveals that the usual home advantage disappears when the game is in the middle of the week instead of being on the weekend. Our results indicate that, since the midweek matches are unevenly allocated among teams, the actual schedules of the Bundesliga favour teams with fewer home games in midweek. The paper also shows that these soccer-specific findings have some implications for the design of contests in general.

Keywords

Performance, schedule effects, soccer.

JEL Classification

D00, L00, D20, Z20.

1 Introduction

The effect of the schedule on the performance of individuals or groups in competitive environments has been widely investigated in the recent behavioural economics literature (Page and Page, 2010; Palacios-Huerta, 2014; Cohen-Zada, Krumer and Shtudiner, 2016). The increased interest stems from a possible unfair ex-post advantage to one of the contestants caused by psychological or strategic effects driven by the schedule, which, ex-ante, seemed to be as fair. Therefore, fairness in scheduling actions in competitive environments can be an important economic issue. To be more specific, an unfair schedule may create selection efficiency concerns by reducing a 'better' contestant's probability of winning. In addition, it can also harm contestants' future's revenues and therefore affect their willingness to exert efforts in the present. Consequently, to maximize both, selection efficiency and effort, it is important for contest designers to minimize any possible advantage to one of the contestants that stems from an unbalanced schedule.

The role of scheduling in tournament settings was presented in different types of contests. For example, Klumpp and Polborn (2006) described the unfairness of the primary party based election system used in the USA to nominate a candidate of one of the major parties for the participation in presidential elections. According to the authors, this structure is unfair, since it shifts too much power to the voters in early primary states. Page and Page (2010) presented systematic bias in the sequential evaluation of performance, namely that contestants who performed in the later serial position in the popular *Idol* series had a significantly larger advantage with respect to a positive evaluation.[1] De Bruin (2005) found similar results for the Eurovision song contest and for the World and European figure skating championships. In another study, Page and Page (2007) showed that there is advantage of

[1] The *Idol* show is a popular reality television-music competition format where judges and audience select the winner. For additional information, see https://en.wikipedia.org/wiki/Idols_(TV_series). Last accessed on 01/04/2016.

playing in the second home leg game in soccer European tournaments. Krumer (2013) explained this result theoretically, assuming the existence of a psychological advantage. Finally, to insure the fairness of multi-stage contests with sequential order of moves, Palacios-Huerta (2012) proposed to use the so-called Prouhet-Thue-Morse sequence, where the sequence of the first *n* moves is the exact mirror image of the next *n* moves.

The aim of this paper is to evaluate the effect of midweek matches on the home advantage in the German Bundesliga 1 (hereafter Bundesliga), which is the highest division of German male soccer.[2] The relevance of this question stems from the fact that some teams play more midweek matches at their home stadium than others. Therefore, a schedule is considered as fair if ex-ante all teams in the Bundesliga have the same probability to convert the home advantage into success, given their individual characteristics, regardless of the weekday.

In general, the home advantage phenomenon is a well-established feature in sports' competitions. Courneya and Carron (1992) defined the home advantage as "the consistent finding that home teams in sports competitions win over 50% of the games played under a balanced home and away schedule" (p. 13). In their book, Moskowitz and Jon Wertheim (2011) survey 19 different sports leagues covering more than 40 countries between the years 1871-2009 and showed that the within league home field advantage "is almost eerily constant through time" (p. 113). The percentage of games won by the home teams in these leagues varied between 53.3% and 69.1%. The home advantage phenomenon can be attributed to crowd noise (Pettersson-Lidbom and Priks, 2010), positive psychological states during home games (Terry, Walrond and Carron, 1998), familiarity with facilities (Pollard, 2002), increased level of testosterone in the players (Neave and Wolfson, 2003), distance between cities (Oberhofer, Philippovich and Winner, 2010) or referee bias (Sutter and Kocher, 2004;

[2] On average, teams earn almost half a point more at home compared to playing away.

Garicano, Palacios-Huerta and Prendergast, 2005; Dohmen and Sauermann, 2015). Whatever the reason, it is clear that a certain home advantage is a feature of very many sporting events.

Despite the fact that home advantage has been widely analysed in the literature, to the best of our knowledge, there is no study on the effect of playing midweek on the size of the home advantage. It is, however, well documented that midweek matches attract a lower crowd and lower TV ratings in English soccer (Buraimo and Simmons, 2015; Buraimo, 2008; Forrest and Simmons, 2006), US Major League Baseball (Knowles, Sherony and Haupert, 1992), English cricket (Schofield, 1983) and in the North American National Hockey League (Paul, 2003). Therefore, it seems to be natural that the home advantage itself may differ between weekend and midweek days.

Indeed, based on 1,908 Bundesliga matches in the seasons 2007-08 to 2015-16, we find that home advantage in the midweek matches completely disappears. According to our propensity score matching analysis below, playing in the midweek reduces the difference in points between home and away teams from 0.49 points over the weekend to essentially zero.[3] In our robustness checks, we rule out other possible explanations like fatigue or the size of the crowd.[4] Interestingly, we also find that both teams commit less fouls in the midweek matches. However, this reduction is significantly higher for home teams than for away teams. Therefore, it seems unlikely that referee bias in favour of away teams occurring in midweek matches explains the midweek effect. Another possible explanation of our results can be linked to the decreased importance of the midweek matches as perceived by home teams' players. This may reduce the association of testosterone, which is known to enhance

[3] Note that the winning team receives 3 points, while the losing team gets no points. In case of a draw, each team gets one point.

[4] The elimination of the fatigue explanation is in line with Scoppa (2015), who investigated all FIFA World Cups and UEFA Championships and found no effect of additional rest days on teams' winning probabilities.

performance and aggressiveness, and territoriality that was described by Neave and Wolfson (2003).[5]

To illustrate a possible relationship between an unbalanced schedule and resulting monetary rewards one can look at the distribution of revenues from TV broadcast contracts in season 2015-16. For example, the fourth best team with regard to TV revenues in the Bundesliga 2, *SC Paderborn 07*, which was relegated from the Bundesliga in the 2014-15 season, receives 9.89 Million Euros. In stark contrast, the lowest TV revenues in the Bundesliga equal 20.19 Million Euros and were earned by *SV Darmstadt 98*. This means that if *SC Paderborn 07* would have stayed in the Bundesliga, its revenue from TV alone would have been at least 10.3 Million Euros higher (not counting all other revenues from ticketing, advertising, and so on).[6] The case of *SC Paderborn 07* is interesting also because in the relegation season, this team had four points less than the *Hamburger SV*, a team that finally survived in the Bundesliga. In that season, each team was scheduled to play three matches in the midweek rounds. *SC Paderborn 07* played two midweek matches at home. One of these games was against *Hamburger SV* in which the latter won. However, *Hamburger SV* had to play only one midweek match at home. Of course, we do not claim that the main reason for *SC Paderborn 07*'s relegation was the fact that this team played at home in the midweek round against the closest rival in the relegation fight. However, this example illustrates that the uneven schedule may have an effect on the final rankings (and thus on future revenues).

The remainder of the paper is organized as follows: Section 2 describes the Bundesliga schedule. The data and some descriptive results are presented in Section 3. Section 4 presents

[5] Territoriality is a protective response to an invasion of one's perceived territory, which is common among animals. For example, Huntingford and Turner (1987) showed that animals attack more readily and with higher toughness when defending a home territory.

[6] Numbers are taken from http://www.bavarianfootballworks.com/2015/11/23/9782628/how-much-will-bayern-munich-make-from-bundesliga-tv-revenues . Last accessed on 08/03/2016.

the estimation strategy. The results are contained in section 5. Finally, in Section 6 we offer concluding remarks.

2 Description of the Bundesliga schedule

The German Bundesliga consists of 18 clubs. The matches are organized as a round-robin system. Each round consists of 9 different matches, such that in each round, each team plays only once.[7] In the first half of the season (typically August to December) every team plays in 17 different matches against all other teams. Half of the matches are at home. In the second half of the season (January to May), each team plays again against all other teams, but teams played at home in the first half of the season are now playing away. Thus, in total, each team plays 34 matches, 17 of them at home and another 17 away from home. There is a break of about one month between the first and the second half of a season without any matches.

The matches usually take place on weekends. A typical weekend round consists of one match on Friday at 20:30, several matches on Saturday, usually at 15:30 and one game at 18:30. The remaining matches take place on Sundays, usually at 15:30 and 17:30.[8] However, there are some rounds that take place during the midweek days. These matches always take place on Tuesdays and Wednesdays at 20:00. The reason for the existence of these midweek rounds is that the schedule should take into account the winter break (weather conditions), the summer break (players' vacation and recovery time), as well as the international tournaments, such as the FIFA World Cup and UEFA European Championship that take place every two years in June and July. Therefore, since there are not enough weekends between August and May, several rounds are played in midweek. In addition, a few regular weekend matches that were postponed due to weather conditions also take place in midweek.

[7] See Krumer, Megidish and Sela (2016) for additional details on round-robin structure.

[8] For example, in two other big European soccer leagues, the English Premier League and the Spanish La Liga, a weekend round always consists of one match that is played on Monday.

In the end of a season the final table determines which teams participate in the following season's European club tournaments, such as the Champions League, which is the most prestigious club tournament in Europe, and the Europe League (former UEFA Cup), which also yields big monetary rewards. For example, in the 2015-16 season, the four highest ranked teams participated in the Champions League (the fourth ranked team had to play an additional international qualification game to participate in the group stage of Champions League). Teams in the 5th to 7th position played in the Europe League (this may depend also on the outcome of an elimination tournament, called the 'DFB-Pokal'). In addition, the two worse ranked clubs relegate to the lower division and the team ranked 16th has to participate in the relegation play-offs against the team that was ranked third in the Bundesliga 2 for the right to play in the Bundesliga in the following year.[9] Note that the different outcomes have financial consequences for the clubs in the next season.

3 Data and descriptive results

3.1 Data base

We collected data on all the matches in the Bundesliga from the 2006-07 season up to the 25th round of the 2015-16 season. Data collection starts with the 2006-07 season, because a large amount of important information was unavailable prior to that season. The most recent matches in our database already include all the midweek rounds of the 2015-16 season. In total, this data covers 2,979 matches. However, data on 306 matches played in the 2006-07 season were used to control for previous season's team's characteristics. In addition, we disregard matches of teams playing the European competitions just before and after these games (UEFA Champions League or UEFA Europa League), because such matches may

[9] The relegation play-off format was introduced in 2008-09 season. Previously, up to 2007-08 season, three teams were directly relegated to the Bundesliga 2.

create different allocation of efforts (for example, saving best players to more important European Cups matches, fatigue or psychological momentum). We also didn't take into account matches in which a home team didn't play at its home stadium (for example Bayer Leverkusen in season 2008-09), matches that took place after an international break in which national teams played friendly or qualification games and matches in which one of the teams was already relegated or already won the title. After dropping these games, 1,908 matches enter the estimation.

For every match, there is information on the exact day and hour, attendance, and the final score. For each team in a particular game we observe the number of shots, shots on target (i.e. all shots that would score in the absence of a goalkeeper), number of fouls, as well as the number of corners and yellow and red cards. In addition, we use data from the *Transfermarkt* website (www.transfermarkt.com) to proxy the market value of each player of each team's in every season. Finally, we have data on the dates of the beginning and the end of work of each coach, as well as data on the capacity of each stadium and on regional economic characteristics. The data were collected from several web sites (see Appendix D for the full list).

3.2 Descriptive statistics

To estimate possible effect of playing in the midweek we have a set of possible outcome variables on the level of a single match between home and away teams. The first two are defined as the number of points obtained by home and away teams. In Table 3.1 we can see that in line with the home advantage phenomenon, a home team attains on average 1.60 points per weekend match, which is significantly higher than the 1.33 points to be expected in the absence of a home advantage.[10] An away team achieves on average 1.14 points per such

[10] Assuming an equal probability of a loss, a win and a draw.

match. However, in the midweek matches, we observe that the home advantage completely disappears.

Next, we define the number of goals scored by a home and away teams. Based on these two variables we also calculate the difference of goals between home and away teams. Table 3.1 presents, not surprisingly, that on average a home team scores more goals than an away team. Other possible outcome variables are related to the shots and shots on target. Table 3.1 shows that home teams have higher values for both shots related variables.

Another dimension, which is interesting to investigate, is related to the aggressiveness of the teams, such as committed fouls, yellow and red cards. From the descriptive statistics, we learn that in general home teams commit less fouls, which is probably translated to the lower number of yellow and red cards.

3.3 Variables

To estimate the effect of midweek matches on performance, we code a dummy variable that gets the value of one if a match was played in the midweek and zero otherwise. We also use a rich set of variables that characterises team value and players' ability, game attendance, and the international and national schedule (and the resulting demands on the international players). In the following, we present some of the most important measures (a more comprehensive list of variables appears in Appendix A).

To approximate teams' abilities, we use teams' monetary values obtained from a popular German soccer website, *Transfermarkt*, which is a reliable data source that provides data on players' market values. As reported by Bryson, Frick and Simmons (2013), the coverage of *Transfermarkt* is quite "impressive with information on 190,000 players across 330 football competitions" (p. 611). According to Franck and Nüesch (2012), players' values are estimated by industry experts and take into account salaries, signing fees, bonuses and

transfer fees. The authors found that the correlation between values evaluated by *Transfermarkt* and *Kicker*, another highly-respected sport magazine in Germany, is as high as 0.89. In addition, Frick (2006) finds that the correlation between salary information published by *Kicker* and actual salaries for two seasons in Bundesliga is 0.8.

The players' values were used to create some additional measures like the distribution of values between and within teams. More specifically, for each team we computed the standard deviation of players' values, the Herfindahl-Hirschman Index (HHI), which is defined as the sum of the squares of the values shares of each player within the team. In addition, we created some other within-team-inequality related variables such as the ratio of different players' values according to their ranking order in the team. For example, one measure is the ratio between the top three players to players ranked 9-11 according to their values within a team (see Appendixes A and B for more details).[11] It is important to note that the goal of our empirical analysis is to evaluate the effect of midweek matches rather than to determine players' values. We use values-related measures only as covariates, which are supposed to reflect teams' abilities. The teams' values measure strongly correlates with teams' performance, suggesting that we measure teams' abilities quite well.[12] In addition to players' values, we also use several other variables that may reflect the level of ability such as a dummy for a team's first season in the Bundesliga after being promoted from Bundesliga 2, whether a team dismissed its coach during a season, and teams' previous season's characteristics, such as shots, corners, yellow and red cards.

As found previously in the literature, the home advantage is affected by the attendance level. Therefore, we create a measure to reflect the attendance in a match. Our preferred measure, attendance as share of the capacity of the stadium, is the ratio between the number

[11] See Coates, Frick and Jewell (2014) and for discussion on the relationship between players' inequality in salaries and teams' performance.

[12] The results of the relevant regression analysis is available upon the request.

of viewers in a match and the maximal possible capacity of the respective stadium. Table 3.1 demonstrates that this measure is lower in midweek than in weekend matches. There is also information about the distance between cities and public transport commuting time between cities.

Table 3.1: Descriptive Statistics of Selected Variables

Variable	Weekend games (N=1,765)	Midweek games (N=143)
Game outcomes		
Points home team	1.60 (1.31)	1.38 (1.38)
Points away team	1.14 (1.26)	1.45 (1.39)
Goals home team	1.56 (1.27)	1.55 (1.32)
Goals away team	1.23 (1.14)	1.38 (1.19)
Shots home team	14.43 (4.97)	13.97 (5.31)
Shots away team	11.93 (4.59)	11.82 (4.52)
Shots on target home team	5.14 (2.55)	5.01 (2.63)
Shots on target away team	4.19 (2.34)	4.45 (2.32)
Fouls home team	16.02 (4.50)	14.68 (4.41)
Fouls away team	17.11 (4.77)	16.45 (5.12)
Yellow cards home team	1.63 (1.18)	1.73 (1.15)
Yellow cards away team	1.95 (1.22)	1.91 (1.32)
Red cards home team	0.07 (0.28)	0.10 (0.30)
Red cards away team	0.10 (0.31)	0.10 (0.33)
Game characteristics		
Attendance	40,765 (15,807)	40,767 (17,402)
Attendance as share of capacity of stadium	0.91 (0.12)	0.86 (0.14)
Africa Cup of Nations (dummy variable for respective month)	0.13	0.06
World Cup or European Championship (dummy variable for two months period before and after)	0.07	0.19
Distance between the cities of the teams (km)	365 (182)	370 (179)
Team characteristics		
Value of home team (Mil. €)	86.1 (64.0)	106.3 (112.7)
Value of away team (Mil. €)	89.9 (69.7)	103.2 (87.8)
Ratio of top 3 to ranked 9-11 players' values- home team	2.34 (0.67)	2.16 (0.51)
Ratio of top 3 to ranked 9-11 players' values- away team	2.33 (0.66)	2.46 (0.72)
First season after promotion- home team (dummy variable)	0.16	0.15
First season after promotion- away team (dummy variable)	0.15	0.12
New coach- home team (dummy variable)	0.18	0.10
New coach- away team (dummy variable)	0.17	0.15

Note: This table presents average values and standard deviations (in brackets for non-binary variables). The difference and ratio related variables are defined as difference or ratio between home and away measures.

In addition, we obtain information on other schedule related variables in international competitions such as two pre- and post-World Cup and European Championships months, as well as the months in which the Africa Cups of Nations took place. Furthermore, we take into account different parts of the season, such that the beginning of the season is defined as the

first eleven rounds, the middle of the season is defined as rounds 12-22, and end of the season include rounds 23-34. In addition, we also split the beginning of the season into several parts.

4 Econometrics

4.1 The causal question

We are interested in learning the effect of playing in the middle of the week on the success of the home team in terms of the variables measuring different aspects of the outcome of a Bundesliga soccer game as described in the previous section. If the allocation of the midweek games over the season were entirely random, then we would compare the means of these variables for midweek matches to the means obtained for weekend matches. The difference would be a consistent estimate of the desired effect. However, scheduling is only partially random, since many other considerations are considered when fixing a league schedule, like weather, players' rest period, European Cups, National teams' tournaments, among others. Furthermore, the distribution of the characteristics shown in Table 3.1 already point to (small) deviations from randomness. Such deviations need to be taken into account in any estimation strategy, if they are correlated with the outcomes of interest (e.g. Imbens and Wooldridge, 2009), which are measures of the success of the home team in our case[13]. In our case, the data base available is rich enough in game and team characteristics that we opt for a selection-on-observable strategy to identify the causal effects of interest. As described previously, since the schedule of the Bundesliga has to take into account winter and summer breaks, as well as international tournaments, we expect to capture other schedule related characteristics, such as the periods of time that are associated with the World Cups, European Championships and the Africa Cup of Nations. In addition, according to the previous literature on the linkage between midweek matches and the crowd, we suppose to capture

[13] Note that the results would be symmetric if we focus on the success of the away team instead.

attendance related variables as well. Finally, we also capture other differences related to team, location, and timing by the variables described above.

4.2 Estimator used

Since the previous section suggests that controlling for observable characteristics will be sufficient to identify a causal effect, we face two challenges. The first challenge is that we expect that the effect of midweek games may be different for different clubs (depending on their actual position in the season, for example) and games (early vs. late in the season) in the Bundesliga. Since the exact kind of heterogeneity is unknown, and since a very flexible way of controlling for the various confounding factors appears to be called for, we use a matching approach. To be more specific, we employ the radius-matching-on-the-propensity-score matching estimator with bias adjustment as suggested by Lechner, Miquel and Wunsch (2011) because it showed its superior finite sample and robustness properties in the large scale empirical Monte Carlo study conducted by Huber, Lechner, and Wunsch (2013).

The second issue we face is how to exactly specify the propensity score, which is the probability of a weekday match given the relevant characteristics. The problem is that although we have prior knowledge on the kind of variables needed, these considerations are uninformative about exactly which measurements to use (like which functional form, which interactions, or which particular measure of distance, like travel time or km, to mention just a few). In the past, researchers more or less ad hoc chose specifications that pass certain checks with respect to the performance of the matching procedures, like so-called balancing tests. However, recent advances in machine learning techniques allow the use of more principled variable selection procedures, which we use here as well. In particular, we employ the ideas of Belloni, Chernozhukov and Hansen (2014) of using the LASSO (in fact we use the adaptive LASSO, Zou, 2006; see also Hastie, Tibshirani, and Friedmann, 2009, and Bühlmann and van den Geer, 2011) twice. The first LASSO estimation concerns the selection

equation. The second LASSO estimation has the purpose to identify variables that are highly correlated with the outcome (ignoring the midweek variable), as the omission of such variables may lead to substantial biases even if they are only mildly correlated with the fact of playing in midweek. The variables used in the matching estimation is the union of variables selected by the LASSO in either of those two steps.

The inference for the matching estimator is based on the weighted bootstrap (see also the empirical Monte Carlo results on the performance of different inference procedures investigated in Bodory, Camponovo, Huber, and Lechner, 2016) ignoring the variable selection step (which is justified by the LASSO's oracle properties).

5 Results

Although the purpose of the propensity score estimation is only a technical one, namely to allow the easy purging of the results from selection effects, it is nevertheless interesting to see which variables drive selection. Generally, as already apparent from Table 3.1, selection effects are limited. They are substantially driven by the lower attendance at midweek games as well as timing effects. The detailed results can be found in Appendix B.

Table 5.1 shows the key results of this paper, namely the effect of playing midweek compared to playing weekends on various outcome variable that may be used to characterise the results of soccer games. The most important one is of course the expected number of points earned (top of table): Playing midweek leads to an effect of about half a point in total, resulting from the home team losing about 0.2 points, while the away team gains about 0.3 points (the asymmetry results from the '3 points rule'). Considering the levels of expected points, it becomes clear that the home team loses all its home advantages in midweek games. In midweek games the home and the away team (with the same characteristics as the home team) can expect to earn about 1.4 points on average, while on weekends the (same) home

and away teams earn about 1.6 and 1.1 points respectively. Similar results appear when considering related measures, namely the goals scored and the teams' shots (although not always statistically significant).

Table 5.1: Levels and effects of playing midweek

Variables	Expected value when playing midweek	Expected value when not playing midweek	Effect of playing midweek	Standard error of the effect
Points home team	1.400	1.616	-0.216*	0.106
Points away team	1.420	1.129	0.291***	0.101
Difference in points	-0.020	0.487	-0.507**	0.204
Goals home team	1.407	1.582	-0.175*	0.107
Goals away team	1.341	1.229	0.112	0.094
Difference in goals	0.066	0.352	-0.286*	0.161
Shots home team	13.876	14.471	-0.595	0.365
Shots away team	11.722	11.826	-0.104	0.301
Difference in shots	2.154	2.645	-0.491	0.514
Shots on target home team	4.770	5.181	-0.411**	0.177
Shots on target away team	4.237	4.172	0.065	0.135
Difference in shots on target	0.533	1.009	-0.477**	0.229
Fouls home team	14.495	15.909	-1.414***	0.325
Fouls away team	16.280	17.043	-0.763**	0.316
Difference in fouls	-1.785	-1.134	-0.651*	0.394
Yellow cards home team	1.824	1.575	0.249**	0.074
Yellow cards away team	1.985	1.917	0.068	0.098
Difference in yellow cards	-0.161	-0.343	0.181	0.133
Red cards home team	0.047	0.068	-0.021	0.020
Red cards away team	0.147	0.096	0.051	0.033
Difference in red cards	-0.100	-0.028	-0.072*	0.039

Note: Average treatment effect. *, **, *** denotes significance at the 10%, 5%, 1% level respectively. Inference based on bootstrapping (4999 replications) p-values. Difference related variables are defined as difference between home and away measures.

Interestingly, when considering one aspect of the playing style by looking at fouls and cards, it turns out that both teams commit fewer fouls in midweek than on weekends. This fact points to a reduced aggressiveness of both teams in midweek games, which might be attributed to the general lower attendance in this games (although the level of attendance is flexibly controlled for).

In addition, we investigated whether the results are robust to including the information about attendance as control variable. If spectators know that midweek games have no or a reduced home advantage, then this fact may reduce their inclination to visit the games in

midweek and thus this variable is endogenous and we should expect a bias of the result towards zero when controlling for attendance. However, this is clearly not the case as can be seen in Table C.1. In fact, the results without conditioning are even somewhat smaller.

Finally, the explanation of the midweek effect might be that the teams are more tired because they have a reduced rest (about half compared to a weekend game without prior midweek game) and thus less aggressive which might reduce the advantage of the home team. To investigate this issue we pooled midweek games together with weekend games after a midweek game and compared them to weekend games without a prior midweek game. When doing so (Table C.1), the effect became much smaller and statistically insignificant, which is essentially ruling out that hypothesis.

One possible explanation to our results may be linked to the size of the crowd. Despite the fact that we control for many crowd related variables, the size of the crowd may have indirect effects on performance. As discussed previously, a smaller crowd in the midweek matches is a well-known phenomenon across different sports in different countries, which is found in our data base as well. Therefore, it is likely that home team's players anticipate lower attendance before these matches, such that home team's players may consider midweek matches less important, because fewer viewers will monitor their actions.[14] If so, then our findings on the disappearing home advantage and lower aggressiveness of home teams, as measured by the lower number of its fouls, are in line with the literature on testosterone, which is known to enhance performance and aggressiveness.[15] The point is that the above described anticipation can affect the relationship between testosterone and territoriality that was described by Neave and Wolfson (2003). In fact, these authors provide direct evidence

[14] For example, Georganas, Tonin and Vlassopoulos (2015) found some evidence that subjects being observed increase their productivity. In addition, Bernheim and Thomadsen (2005) showed the importance of behavioural implications of anticipatory emotions, whereas Benabou and Tirole (2002) highlighted the role of memory in economic behaviour.

[15] For additional details on positive effect of testosterone on performance in sports see the comprehensive review of Wood and Stanton (2012).

that the level of testosterone among soccer players was significantly higher before home matches than before away matches or training sessions. No difference was found between away matches and training sessions. In addition, they found that the increase in testosterone was higher before matches that were perceived as more important. Similarly, Mazur, Booth and Dabbs Jr. (1992) showed that a pre-game increase in testosterone is less likely to occur in the event that is regarded as less important. These findings are in line with Ward (1998) who studied the effect of opening day matches in Major League Baseball on home advantage. In general these matches are perceived as very important and described as "…more than "just another game"…" and as "…highly ritualistic and festive occasion…" Ward (1998, p. 280). Therefore, players and fans in these matches are expected to be more motivated and as a result the home advantage should be greater. Indeed, the author found significantly higher winning probabilities of home teams on theses opening day matches than in other matches during a regular season.

6 Conclusion

The main motivation of this study is the potential effect of scheduling on the performance of high-profile agents in a real competitive environment for which good productivity data are available. We find that in the German soccer Bundesliga, the home teams perform significantly worse in midweek matches than in weekend matches. In these games, the home advantage, which is important in many different sports, disappears completely. Since the midweek matches are unevenly allocated among teams, this finding implies that the actual schedule of the Bundesliga favours teams with fewer home (more away) games in midweek, which may be considered as an unfair advantage for those teams. Such unfair scheduling plays a significant role in determining teams' season outcomes and as a result may change their income by tens of millions Euros per year.

Our results on lower aggressiveness and decreased performance of home teams during their midweek matches, in addition to the lower crowd during these games, are in line with a biological literature on the relationship between testosterone, importance of the event, performance and territoriality. According to this literature, the midweek matches may be perceived by the home teams' players as less important, which may lead to decreased motivation and as a result to a disappearing home advantage.

Despite being driven by different factors, the day of the week effect on performance was also found in completely different settings. In their seminal paper, Gibbons and Hess (1981) showed that there was a negative mean return of financial assets for Mondays and a positive return for Fridays. More recently, Siganos, Vagenas-Nanos, and Verwijmeren (2014) found a significant relationship between Sunday's sentiment and Monday's stock market characteristics, highlighting the behavioural factors like mood, optimism and happiness that are responsible for this finding. Therefore, since the day of the week effect on performance seems to be a more general behavioural feature than just the effect in soccer, it should be taken into account when evaluating individuals' performance in various fields, such as labour market contests, financial markets or sports competitions.

In particular, it is worthwhile for the Bundesliga management (DFL) to allocate the midweek matches evenly among teams. For example, if there was a midweek round in the first half of the season, then there should be a midweek round in the second half of the season and it should involve the same teams (even if this means changing the order of games in both halves of the season). This more balanced schedule increases the fairness of the tournament.

7 References

Belloni, A., Chernozhukov, V. and Hansen, C., 2014. High-dimensional methods and inference on structural and treatment effects. *The Journal of Economic Perspectives*, 28(2), pp.29-50.

Benabou, R. and Tirole, J., 2002. Self-confidence and personal motivation. *Quarterly Journal of Economics*, 117, pp.871–915.

Bernheim, B.D. and Thomadsen, R., 2005. Memory and anticipation. *The Economic Journal*, *115*(503), pp.271-304.

Bodory, H., Camponovo, L., Huber, M. and Lechner, M., 2016. The finite sample performance of inference methods for propensity score matching and weighting estimators. Mimeo.

Bryson, A., Frick, B. and Simmons, R., 2013. The returns to scarce talent footedness and player remuneration in European soccer. *Journal of Sports Economics*, 14(6), pp.606-628.

Bühlmann, P. and van de Geer, S. 2011, Statistics for High-Dimensional Data: Methods, Theory and Applications, Heidelberg: Springer.

Buraimo, B. and Simmons, R., 2015. Uncertainty of outcome or star quality? Television audience demand for English Premier League football. *International Journal of the Economics of Business*, *22*(3), pp.449-469.

Buraimo, B., 2008. Stadium attendance and television audience demand in English league football. *Managerial and Decision Economics*, *29*(6), pp.513-523.

Coates, D. Frick, B. and Jewell, T., 2014. Superstar salaries and soccer success: The impact of designated players in Major League Soccer. *Journal of Sports Economics*, forthcoming.

Cohen-Zada, D. Krumer, A. and Shtudiner, Z., 2016. Psychological momentum and gender. *IZA Discussion paper No. 9845*.

Courneya, K.S. and Carron, A.V., 1992. The home advantage in sport competitions: a literature review. *Journal of Sport & Exercise Psychology*, *14*(1).

De Bruin, W.B., 2005. Save the last dance for me: Unwanted serial position effects in jury evaluations. *Acta Psychologica*, *118*(3), pp.245-260.

Dohmen, T. and Sauermann, J., 2015. Referee bias. *Journal of Economic Surveys*, forthcoming.

Forrest, D. and Simmons, R., 2006. New issues in attendance demand the case of the English Football League. *Journal of Sports Economics*, *7*(3), pp.247-266.

Franck, E. and Nüesch, S., 2012. Talent and/or popularity: What does it take to be a superstar?. *Economic Inquiry*, *50*(1), pp.202-216.

Frick, B., 2006. Salary determination and the pay-performance relationship in professional soccer: Evidence from Germany. Sports Economics After Fifty Years: Essays in Honour of Simon Rottenberg. Oviedo: Ediciones de la Universidad de Oviedo, pp.125-146.

Garicano, L., Palacios-Huerta, I. and Prendergast, C., 2005. Favoritism under social pressure. *Review of Economics and Statistics*, *87*(2), pp.208-216.

Georganas, S., Tonin, M. and Vlassopoulos, M., 2015. Peer pressure and productivity: The role of observing and being observed. *Journal of Economic Behavior & Organization*, *117*, pp.223-232.

Gibbons, M.R. and Hess, P., 1981. Day of the week effects and asset returns. *Journal of Business*, pp.579-596.

Hastie, T., Tibshirani, R. and Friedman, J. (2009): The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition, Springer (10th printing with corrections, 2013).

Huber, M., Lechner, M. and Wunsch, C., 2013. The performance of estimators based on the propensity score. *Journal of Econometrics*, 175(1), pp.1-21.

Huntingford, F.A. and Turner, A.K., 1987. Animal conflict. London: Chapman and Hall.

Imbens, G.W., and Wooldridge, J.M., 2009. Recent Developments in the Econometrics of Program Evaluation. *Journal of Economic Literature*, 47 (1), pp.5-86.

Klumpp, T. and Polborn, M.K., 2006. Primaries and the New Hampshire effect. *Journal of Public Economics*, *90*(6), pp.1073-1114.

Knowles, G., Sherony, K. and Haupert, M., 1992. The demand for Major League Baseball: A test of the uncertainty of outcome hypothesis. *The American Economist*, pp.72-80.

Krumer, A., 2013. Best-of-two contests with psychological effects. *Theory and decision*, *75*(1), pp.85-100.

Krumer, A., Megidish, R. and Sela, A., 2016. First-mover advantage in round-robin tournaments. mimeo.

Lechner, M., Miquel, R. and Wunsch, C., 2011. Long-run effects of public sector sponsored training in West Germany. *Journal of the European Economic Association*, 9(4), pp.721-784.

Mazur, A., Booth, A. and Dabbs Jr, J.M., 1992. Testosterone and chess competition. *Social Psychology Quarterly*, pp.70-77.

Moskowitz, T. and Wertheim, L.J., 2011. Scorecasting: The hidden influences behind how sports are played and games are won. Crown Archetype.

Neave, N. and Wolfson, S., 2003. Testosterone, territoriality, and the 'home advantage'. *Physiology & Behavior*, *78*(2), pp.269-275.

Oberhofer, H., Philippovich, T. and Winner, H., 2010. Distance matters in away games: Evidence from the German football league. *Journal of Economic Psychology*, 31(2), pp.200-211.

Page, L. and Page, K., 2007. The second leg home advantage: Evidence from European football cup competitions. *Journal of Sports Sciences*, *25*(14), pp.1547-1556.

Page, L. and Page, K., 2010. Last shall be first: A field study of biases in sequential performance evaluation on the Idol series. *Journal of Economic Behavior & Organization*, *73*(2), pp.186-198.

Palacios-Huerta. I., 2012. Tournaments, fairness and the Prouhet-Thue-Morse sequence. *Economic Inquiry*, *50*(3), pp.848-849.

Palacios-Huerta, I., 2014. Psychological pressure on the field and elsewhere. Chapter 5 in Beautiful game theory: How soccer can help economics. Princeton University Press.

Paul, R.J., 2003. Variations in NHL attendance: the impact of violence, scoring, and regional rivalries. *American Journal of Economics and Sociology*, *62*(2), pp.345-364.

Pettersson-Lidbom, P. and Priks, M., 2010. Behavior under social pressure: Empty Italian stadiums and referee bias. *Economics Letters*, *108*(2), pp.212-214.

Pollard, R., 2002. Evidence of a reduced home advantage when a team moves to a new stadium. *Journal of Sports Sciences*, *20*(12), pp.969-973.

Schofield, J.A., 1983. Performance and attendance at professional team sports. *Journal of Sport Behavior*, *6*(4), p.196.

Scoppa, V., 2015. Fatigue and team performance in soccer: Evidence from the FIFA World Cup and the UEFA European Championship. *Journal of Sports Economics*, 16(5), pp.482-507.

Siganos, A., Vagenas-Nanos, E. and Verwijmeren, P., 2014. Facebook's daily sentiment and international stock markets. *Journal of Economic Behavior & Organization*, *107*, pp.730-743.

Sutter, M. and Kocher, M.G., 2004. Favoritism of agents–the case of referees' home bias. *Journal of Economic Psychology*, 25(4), pp.461-469.

Terry, P.C., Walrond, N. and Carron, A.V., 1998. The influence of game location on athletes' psychological states. *Journal of Science and Medicine in Sport*, *1*(1), pp.29-37.

Ward, R.E., 1998. Rituals, first impressions, and the opening day home advantage. *Sociology of Sport Journal*, *15*, pp.279-293.

Wood, R.I. and Stanton, S.J., 2012. Testosterone and sport: Current perspectives. *Hormones and Behavior*, *61*(1), pp.147-155.

Zou, H., 2006. The Adaptive Lasso and Its Oracle Properties, *Journal of the American Statistical, Association*, 101(476), pp.1418-1429.

Appendix A: Descriptive statistics

The following table contains descriptive statistics for all variables (outcomes, treatment, and controls) relevant for this study.

Table A.1: Descriptive statistics (sample means)

Variables	Weekend games	Midweek games	Long rest games	Short rest games	Overall
Game outcomes					
Points- home team	1.60	1.38	1.60	1.45	1.58
Points- away team	1.14	1.45	1.14	1.33	1.16
Goals- home team	1.56	1.55	1.57	1.54	1.56
Goals- away team	1.23	1.38	1.23	1.31	1.24
Shots- home team	14.43	13.97	14.45	13.99	14.39
Shots- away team	11.93	11.82	11.91	12.05	11.93
Shots on target- home team	5.14	5.01	5.15	5.03	5.13
Shots on target- away team	4.19	4.45	4.19	4.36	4.21
Fouls- home team	16.02	14.68	16.01	15.26	15.92
Fouls- away team	17.11	16.45	17.14	16.53	17.06
Yellow cards- home team	1.63	1.73	1.63	1.69	1.64
Yellow cards- away team	1.95	1.91	1.95	1.93	1.95
Red cards- home team	0.07	0.10	0.07	0.08	0.08
Red cards- away team	0.10	0.10	0.10	0.11	0.10
Corners- home team	5.59	5.38	5.58	5.53	5.57
Corners- away team	4.42	4.14	4.42	4.26	4.40
Game characteristics					
Attendance	40,765	40,767	40,851	40,154	40,765
Attendance as share of capacity of stadium	0.91	0.86	0.91	0.88	0.90
Attendance as share of capacity of stadium if higher than 0.99	0.34	0.24	0.34	0.27	0.33
Ln of stadium capacity	10.65	10.69	10.65	10.66	10.65
Distance between the cities of the teams (km)	365	370	366	361	365
Public transport commuting time between the cities (minutes)	194	198	194	196	194
Africa Cup of Nations months	0.13	0.06	0.13	0.08	0.12
Two months before World Cup or European Championship	0.10	0.19	0.10	0.18	0.11
Two months after World Cup or European Championship	0.07	0.19	0.06	0.18	0.08
Season after World Cup or European Championship	0.45	0.52	0.44	0.54	0.45
Rounds 1-11 (beginning of a season)	0.27	0.39	0.26	0.36	0.27
Rounds 12-22 (middle of a season)	0.35	0.22	0.36	0.23	0.34
Rounds 23-34 (end of a season)	0.38	0.39	0.38	0.40	0.38
August or September	0.18	0.32	0.18	0.30	0.20
Rounds 1-6	0.14	0.20	0.15	0.12	0.15

Table A.1 to be continued

Table A.1: Continued…

Variables	Weekend games	Midweek games	Long rest games	Short rest games	Overall
Team characteristics					
Value of home team (Mil. €)	86.1	106.3	86.3	96.7	87.6
Value of away team (Mil. €)	89.9	103.2	89.3	102.4	90.9
Standardized value of home team	-0.19	-0.03	-0.18	-0.12	-0.18
Standardized value of away team	-0.14	0.01	-0.15	-0.02	-0.13
First season after promotion- home team	0.16	0.15	0.16	0.14	0.16
First season after promotion- away team	0.15	0.12	0.15	0.13	0.15
Ratio of top 3 to ranked 9-11 players' values- home team	2.34	2.16	2.33	2.27	2.33
Ratio of top 3 to ranked 9-11 players' values- away team	2.33	2.46	2.34	2.36	2.34
HHI of players' values- home team	0.06	0.06	0.06	0.06	0.06
HHI of players' values- away team	0.06	0.06	0.06	0.06	0.06
New coach- home team	0.18	0.10	0.18	0.14	0.17
New coach- away team	0.17	0.15	0.18	0.13	0.17
Previous season shots-home team	14.61	15.06	14.62	14.78	14.63
Previous season shots-away team	11.97	12.10	11.96	12.08	11.98
Previous season shots on target-home team	5.63	6.16	5.63	5.93	5.67
Previous season shots on target-away team	4.56	4.90	4.55	4.82	4.58
Previous season corners-home team	5.67	5.78	5.69	5.63	5.68
Previous season corners-away team	4.39	4.44	4.38	4.43	4.39
Previous season fouls-home team	16.35	16.02	16.35	16.12	16.32
Previous season fouls-away team	17.56	17.33	17.57	17.34	17.54
Previous season yellow cards-home team	1.63	1.58	1.63	1.62	1.63
Previous season yellow cards -away team	1.97	1.94	1.97	1.94	1.96
Previous season red cards-home team	0.08	0.07	0.08	0.07	0.08
Previous season red cards -away team	0.11	0.11	0.11	0.11	0.11

Note: This Table presents the selected characteristics. Weekend games are the games that took place on Fridays-Sundays. Midweek games are the games that took place on Mondays-Thursdays. Long rest games are the games that took place on weekend with no previous midweek league's matches. Short rest games are second matches a team played during a week, namely weekend matches after midweek matches or midweek matches after the weekend matches.

Appendix B: Propensity score estimation

Table B.1 contains the detailed estimation results of the propensity (after variable selection by the double-Lasso as described in the main text).

Table B.1: Estimation of propensity score (mean marginal effects)

Variables	Midweek with attendance	Midweek without attendance	Short rest with attendance	Short rest without attendance
Game characteristics				
Attendance (in 10,000)	0.004**		0.001	
Attendance as share of capacity of stadium	0.192		0.740	
Attendance as share of capacity of stadium squared	-0.405		-0.680	
Attendance as share of capacity of stadium if higher than 0.99	-0.010		-0.010	
Africa Cup of Nations months	-0.028*	-0.025	-0.036*	-0.020
August or September	0.151***	0.157***	0.249***	0.278***
Ln of stadium capacity	-0.110*	0.027	-0.063	0.006
Season after World Cup or European Championship	0.059***	0.063***	0.084***	0.076***
Two months before World Cup or European Championship	0.149***	0.111***	0.201***	0.154***
Two months after World Cup or European Championship			0.178***	0.216***
Difference between teams' values two months before World Cup or European Championship	0.000	-0.000		-0.000
Rounds 1-6	-0.055***	-0.057***	-0.165***	-0.168***
Team characteristics				
Difference in promotion status	0.008	0.001	0.011	-0.007
Difference in HHI in the middle of season	4.033***	3.001***	1.141	0.682
Difference in new coach in the middle of season	-0.036*	-0.030		-0.003
Difference in teams' standardized values	0.000	-0.000	-0.017	-0.003
Standardized value of home team if less than -0.8			-0.050**	
Difference in teams' median values	-0.001	0.000	-0.009	-0.002
Median value- home team			0.017**	
Squared value-home team			0.000	
Squared difference in teams' values	0.001***	0.001***		0.001***
Squared difference in teams' values in the end of season	0.000			
Squared ratio of teams' values in the beginning of season		0.000	0.001	
Ln of difference of teams' ratio of top 3 to ranked 9-11 players' values	-0.100***	-0.084***	-0.039*	-0.028
Ln of difference of teams' ratio of top 11 to ranked 12-22 players' values in the beginning of season	0.073**			
Squared difference of teams' ratio of top 11 to ranked 12-22 players' values	-0.000	0.000		0.000
Difference in standardized values of teams if values are positive	-0.015	-0.018		0.004

Table B.1 to be continued

Table B.1: Continued…

Variables	Midweek with attendance	Midweek without attendance	Short rest with attendance	Short rest without attendance
Ratio between teams' values if higher than 5	-0.026			
Ratio between teams' values if higher than 3 in the middle of season	0.024			
Ratio between teams' values if higher than 4 in the middle of season			0.261**	
Ratio between teams' values if higher than 1 in the beginning of season			0.043	
Difference between teams' values if ratio between values is higher than 2 in the middle of season	-0.009	-0.015	-0.002	
Difference between teams' values if ratio between values is higher than 2 in the beginning of season		0.000		
Difference between teams' values if ratio between values is higher than 5 in the end of season			-0.123***	
Difference between teams' values if ratio between values is higher than 5 in the middle of season			-0.102**	
Ratio between teams' values if higher than 3 in the end of season			0.134***	
Difference between previous season's corners in the end of current season	0.015**	0.012*		0.009
Ln of previous season's corners-home team	0.014	-0.072	-0.066	-0.177***
Difference in previous season's fouls in the end of current season	0.004	0.006	0.001	-0.001
Difference in previous season's fouls in the middle of current season			0.014***	
Ln of previous season's fouls- home team			-0.211***	
Previous season's red cards-home team	-0.082	-0.103		-0.108
Difference in previous season's shots in the beginning of current season	0.002	0.001		0.004
Difference in previous season's yellow cards	-0.003	0.006	0.014	0.013
Difference in previous season's red cards in the middle of current season			-0.272**	
Previous season's shots on target- home team		0.018***	0.015***	0.019***

Note: Mean marginal effects presented. *, **, *** denotes significance at the 10%, 5%, 1% level respectively. Inference based on bootstrapping (99 replications) standard deviation and using asymptotic normal distribution for inference. The difference and ratio related variables are always defined as difference or ratio between home and away measures.

Appendix C: Results of robustness checks

Table C.1 shows the results for using different specifications of the 'treatment variable', 'midweek' and 'short rest', which covers all games with a shorter rest period, i.e. midweek games, as well as weekend games after midweek games. Furthermore, both specifications are shown when controlling and not controlling for attendance (which be considered as affected by the midweek effect and thus be endogenous).

Table C.1: Effects of different specifications

Variables	Midweek with attendance	Midweek without attendance	Short rest with attendance	Short rest without attendance
Points home team	-0.216*	-0.080	-0.011	-0.023
Points away team	0.291***	0.190**	0.073	0.093
Difference in points	-0.507**	-0.271	-0.085	-0.116
Goals home team	-0.175*	-0.027	0.056	0.043
Goals away team	0.112	0.075	0.017	0.078
Difference in goals	-0.286*	-0.102	0.039	-0.035
Shots home team	-0.595	-0.868***	-0.575**	-0.515
Shots away team	-0.104	0.000	0.390*	0.285
Difference in shots	-0.491	-0.868	-0.965***	-0.800*
Shots on target home team	-0.411**	-0.457***	-0.131	0.023
Shots on target away team	0.065	0.086	0.173	0.314*
Difference in shots on target	-0.477**	-0.543***	-0.303*	-0.292
Fouls home team	-1.414***	-1.610***	-0.615***	-0.386
Fouls away team	-0.763**	-0.617**	-0.451**	-0.695**
Difference in fouls	-0.651*	-0.994**	-0.164	0.309
Yellow cards home team	0.249**	0.124*	0.086	0.086
Yellow cards away team	0.068	-0.032	0.200**	0.119
Difference in yellow cards	0.181	0.156	-0.114	-0.033
Red cards home team	-0.021	0.023	0.015	0.017
Red cards away team	0.051	0.015	0.015	-0.006
Difference in red cards	-0.072*	0.005	-0.000	0.023
Attendance as share of capacity of stadium		-0.079***		-0.024*
Remaining observations in common support (%)	82	92	99	100

Note: Mean marginal effects presented. *, **, *** denotes significance at the 10%, 5%, 1% level respectively. Inference based on bootstrapping (4999 replications) p-values. The difference related variables are defined as difference between home and away measures.

Appendix D: List of Sources

www.uefa.com

www.fifa.com

www.transfermarkt.com

www.football-data.co.uk

www.rsssf.com

www.espnfc.com

https://en.wikipedia.org/wiki/Bundesliga

www.regionalstatistik.de