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Competition and Fan Substitution Between Professional Sports Leagues

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Abstract

A peculiarity in professional sports is the fact that leagues regularly hold monopoly power *within their sports*. However, whether and to what extent these leagues may compete with other leagues *across sports* is relatively unexplored. This paper contributes to the literature by analyzing competition and fan substitution in Germany, where top-tier league managers in handball, basketball, and ice hockey have recently claimed that their teams suffer from football's dominant position. Our attendance demand models confirm the existence of significant substitution effects in this setting, which suggests that leagues indeed do compete economically *across sports* for fan attendance.

Keywords Budget constraints · Spatial competition · Sports demand · Time constraints

1 Introduction

Competitor identification is an important task for any company with competitive threats that arise from substitutability either on the supply or the demand side. Moreover, it is important for clearly defining markets—which, in turn, is crucial for developing antitrust and regulatory policies in any industry (Bergen & Peteraf, 2002). Accordingly, the analysis of substitutability has already some tradition in empirical economic research (e.g., Kalnins, 2003; Stigler & Sherwin, 1985).

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A peculiar case in this regard is professional sports. On the one hand, leagues regularly hold monopoly power *within their sports* (for a discussion see Vrooman, 2009). On the other hand, they may well compete for broadcasting revenues, sports ownership, or fan interest with leagues in *other sports*. In fact, already in 1982, the U.S. Circuit Court of Appeals (670 F.2d 1249) found the National Football League (NFL) ban on cross-ownerships to be anticompetitive. This was based on the argument that the ban restricts teams in other sports—in this case North American Soccer League (NASL) teams—from sports ownership capital.[1]

However, whether and to what extent leagues *indeed* compete across sports, is relatively unexplored. The few existing studies that previously looked at competition and fan substitution across sports exclusively focused on the North American market where selection issues are present. Most notably, the franchise system enables leagues to limit or even avoid any competition across sports within the same region. Moreover, most of these studies only offer limited evidence given the rough substitution measures that were employed.

By using game-level attendance data for the top-tier German leagues in handball, basketball, and ice hockey, we analyze the effect on these leagues of top-tier football (soccer) games that are played concurrently in Germany. We contribute to the literature in two ways: *First*, we analyze competition and fan substitution in a European setting, where the implemented promotion-and-relegation system makes it impossible for leagues to take full control over the team-league-allocation in a given league. Moreover, professional football dominates *by far* all other sports (see Buzzacchi et al., 2010) and thereby constitutes a practically highly relevant case to explore. This dominant position has raised serious concerns among league officials and managers in other sports, who have recently claimed that their teams suffer from an intensified competition for fan interests – particularly in Germany.[2] *Second*, we depart from previously implemented substitution measures and explicitly test whether substitution can be observed even for games that are not played concurrently but are played a few days before or after.

Overall, our findings suggest that scheduling overlaps with nonlocal and local football games have a sizeable negative impact on the demand for games in other sports leagues. Moreover, we provide some evidence for the relevance of intertemporal time and budget constraints since substitution effects are also evident within a few days before or after football games take place.

[1] The U.S. Supreme Court subsequently denied the NFL's petition for certiorari (459 U.S. 1074). However, Justice Rehnquist wrote a dissent in this case in which he argued (amongst others) that individual NFL teams compete with each other on the field, but rarely in the marketplace. Moreover, he argued that NFL teams compete as a unit against other sports leagues and other forms of entertainment for consumers. Note that the NFL continued to operate as if the cross-ownership ban was still in place (with few exceptions) until recently. The NFL owners voted to lift the longstanding cross-ownership prohibition in October 2018.

[2] In Germany, the top-tier football league generates about eight times as much revenues – about €2.4 billion – as the top-tier leagues in handball ('Handball Bundesliga' – HBL), basketball ('Basketball Bundesliga' – BBL), and ice hockey ('Deutsche Eishockey Liga" – DEL) *together*: about €300 million. Recently, the HBL decided to schedule the majority of its games from season 2017/18 onwards either on Thursday evening or on Sunday noon in order to avoid scheduling clashes with football games.

The remainder of the paper is as follows: The following section provides the theoretical background and discusses the related literature. The third section presents some relevant background information on the organizational and financial structures of the professional sports leagues and outlines the empirical strategy that we employ. The fourth section presents the findings of this study. The fifth section concludes.

2 Conceptual Framework and Related Literature

Considering substitution in general, Hotelling's (1929) seminal work was the first to mention the relevance of spatial proximity of firms that compete in a duopolistic market. Since then, the literature on spatial competition and location choice emerged (e.g., Chamberlin, 1953; Lerner & Singer, 1937; Lösch, 1954). Rottenberg (1956) was the first to discuss the relevance of (spatial) competition and the possibilities of fan substitution in professional sports.

Following Mongeon and Winfree (2013), it can be argued that in contrast to fans of a specific sport, more general sport-interested people are likely to consume any available sport in the market. Thus, 'general sports fans' might seek to attend all of the games in which they are interested and would not necessarily substitute one game for another. However, certain constraints keep these fans from consuming all of the games that they are generally willing to attend.

For instance, temporally overlapping games force the 'general sports fan' to choose between either attending a game of sports league *x* at a given venue or watching a game of sports league *y* on TV (or computer, tablet, phone or any other favorite connected device). If clubs from different sports leagues are located in proximity, such a fan might even consider physically attending a game of sports league *y* instead. Moreover, individual time and budget constraints (Becker, 1965) force 'general sports fans' to allocate their available time and money to alternative leisure activities *within a certain time frame*.

Given these constraints and the massive appeal of professional football in Europe, it appears plausible to assume that professional football games are perceived as substitutes for other (less popular) sports and athletes—at least by 'general sports fans' who prefer football and the star appeal of its players (Adler, 1985).

Recent literature on substitution in sports has predominantly focused on substitution effects in North American Major Leagues. Some of these studies analyzed substitution effects of clubs that compete within the same league (e.g., Mills & Rosentraub, 2014; Mills et al., 2016; Mondello et al., 2017; Tainsky & Jasielec, 2014; Tainsky et al., 2016; Winfree et al., 2004), while others have examined substitution across different leagues and divisions of the same sport (e.g., Gitter & Rhoads, 2010; Rascher et al., 2009; Winfree & Fort, 2008).

The few existing studies that have analyzed fan substitution in Europe have focused on the same-sport comparisons. In this regard, attendance demand for lower division games was found to be negatively affected by concurrent European club competition broadcasts (Buraimo et al., 2009; Forrest & Simmons, 2006; Forrest et al., 2004). In addition, Wallrafen et al. (2019) found significant substitution effects between top and lower division football games by considering both spatial proximity and temporal overlaps. Finally, Nielsen et al. (2019) looked at the impact of English Premier League (EPL) broadcasts on Danish first-division football attendance and introduced an interaction between televised games and weather conditions. They found that the negative effect of adverse weather conditions on attendance demand is amplified when EPL games are broadcast concurrently.

Only a few studies have focused on competition between different sports (leagues). For instance, examining baseball attendance and local competition with other North American major sports leagues, Baade and Tiehen (1990) found that having other competitors in the same geographic area has an adverse effect on attendance. In contrast, Kahane and Shmanske (1997) did not find any statistically significant relationship in the same setting. Paul (2003) reported decreased attendance for National Hockey League (NHL) clubs due to the existence of other professional clubs in the same metropolitan area. With regard to the National Basketball Association (NBA), Rascher et al. (2009) as well as Winfree (2009) found a positive effect on attendance demand in the league during the 2004–2005 NHL lockout, which indicates the existence of substitution effects between these two major sports leagues. Finally, Mills et al. (2015) provided evidence for fan substitution across North American sports leagues by analyzing whether passenger car border crossings between the US and Canada are affected by National Football League (NFL), Major League Baseball (MBL), NHL, NBA, and Canadian Football League (CFL) games of teams that are located across the border.

Our contribution to the literature is twofold: *First*, we analyze the relevance of local and nonlocal competition between sports leagues in the European market.[3] This seems highly relevant since a single sport—football—dominates *by far* the domestic sports markets in most European countries. Moreover, the North American franchise system enables leagues to limit or even avoid any competition across sports within the same region, which raises some selection issues. In Europe, however, the promotion-and-relegation system makes it impossible for leagues to take full control over the team-league allocation in a given league.

Second, our study is the first to test whether substitution can be observed even for games that are not played concurrently but instead are played a few days before or after. By considering such intertemporal consumption plans of sports fans, we hope to stimulate the empirical design of future studies that analyze substitution effects in sports and other (entertainment) industries.

[3] To the best of our knowledge, the only related study in a European setting examines the effects of major tournaments – the Wimbledon tennis tournament and the FIFA Football World Cup – on the attendance of “friendly games” in British cricket (Hynds and Smith, 1994).

3 Setting and Empirical Design

Our setting is Germany, where the leagues of the most popular sports are ranked among the best in Europe: Football 4th; Handball 1st; Basketball 7th; and Ice Hockey 5th.[4] At the same time, however, football has a particularly dominant position in the German market—with the average attendance (season 2014/2015) of handball, basketball, and ice hockey being just about 12 (30) percent of the average attendance for the first (second) division in football. Likewise, large differences occur also with regard to the revenues that are generated by these leagues. Moreover, since all leagues begin and end more-or-less at the same time of the year—amongst other reasons, so as to avoid scheduling clashes with international tournaments such as the Olympic Games—and all matchdays are frequently scheduled on Fridays, Saturdays, and Sundays, there is a considerable number of overlapping games. See Table 1 for more details about the respective leagues.

3.1 Sampling

We use game-level attendance data for the HBL, BBL, and DEL over five seasons (2012/2013–2016/2017), with a gross sample of 1566, 1670, and 2036 observations, respectively. These observations reduce to a net sample of 1506 HBL, 1561 BBL, and 2001 DEL games due to the following reasons:

First, all leagues under consideration operate with a club licensing system. If clubs fulfil a set of requirements—which include sports-related, legal, and financial criteria—they are eligible to participate in the concerning competitions. During the period under consideration, four licenses were withdrawn as the clubs failed to meet at least one of these criteria. Two of these withdrawals occurred during the regular season, which led to missing values for 34 games of *HSV Hamburg* (HBL, season 2015/2016) and 23 missing values for *Phoenix Hagen* (BBL, season 2016/2017).

Second, due to promotion and relegation, some football games that potentially were in competition to HBL, BBL, or DEL games were played by clubs that participated in the third division or even the fourth division during any of the seasons in our observation window. Given that fourth-division clubs (i) are regularly semi-professional only, (ii) their games are less popular in terms of demand, and (iii) severely affected by substitution to top-tier football themselves (see Wallrafen et al., 2019), the inclusion of football games that were played at that level causes severe

[4] As of November 2018. In European professional sports, country rankings reflect the performance of the domestic clubs in Pan-European competitions such as the UEFA Champions League. Based on their international performance, these clubs accumulate points (referred to as “club coefficients”), which are summed over a certain period: three seasons in handball; four seasons in ice hockey; five seasons in football. Country rankings represent the collective (international) performance of these clubs over that period. Football rankings are based on the UEFA association club coefficients. Handball rankings are based on the European Handball Federation (EHF) club coefficients. Ice hockey rankings are based on the Champions Hockey League’s (CHL) club coefficients. Basketball rankings are taken from a commercial provider (eurohoops.net) since there is no official league level ranking of an international federation available.

Table 1 League characteristics

Characteristic	HBL	BBL	DEL	2BL	1BL
League system	Open	Open	Closed [1)]	Open	Open
Number of teams	18	18	14	18	18
Regular season modus	2 × round robin	2 × round robin	4 × round robin	2 × round robin	2 × round robin
Playoffs	No	Yes	Yes	No	No
Points for win / draw / loss	2/1/0	2/–/0	3(2)/–/0(1) [2)]	3/1/0	3/1/0
Season start	23/08/2014	02/10/2014	12/09/2014	01/08/2014	22/08/2014
Season end	05/06/2015	21/06/2015	26/04/2015	24/05/2015	23/05/2015
Average attendance	4591	4655	6528	17,613	42,685
Total revenues in million EUR	96.1	97.8	107.4	463.1	2391.8
Total expenditures in million EUR	89.8	94.1	Not specified	458.2	2198.0

An open (closed) league system means (no) sporting promotion and relegation of clubs. [(1)] DEL implemented an open league system from season 2020/2021 onwards. [(2)] In the DEL, teams receive three points for a win or zero points for a loss within the normal playing time as well as two points for a win or one point for a loss when there is overtime and/or penalty shootout. Season scheduling, average attendance, and revenues/expenditures are as of season 2014/2015. Total league revenues/expenditures data were retrieved from DFL (2018) and Deloitte (2015). Figures exclude transfer revenues/expenditures. *BBL* Basketball Bundesliga; *DEL* Deutsche Eishockey Liga [German Ice Hockey League]; *HBL* Handball Bundesliga; *1BL* First German Football Bundesliga; *2BL* Second German Football Bundesliga endogeneity concerns. Therefore, we decide to remove these fourth-division cases from our sample. Overall, 17 handball games (*ThSV Eisenach* in season 2013/14), 51 basketball games (*Mitteldeutscher B.C.* in season 2012/13; *Würzburg* in season 2012/13 and 2013/14), and 29 ice hockey games (*Straubing Tigers* in season 2015/16) are removed. In contrast, however, since empirical evidence suggests that third-division clubs are only marginally affected by substitution to top-tier football (see Wallrafen et al., 2020), we decide to keep HBL, BBL, and DEL games that were in competition to games that featured teams that were (recently) relegated to the third division. Finally, we remove some observations (9 for the HBL, 35 for the BBL, and 6 for the DEL) due to missing information on attendance figures, weather conditions, or betting odds.

3.2 Empirical Model

Our main hypothesis is that football games that are played concurrently or in temporal proximity have a negative effect on the demand in other leagues. In order to test this hypothesis, we regress the natural logarithm of attendance at the game of home team i against visiting team j in season s on variables that capture these potential substitution effects (S_{ijs}), as well as a vector of variables that control for game characteristics, scheduling information, and opportunity costs (C_{ijs}).[5] In order to control for unobservable heterogeneity between the markets of each team as well as time trends and season-specific unobserved effects, we include fixed effects that identify the home team (α_i), the away team (α_j), and the season (α_s). e_{ijs} is the error term that captures any unobservable factors that affect attendance.

This leads to the following specification:

$$\ln(ATT)_{ijs} = \beta_1 S_{ijs} + \beta_2 C_{ijs} + \alpha_i + \alpha_j + \alpha_s + e_{ijs}. \tag{1}$$

In order to measure substitution, we utilize two different variables (S_{ijs}): Following Forrest and Simmons (2006), we employ a dummy variable (*UCL*) that measures concurrent televised UEFA Champions League games that feature German clubs that are played on Tuesday and Wednesday; the variable takes the value '1' for games that were played up to two hours before or after the kick-off time of UEFA Champions League games.[6] Since local fans typically support local (football) teams (for a discussion see Giulianotti, 2002), the second variable (*Local*) measures the absolute number of days between each home game (of HBL, BBL, and DEL clubs) and the temporally closest home game of the nearest 1BL or 2BL club; thus every HBL, BBL, and DEL team has a fixed football competitor in our setting (see Table 6). This way we are able to consider intertemporal consumption plans of sports consumers. We hypothesize that the more days that separate both games, the

5 The use of this log-specification allows for comparing estimates across leagues by interpreting results in percentage changes.

6 In contrast to Wallrafen et al. (2019), we do not employ a measure for concurrent televised domestic football games at the traditional kick-off time – Saturdays 3.30 p.m. – since we observe very few HBL, BBL, and DEL games on Saturday afternoons.

less likely it is that the time or budget constraints of the sports consumers are binding. Therefore, comparably larger substitution effects are expected for games with comparably closer temporal proximity.[7]

Table 2 provides an overview of the characteristics of the respective football clubs that are (potentially) in competition to HBL, BBL, and DEL clubs. It becomes apparent that the sporting performance (average league ranking) and popularity (number of club members[8]) of the potential substitutes is on average higher for BBL and DEL clubs than for HBL clubs. Moreover, compared to the BBL and DEL, the average distance to the nearest football club is larger in the HBL.

The vector of control variables (C_{ijs}) covers relevant predictors of attendance demand in line with previous empirical studies. Following Forrest and Simmons (2002), we use the points scored by the home ($Perf_H$) and away ($Perf_A$) team in the previous five games as a proxy for current performance. It is expected that better performance exerts a positive effect on demand. Furthermore, using betting odds data, we estimate the home win probability (*Hwin*) and its squared term ($Hwin^2$) to test the "uncertainty-of-outcome hypothesis" (UOH) (see Rottenberg, 1956, and Neale, 1964). Due to the bookmaker's margin, the sum of probabilities (1/decimal odd) of all outcomes (home/away win and draw) is greater than one. As is common in the literature, we adjust each probability by dividing it by the sum of all probabilities in a given game. Overall, the UOH postulates an inverse U-shaped relationship: Attendance is maximized in games where the contestants have relatively equal chances of winning.[9]

Moreover, a set of dummy variables is used to control for the day of the week and public holidays (*Hday*). Based on previous findings it is expected that weekend games (Knowles et al., 1992) and games staged on public holidays (Schofield, 1983) attract larger audiences. Furthermore, we control for the number of matchdays played and its squared term (*Mday*, $Mday^2$). In line with previous studies on outdoor sports (e.g., Pawlowski & Anders, 2012; Pawlowski & Nalbantis, 2015), we expect

[7] Due to the high demand for football game tickets in Germany – for instance, the average capacity utilization in the 1BL in season 2016/2017 was 91% (DFL, 2018) – we expect that sports consumers purchase tickets several days in advance. Indeed, available disaggregated ticket sales data of a German 1BL club suggests that about 95% of attendees regularly purchase tickets at least two days before kick-off.

[8] Historically, most sports clubs in Germany are not-for profit organizations, owned and run by members' associations. Usually, they comprise a variety of sport departments/segments which can be run as for-profit (e.g., professional football club) or not-for profit (e.g., gymnastics) organizations. Typically, the members pay an annual fee and receive in turn several benefits (e.g., access to gyms, ticket or merchandizing discounts, or else), but also voting rights. Regarding professional football clubs, with few exceptions (e.g., Bayer Leverkusen), the members' associations hold the majority of the voting rights and thus retain overall control (for a discussion see Coates et al., 2021).

[9] Note, the UOH is subject to theoretical and empirical contradictions. Budzinski and Pawlowski (2017) provide a recent overview on alternative theories grounded in behavioral economics. See Pawlowski et al. (2018) or Nalbantis and Pawlowski (2019) for some latest empirical findings contradicting the UOH. An overview on previous studies that test the UOH for TV viewing is provided by Nalbantis and Pawlowski (2016). For an overview on previous studies that test the UOH with regard to attendance demand see Pawlowski (2013), Coates et al. (2014) or Schreyer et al. (2016).

Table 2 Characteristics of football clubs functioning as substitutes

	HBL			BBL			DEL		
Football division	Average Ranking	Average Members	Average Distance in km	Average Ranking	Average Members	Average Distance in km	Average Ranking	Average Members	Average Distance in km
First division	10.6	67,123	55	10.0	86,603	38	8.8	82,609	16
Second division	9.2	15,417	38	7.0	19,545	49	9.0	22,846	16
Third division	6.5	8404	63	5.9	4314	49	11.2	2700	52
Overall	9.9	47,558	51	8.6	56,689	43	9.0	58,099	17

The *Ranking* denotes the average of rankings at the end of each season of every substitute in our dataset. *Members* as of August 2019 and denote the average of club's members in our dataset. *Distance in km* denotes the average distance in kilometers between the venues of HBL, BBL, and DEL clubs to the venues of their nearest football club competitor for each observation in our dataset. Data on *Ranking* and *Members* were retrieved from www.transfermarkt.de. The *Distance* is based on own calculations (see Table 6 in the Appendix). *BBL* Basketball Bundesliga; *DEL* Deutsche Eishockey Liga [German Ice Hockey League]; *HBL* Handball Bundesliga to find higher demand at the beginning of the season and also at the end of the season when decisive games take place.[10]

In order to capture the travel costs of away fans, we include the distance between the venues of both opponents (*Dist*) and its squared term (*Dist*^{2}) in our models.[11] In line with previous studies (e.g., Baimbridge et al., 1996), we expect a U-shaped relationship between distance and attendance. On the one hand, short distances capture traditional rivalries, which typically attract more fans (see, for instance, Pawlowski & Nalbantis, 2015). On the other hand, traveling longer distances might be required in case that metropolitan areas—which typically host attractive teams—are rather geographically widely spread (see, for instance, Baimbridge et al., 1996). In fact, metropolitan areas in Germany can be found in the northern, western, eastern, and southern part of the country, while central Germany is relatively less populated.

Moreover, we include a variable (*Prec*) that measures whether precipitation fell during the matchday. Following Nielsen et al. (2019), we expect an inverse U-shaped relationship with regard to the average temperature (*Temp*)[12] on the day of the game (and its squared term *Temp*^{2}) and attendance demand. Since the attractiveness of concurrent broadcasts may depend on weather conditions, we also include interaction terms between *UCL*, *Temp*, and *Temp*^{2}.[13] Our intuition is that precipitation and low temperatures may negatively affect attendance due to travel (in)conveniences. At the same time, however, relatively high temperatures usually come along with an increase in outdoor leisure activity options (Siegfried & Eisenberg, 1980), thus, also reducing attendance demand. Overall, since weather forecasts are regularly more reliable for temperature rather than precipitation, it appears plausible to assume that the decision to purchase a ticket may rely more on temperature than on precipitation.

Finally, we include a dummy variable that measures relocation: 25 HBL games, 36 BBL games, and three DEL games were not played at the 'usual' home grounds but in nearby venues with larger capacities. All variable descriptions and descriptive statistics are provided in Tables 3 and 4.

We estimate Eq. (1) with a regression. Common issues when dealing with attendance data are sellouts and the fact that venue capacities may be reduced due to safety reasons and crowd segregation (Forrest et al., 2004). To approach these issues, we employ league specific Tobit models with individual cut-off points (Amemiya, 1973; Tobin, 1958). For our analysis we report models utilizing a capacity (right-censoring) limit of 99%.[14] Finally, we employ the Huber-White sandwich estimator with heteroscedasticity correction (see Huber, 1967; White, 1980).

[10] In some instances, matchdays in the HBL, BBL and DEL do not take place in a chronological order. Therefore, we manually adjusted these observations in order to obtain chronologically ordered matchdays.

[11] Three HBL clubs – *Bergischer HC, SG BBM Bietigheim*, and *TVB 1898 Stuttgart* – regularly play their home games in two different but nearby venues. Distances of these clubs as away teams are calculated by taking the mean of the distances to both venues.

[12] The minimum temperature in our dataset is -12C. In line with Nielsen et al. (2019), we added a constant of '13' in order to avoid squaring negative values.

[13] Note, we also tested an interaction between *UCL* and *Prec*. Since we did not find any statistically significant results, we decided to not include these variables in our models.

[14] Our main findings remain when using 100% or 95% as alternative censoring levels (results are available upon request).

Table 3 Variable description

Variable	Form	Description
Att	Metric	Game attendance
ln(Att)	Metric	Natural logarithm of game attendance
UCL	Dummy	Concurrent UEFA Champions League game featuring a German club (1 if ‘yes’)
Local	Metric	Absolute number of days between home team’s game and home game of the nearest 1BL / 2BL club
$Perf_H$	Metric	Number of league points gained by the home team five games prior to the match
$Perf_A$	Metric	Number of league points gained by the away team five games prior to the match
Hwin	Metric	Probability of a home win derived from betting odds excluding bookmaker’s margin
Day	Dummy	Day of the game (1 if ‘Monday’, 1 if ‘Tuesday’, …, 1 if ‘Sunday’) excluding public holidays
Hday	Dummy	Game is played on public holidays (1 if ‘yes’)
Mday	Metric	Number of matchdays under consideration
Dist	Metric	Distance (in kilometers) between the venues of the home and away team
Prec	Dummy	Precipitation, i.e., rain or snow during the day of the game (1 if ‘yes’)
Temp	Metric	Average temperature (in degree Celsius) during the day of the game, plus a constant of ‘13’ degrees
Reloc	Dummy	Game is relocated to another venue (1 if ‘yes’)
Playoffs	Dummy	Playoff game (1 if ‘yes’)

1BL First German Football Bundesliga; *2BL* Second German Football Bundesliga; *UEFA* Union of European Football Associations

Table 4 Descriptive statistics

Variable	HBL				BBL				DEL			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Att	4744	2741	1195	44,189	4598	2107	1800	14,500	6555	3983	1254	51,125
UCL	0.078	0.269	0	1	0.023	0.150	0	1	0.045	0.208	0	1
Local	5.432	4.914	0	29	5.940	6.008	0	41	6.268	6.187	0	33
$Perf_H$	4.528	2.848	0	10	4.635	2.843	0	10	7.157	3.440	0	15
$Perf_A$	4.621	2.823	0	10	4.733	2.840	0	10	7.321	3.446	0	15
Hwin	55.075	26.215	3.328	93.680	59.584	23.847	4.224	96.329	46.617	10.122	14.812	77.542
Mon	0	0	0	0	0.011	0.104	0	1	0.006	0.080	0	1
Tue	0.041	0.199	0	1	0.036	0.186	0	1	0.100	0.299	0	1
Wed	0.278	0.448	0	1	0.079	0.270	0	1	0.053	0.224	0	1
Thu	0.007	0.085	0	1	0.038	0.191	0	1	0.012	0.109	0	1
Fri	0.066	0.249	0	1	0.083	0.276	0	1	0.398	0.490	0	1
Sat	0.334	0.472	0	1	0.359	0.480	0	1	0.009	0.097	0	1
Sun	0.240	.427	0	1	0.337	0.473	0	1	0.400	0.490	0	1
Hday	0.033	0.177	0	1	0.057	0.232	0	1	0.022	0.148	0	1
Mday	17.571	9.810	1	34	19.350	11.303	1	49	30.023	17.629	1	74
Dist	370.562	186.901	10.386	892.213	380.961	174.316	24.262	809.175	419.540	191.811	29.451	800.964
Prec	0.491	0.500	0	1	0.513	0.500	0	1	0.511	0.500	0	1
Temp	22.085	5.967	5.1	37.7	20.059	5.357	1.0	36.8	18.808	5.417	1.2	33.9
Reloc	0.017	0.128	0	1	0.023	0.150	0	1	0.001	0.039	0	1
Playoffs	–	–	–	–	0.085	0.278	0	1	0.103	0.305	0	1

Variable descriptions are provided in Table 3. Total number of observations for the HBL 1506, for the BBL 1561 and for the DEL 2001

BBL Basketball Bundesliga; *DEL* Deutsche Eishockey Liga [German Ice Hockey League]; *HBL* Handball Bundesliga

4 Results and Discussion

Table 5 presents the results of the Tobit estimations.[15] All estimates are discussed with regard to their effect on the latent attendance variable (see McDonald & Moffitt, 1980). Nonlinear relationships as well as interaction terms are illustrated graphically (see Figs. 1 and 2). We begin the discussion of the results by focusing on both substitution measures first.

In line with Nielsen et al. (2019), we find a moderating effect of weather conditions on the impact of *UCL* on attendance demand with regard to the BBL and DEL. Figure 1 shows that the magnitude of the substitution effects that are caused by *UCL* is affected by fairly high and fairly low temperatures. However, league-specific differences arise: For the DEL the findings point towards an inverse U-shaped relationship, that is, substitution effects caused by *UCL* decrease with increasing temperature and are minimized at around 12 degrees, afterwards, they marginally increase again with increasing temperature. For the BBL the findings point towards a U-shaped relationship, that is, substitution effects are minimized by low and high temperatures and are maximized at around 8 degrees. The differences between the leagues may be ascribed to the fact that BBL playoffs regularly start two months later (typically in June) than the DEL playoffs (typically in March), and the fact that the DEL is a winter sports league.

The finding that football games may substitute fan interest in some leagues is also reinforced by the results for our second substitution measure (*Local*): The greater is the temporal gap with the game of the nearest football competitor, the lower is the effect of substitution in the concerning leagues. In detail, the models show that each additional day between a HBL (BBL) [DEL] game and the temporally closest game of the nearest football competitor leads to an increase in attendance by 0.4 (0.3) [0.5] percentage points.[16] For instance, given an average attendance of 4591 (4655) [6528] spectators per HBL (BBL) [DEL] game, this translates into an average increase by 129 (98) [228] spectators when the football game is played *seven days* before or after. Finally, we tested the cross-model hypothesis of equalities of these coefficients. Results suggest that the three leagues do not differ (HBL/BBL: $\chi^2=0.64$, $p=0.42$; HBL/DEL: $\chi^2=0.15$, $p=0.70$; BBL/DEL: $\chi^2=2.56$, $p=0.11$).

These findings come along with some plausible effects of the control variables. The better is the performance of the home team ($Perf_H$), the higher is the attendance at BBL and DEL games; also, good performing away teams ($Perf_A$) attract larger audiences in the HBL and DEL. In addition, neither HBL, BBL, nor DEL attendees seem to value game uncertainty. While the UOH suggests that attendance would be maximized when both contestants have roughly equal chances of winning, demand

[15] We run several models with different specifications. As main models we report those with the lowest (negative) values for AIC/BIC which suggest a better approximation to the true model (Jamison et al., 2016).

[16] We examined the possibility of a nonlinear relationship between *Local* and attendance demand by implementing fractional polynomial selection procedures. In this regard, we tested up to four terms and a default set of eight powers (-2, -1, -0.5, 0, 0.5, 1, 2, 3) at a significance level of $\alpha=0.1$ (see Royston, 2017). Results suggest a linear relationship for all three leagues (results are available upon request).

Table 5 Tobit estimations

Var	HBL	BBL	DEL
UCL	−0.0345 (0.172)	0.377 (0.265)	−0.847** (0.423)
Local	0.00415*** (0.00128)	0.00294*** (0.000789)	0.00472*** (0.000783)
$Perf_H$	0.00348 (0.00252)	0.00496** (0.00207)	0.00596*** (0.00153)
$Perf_A$	0.00729*** (0.00263)	0.000685 (0.00203)	0.00355** (0.00154)
Hwin	0.00967*** (0.00149)	0.00968*** (0.00104)	0.0119** (0.00470)
$Hwin^2$	−6.04e−05*** (1.33e−05)	−7.56e−05*** (9.73e−06)	−7.04e−05 (4.62e−05)
Mon	*omitted*	−0.0544 (0.0405)	0.166** (0.0698)
Tue	−0.0514* (0.0283)	−0.106*** (0.0391)	−0.142*** (0.0195)
Wed	−0.137*** (0.0195)	−0.0297 (0.0211)	−0.122*** (0.0253)
Thu	−0.0760** (0.0379)	−0.0587** (0.0241)	−0.0456 (0.0550)
Fri	−0.00826 (0.0237)	−0.0136 (0.0145)	0.00712 (0.00940)
Sat	−0.0219 (0.0156)	−0.000131 (0.0102)	0.103 (0.0710)
Sun	*R*	*R*	*R*
Hday	0.0235 (0.0269)	0.0132 (0.0234)	0.0819** (0.0318)
Mday	0.0176*** (0.00490)	0.00768*** (0.00256)	−0.00516*** (0.00184)
$Mday^2$	−0.000347** (0.000135)	−0.000138** (7.04e−05)	0.000186*** (2.89e−05)
Dist	−0.000733*** (0.000117)	−0.000729*** (0.000111)	−0.00110*** (0.000107)
$Dist^2$	7.58e−07*** (1.42e−07)	6.74e−07*** (1.38e−07)	9.66e−07*** (1.36e−07)
Prec	−0.00294 (0.0109)	0.00188 (0.00832)	0.00829 (0.00903)
Temp	−0.000638 (0.00621)	0.00285 (0.00553)	0.0108*** (0.00408)
$Temp^2$	1.30e−06 (0.000145)	−7.29e−05 (0.000141)	−0.000249** (0.000114)
UCL * Temp	−0.00378 (0.0187)	−0.0566** (0.0272)	0.0684 (0.0425)
UCL * $Temp^2$	0.000131 (0.000493)	0.00142** (0.000668)	−0.00143 (0.00103)
Reloc	0.669*** (0.144)	0.587*** (0.0679)	1.855*** (0.309)

Table 5 (continued)

Var	HBL	BBL	DEL
Playoffs		−0.0312	0.00246
		(0.0334)	(0.0327)
Const	7.295*** (0.107)	9.092*** (0.0957)	8.015*** (0.128)
Home team FE	*included*	*included*	*included*
Away team FE	*included*	*included*	*included*
Season FE	*included*	*included*	*included*
AIC	−200	−687	−379
BIC	225	−301	−43
N_{total}	1506	1561	2001
$N_{censored}$	332	564	258

The dependent variable is the natural logarithm of game attendance. Variable descriptions are provided in Table 3. Results with individual cut-off points at 99% of venue capacity utilization. Robust standard errors in parentheses. Significance levels: ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1

AIC Akaike information criterion; *BBL* Basketball Bundesliga; *BIC* Bayesian information criterion; *DEL* Deutsche Eishockey Liga [German Ice Hockey League]; *FE* Fixed Effects; *HBL* andball Bundesliga; *R* Reference category

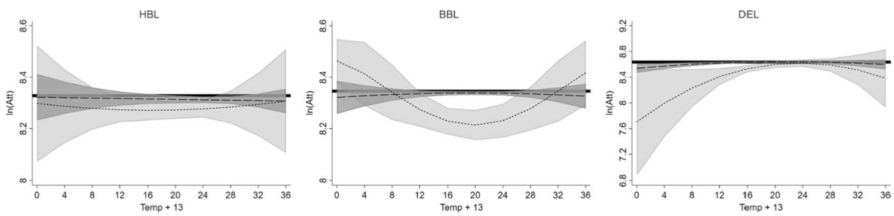

Fig. 1 Predictive margins with 95% confidence intervals on the impact of *Temp* and *UCL*. *Notes*: The long (short) dashed lines denote ‘UCL = 0’ (‘UCL = 1’). The shaded areas denote the 95% confidence interval. The dark (light) shaded areas denote ‘UCL = 0’ (‘UCL = 1’). The thick solid lines denote the average attendance per league. The minimum temperature in our dataset is -12. We added a constant of ‘13’ degrees in order to avoid squaring negative values. *BBL* Basketball Bundesliga; *DEL* Deutsche Eishockey Liga [German Ice Hockey League]; HBL = Handball Bundesliga

in the HBL (BBL) [DEL] is maximized at around 80% (64%) [84%] home win probability. Moreover, in line with Nalbantis et al. (2017), our findings are indicative of a threshold above which fluctuations in home-win probabilities are less relevant (Fig. 2). This is in line with previous literature that suggests that the preference for uncertain games is dominated by home-win preferences and loss aversion (see Coates et al., 2014; and Pawlowski et al., 2018).

Furthermore, attendance figures for HBL and BBL games are maximized on Sundays while DEL games played on Mondays and public holidays (*Hday*) attract comparably larger audiences. We further find for all three leagues that attendance increases as the season proceeds (*Mday*, $Mday^2$), pointing towards a tipping point in

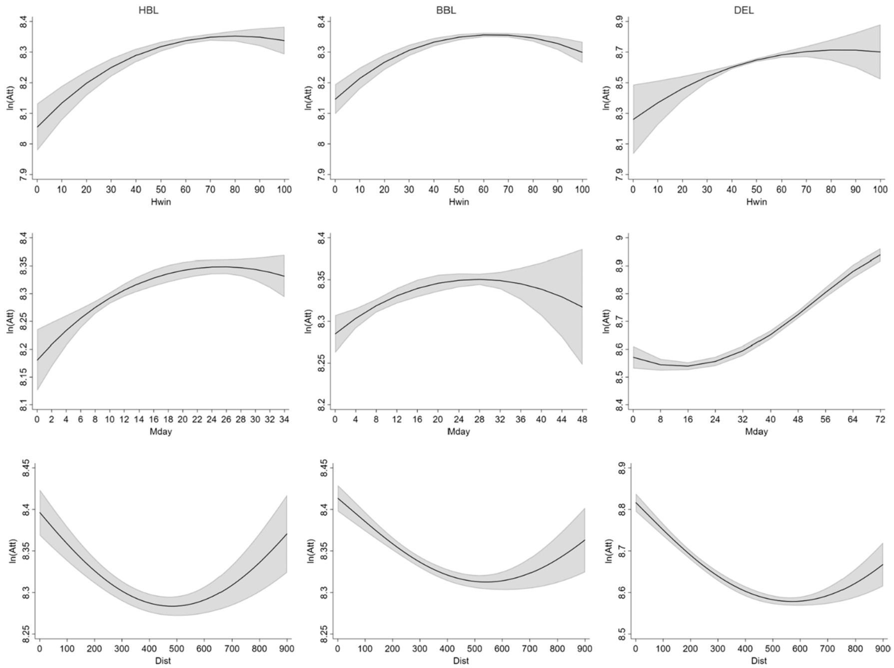

Fig. 2 Predictive margins with 95% confidence intervals on the impact of home win (*Hwin*), matchday *(Mday)*, and distance *(Dist)*. *Notes*: The shaded areas denote the 95% confidence interval. *BBL* Basketball Bundesliga; *DEL* Deutsche Eishockey Liga [German Ice Hockey League]; HBL = Handball Bundesliga

the HBL and BBL. In detail, attendance is maximized at around matchday 25 (28) in the HBL (BBL), while in DEL attendance increases with an increasing rate. Moreover, travel distance (*Dist, Dist*^{2}) between the venues of both teams in contention indicates a U-shaped relationship regarding the demand for HBL, BBL, and DEL games with the minimum at around 483 km in the HBL, 541 km in the BBL, and 570 km in the DEL (see Fig. 2). Finally, while precipitation during the day of the game (*Prec*) and playoff games (*Playoffs*) have no effect on attendance figures, relocated games (*Reloc*) are associated with larger audiences across leagues as expected (we discuss the likely endogeneity of *Reloc* below).

To establish the robustness of our main findings, we re-estimate our models with different (sub-)samples and different specifications, which are reported in supplementary material "Appendix B".

First, we test whether the inclusion of third-division football games affects our findings. We initially include a dummy variable that captures third-division substitutes and interact this variable with our key variable *Local.* In addition, we run subsample estimations by excluding all third division substitutes. For both specifications, our results remain (see Tables B1 and B2).

Second, since our main models include regular season and playoff games, we re-estimate the models for BBL and DEL games with the exclusion of postseason play-off games. While we find no moderating effect of the temperature on the impact of *UCL* on attendance for the BBL, the main findings remain (see Table B3).

Third, the decision to relocate a game to another venue is endogenous. For instance, one HBL club and three DEL clubs played home games in nearby (much bigger) football stadiums. Likewise, some HBL and BBL clubs moved for certain games to bigger indoor venues. Moreover, two HBL games were played in venues with outstandingly *small* capacities since the 'usual' home grounds were occupied. As a robustness check, we re-estimate all models by excluding these games. Our main findings remain (see Table B4).

Fourth, Tobit models with fixed effects could be affected by the incidental parameters problem (see Neyman & Scott, 1948). As a robustness check, we estimate random effects Tobit models with home teams as cross-sectional units and matchdays as time series units including home-team-specific means of explanatory variables to approximate a standard panel fixed effects estimator as introduced by Mundlak (1978). Our results remain the same (see Table B5).

Fifth, instead of the metric variable *Local* we include three dummy variables that measure whether football games were played: (i) on the same day; (ii) up to *X* days before the HBL, BBL, or DEL games or (iii) up to *X* days after one of these games. We test several specifications of *X*, with up to 21 days before and after, and find significant negative effects of these temporal overlaps. Moreover, we find only weak evidence that the effects may differ with regard to whether football games were scheduled either before or after the concerning league games. Overall, results confirm our main findings (see Table B6).

Sixth, some of the games were broadcast either on television or via online stream. The unavailability of (complete) historic data for HBL and DEL prevents us from controlling for this directly. Nevertheless, we take advantage of the fact that all BBL games were broadcast live in three seasons (2014/2015–2016/2017) and run two tests just with the BBL sample. First, we re-estimate a subsample that includes only the seasons during which all games were broadcast live and test the equality of coefficients with regard to the variable *Local* in our main model. Second, we include a dummy variable in our main model that takes the value '1' for the seasons during which all games were broadcast live as well as an interaction term with the variable *Local* to test for possible moderating effects. Both specifications suggest no significant differences compared to our main findings (see Table B7). Moreover, they suggest that apparently broadcasts do not entail any moderating effects on the impact of substitution.

5 Conclusion

Identifying competitors and determining the level of substitutability between products is indispensable to the process of delineating the boundaries of markets in antitrust analysis as well of developing any competitive strategies. A peculiar case in this regard is professional sports, where domestic leagues hold monopoly power within their sports while competing for attendance with leagues in other sports.

Competition for and substitution of league attendance across sports is relatively unexplored. While the few existing studies that previously examined fan substitution focused exclusively on the North American market where selection issues are present, this study is the first to explore competition and fan substitution in a European setting. The advantage of a European setting is the fact that teams enter or leave divisions according to their sporting performance without territorial restrictions. In addition to this, we extend previously implemented substitution measures and test whether substitution can be observed even for games that are not played concurrently but instead are played a few days before or after.

Our demand models reveal that attendance decreases if *UCL* games that feature a German club are scheduled concurrently. Moreover, we find that local football games that are staged shortly before or after HBL, BBL, and DEL games also decrease attendance. This finding suggests the relevance of considering the intertemporal consumption plans of consumers when examining substitution effects in sports. Considering, however, that intertemporal consumption plans may differ between season ticket holders and regular ticket purchasers, and that spur-of-the-moment decisions to attend may occur, future studies are encouraged to include these aspects in their analysis.

Overall, the findings suggest that different sports leagues in Germany *indeed* operate (at least to some extent) in the *same* attendance market. Moreover, they show that professional leagues of other sports in Germany suffer from the popularity and dominance of football. Therefore, avoiding clashes with football games while scheduling the matchdays and kick-off times seems to be reasonable. If future studies confirm these findings in other settings, marketers and authorities would be generally well advised to depart from a single-sport perspective when developing or evaluating competitive strategies and regulatory policies in the sports industry.

Appendix

See Table 6

Table 6 Distances in kilometers to the venues of the nearest 1BL / 2BL substitutes of handball, basketball and ice hockey clubs

HBL club	1BL/2BL club	km	BBL club	1BL/2BL club	km	DEL club	1BL/2BL club	km
SC DHfK Leipzig	*RB Leipzig*	1	Würzburg	*Würzburger Kickers*	1	Hamburg Freezers	HSV Hamburg	1
HC Erlangen	1.FC Nürnberg	1	Löwen Braunschweig	Eintracht Braunschweig	4	Nürnberg Ice Tigers	1.FC Nürnberg	1
TVB 1898 Stuttgart	VfB Stuttgart	1	Ludwigsburg	VfB Stuttgart	12	Grizzlys Wolfsburg	VfL Wolfsburg	1
HSV Hamburg	HSV Hamburg	1	Phoenix Hagen	Borussia Dortmund	14	ERC Ingolstadt	FC Ingolstadt 04	2
TSV Hannover-B	Hannover 96	1	Skyliners Frankfurt	Eintracht Frankfurt	14	Augsburger Panther	FC Augsburg	6
TUSEM Essen	Schalke 04	9	Bayern München	Bayern München	15	Düsseldorfer EG	Fortuna Düsseldorf	9
Füchse Berlin	Hertha BSC Berlin	18	Berlin	Hertha BSC Berlin	22*	EHC München	Bayern München	9
Rhein-Neckar-Löwen	SV Sandhausen	20	Baskets Bonn	1.FC Köln	32	Hannover Scorpions	Hannover 96	10
SG BBM Bietigheim	VfB Stuttgart	21	Ulm	*1.FC Heidenheim*	35	Kölner Haie	1.FC Köln	10
Bergischer HC	Bayer Leverkusen	27	Tigers Tübingen	VfB Stuttgart	37	Adler Mannheim	SV Sandhausen	20
TSG L.-Friesenheim	SV Sandhausen	31	Crailsheim Merlins	*VfR Aalen*	38	Eisbären Berlin	Hertha BSC Berlin	22*
TuS N.-Lübbecke	Arminia Bielefeld	33	Bamberg	Greuther Fürth	44	Krefeld Pinguine	Fortuna Düsseldorf	23
TV Neuhausen	VfB Stuttgart	37	Mitteldeutscher B.C	*RB Leipzig*	46	Iserlohn Roosters	Borussia Dortmund	31
TBV Lemgo	*SC Paderborn*	38	Giessen 46ers	*FSV Frankfurt*	50	Straubing Tigers	*Jahn Regensburg*	52
Frisch Auf! Göppingen	VfB Stuttgart	47	Eisbären Bremerhaven	Werder Bremen	61	Fischtown P. B	Werder Bremen	60
TV Grosswallstadt	*FSV Frankfurt*	48	Baskets Oldenburg	Werder Bremen	68	Schwenninger W. W	SC Freiburg	71
GWD Minden	*Arminia Bielefeld*	51	SC Vechta	Werder Bremen	74			
VfL Gummersbach	Borussia Dortmund	53	Bayreuth	1.FC Nürnberg	76			
HSG Wetzlar	Eintracht Frankfurt	54	BG Göttingen	Hannover 96	92			
HBW Balingen-W	VfB Stuttgart	72	Artland Dragons	*Arminia Bielefeld*	94			
TV Emsdetten	Borussia Dortmund	75	Science City Jena	*RB Leipzig*	97			
THW Kiel	Hamburger SV	84	TBB Trier	1.FC Kaiserslautern	129			
HSC 2000 Coburg	Greuther Fürth	87						
MT Melsungen	*SC Paderborn*	100						
SC Magdeburg	VfL Wolfsburg	101						
SG Flensburg.-H	Hamburger SV	139						

Table 6 (continued)

HBL club	1BL/2BL club	km	BBL club	1BL/2BL club	km	DEL club	1BL/2BL club	km
ThSV Eisenach	*Würzburger Kickers*	140						

Distance as the crow flies is calculated by using the shortest curve between two points of a mathematical model of the earth (Picard, 2010; Vincenty, 1975). In italics are denoted first and second Bundesliga football clubs that participated also in the third division during our observation window (Arminia Bielefeld 2012/13, 2014/15; FSV Frankfurt 2016/17; Jahn Regensburg 2013/14, 2014/15, 2016/17; RB Leipzig 2013/14; SC Paderborn 2016/17; VfR Aalen 2015/16; Würzburger Kickers 2015/16; 1.FC Heidenheim 2012/13, 2013/14)

BBL Basketball Bundesliga; *DEL* Deutsche Eishockey Liga [German Ice Hockey League]; *HBL* Handball Bundesliga; *km* kilometers; *1BL* First German Football Bundesliga; *2BL* Second German Football Bundesliga

*The second nearest substitute (first division club Hertha BSC Berlin) is taken instead of the nearest substitute (second division club 1. FC Union Berlin) as both clubs are in close proximity to the BBL/DEL club with only a few kilometers in between

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