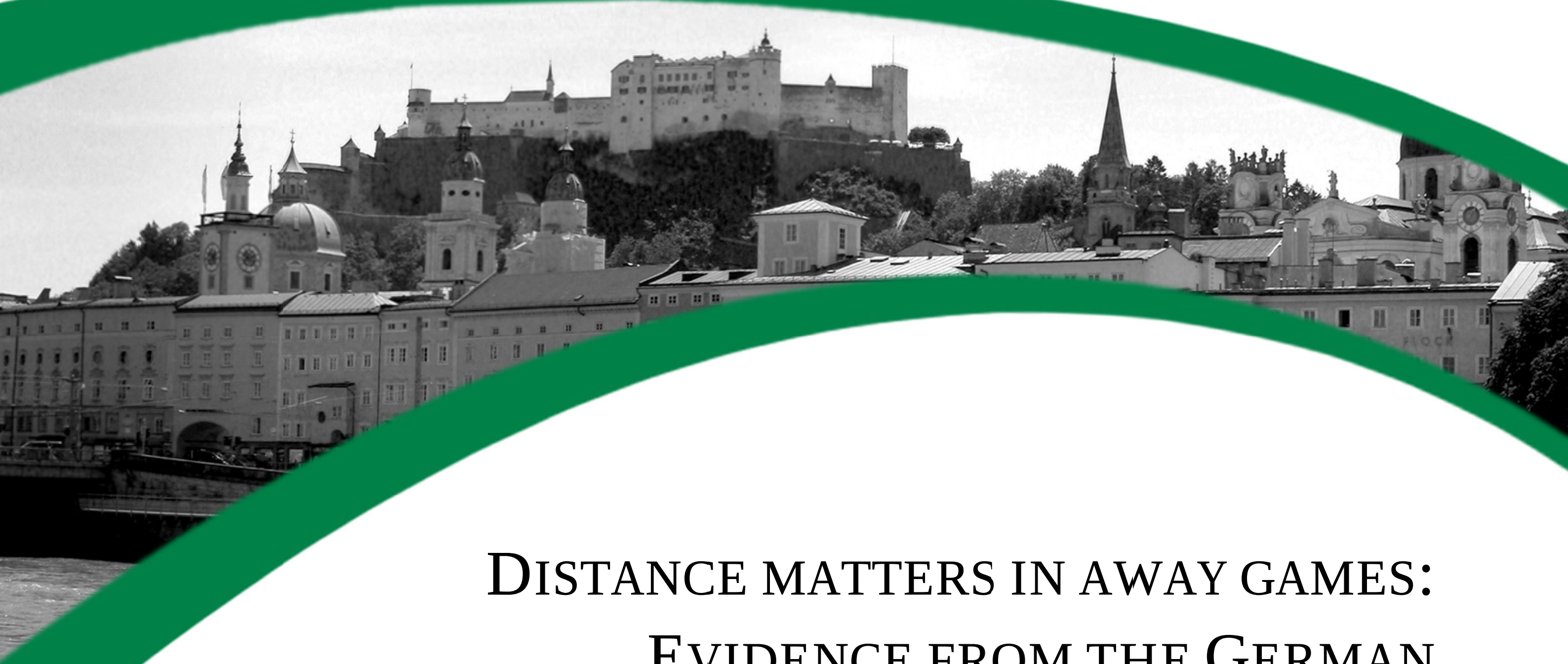

Distance matters in away games: Evidence from the German Football League

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Distance matters in away games: Evidence from the German Football League

Harald Oberhofer[†], Tassilo Philippovich[‡] and Hannes Winner[§]

Abstract

This paper assesses the role of distance in professional team sports, taking the example of football (soccer). We argue that a team's performance in terms of scored and conceded goals decreases with the distance to the foreign playing venue. To test this hypothesis empirically, we investigate 6,389 away games from the German Football Premier League ('Erste Deutsche Bundesliga') between the playing seasons 1986-87 and 2006-07. We find that distance increases a guest team's propensity to concede goals and exhibits a negative but insignificant impact on the ability to score goals. The parameter estimates of the squared distance terms indicate that the effects of distance on team performance are non-monotonic. Further, focusing on the outcome of the game (i.e., win, draw or defeat) as a measure of the overall success of a football team we observe significantly negative effects of distance.

JEL Codes: L25, L83, C29

Keywords: Professional team performance; distance; event count data; poisson regression model

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1 Introduction

The economic literature is full of examples demonstrating that geographical distance affects the behavior of households and firms in a systematic way. The importance of distance has been illustrated, for instance, in labor economics (e.g., commuting behavior of employees; see van Ommeren et al., 1997, 1999), international economics (e.g., production and location decisions of firms; see Markusen, 2002), urban and regional economics (e.g., agglomeration forces in space; see Fujita & Thisse, 2002) or public economics (e.g., effect of sales taxes on cross-border consumer behavior; see Kanbur & Keen, 1993). When it comes to empirical applications, the *gravity model* is one of the leading frameworks to analyze the effects of distance. For example, bilateral trade flows are usually explained by characteristics of home and host country markets (e.g., market thickness, firm competition) along with (bilateral) distance.[1]

To analyze the role of distance on firm behavior the previous research mainly relies on aggregate data (volumes of exports and imports, number of firms in a specific market, number of commuters, etc.). The corresponding findings are only valid for specific industries (if industry data are used) or even for the whole economy. However, it might be more interesting whether firms are differently exposed to distance due to different types of mobility costs or simply due to the existence of economies of scale. Unfortunately, information about output at the firm-level is often ambiguous and hardly available, and even if it exists, distance usually does not vary within the observational units (for example, all German firms exporting to China have the same distance entries). This, in turn, renders an efficient parameter estimation nearly impossible.

In this paper we address this issue by relying on a dataset from professional team sports. Following the recent literature from game theory and industrial organization we argue that a professional sports team might be viewed as a firm (see, e.g., Andersson et al., 2008). Analyzing the economic performance of this firm within the 'market' (league) allows to observe an unambiguous output measure. Since the pairs of competing teams are chang-

[1] One typical result in this regard is that bilateral trade is negatively affected by distance, indicating that it is more difficult for a given (exporting) firm to serve a more distant foreign market (see, e.g., Bergstrand, 1985; Egger, 2000)

ing over each round of a playing season we can also apply a distance variable that varies within the observational units.

To illustrate the role of distance on team performance we focus on the example of professional football (soccer). For this purpose, we employ a dataset from the German Football Premier League (henceforth 'Bundesliga'), including 38 teams and 21 playing seasons between 1986-87 and 2006-07. The outputs of these 'firms' are scored and conceded goals, which, ultimately, determine the success and the performance of a team at the end of the season. We would expect that teams playing further away from their home location score fewer and/or concede more goals, all else equal.

Our dataset comprises information at the bilateral level (i.e., home-guest team-pairs), varying over rounds and years. The dependent variables are goals ('counts') scored and conceded within a fixed playing time. Furthermore, we use the outcome of the game (i.e., win, draw or loss), which might be viewed as the ultimate aim of a football team. Since we are interested in the performance of a football team at foreign playing locations we only focus on the away games for each team played in a given season.[2] In our case, the dataset includes 6,389 away games. Empirically, we estimate a gravity model using a count data estimation framework. To control for the offensive and defensive abilities of the home team we include the most recent performance of the opponent (i.e., goals scored and conceded in home and away games in the last five rounds previous to the actual game), the capacity utilization at the playing venue (match attendances to stadium capacity) and factors determining the mental and physical capacities of a guest team (i.e., the number of coaches within a season). Further, it might be suspected that distance exerts a non-monotonic impact on team performance. We take account for such effects by introducing squared distance as an additional regressor.

The remainder of the paper is organized as follows. Section 2 presents the data and some descriptive statistics. Section 3 elaborates the econometric specification, discusses the empirical findings, provides some sensitivity checks and gives a discussion of our main findings, and Section 4 concludes.

[2] There is a considerable research on the home ground advantage in football (see, e.g., Pollard, 1986; Clarke & Norman, 1995; Nevill et al., 1996; Goddard, 2005). In some of these papers distance enters only indirectly by analyzing whether a potential home advantage is vanishing in local derbies. To the best of our knowledge, however, the role of distance on team performance in away games has not been addressed so far.

2 Data and descriptive statistics

2.1 Data description

Our sample used in the empirical analysis below includes 6,389 away games of 38 teams from the Bundesliga between the playing seasons 1986-87 and 2006-07. For this purpose we built up a unique database containing comprehensive information about the performance of the teams and their most important economic characteristics, such as match attendances to stadium capacities or the number of coaches per season. Information about team performance (number of seasons within the sample period, end of year rank, goals scored and conceded for each round and year) is taken from various web sources (http://www.mbovin.com/soccerdb, http://www.fussballdaten.de and http://t-online.sport-dienst.de). In the empirical analysis, we further use data about stadium capacities, the match attendances per game and the number of head coaches within a season. The corresponding information is collected from the official web page of the German Football Association ('Deutscher Fussball Bund'; http://www.dfb.de) and other web resources as http://t-online.sport-dienst.de/, http://www.duisburgweb.de/Fussballweb/bl_spielzeiten_ab1963.htm and http://mlucom6.urz.uni-halle.de/~bnra5/fussball/bundliga/. Bilateral (geographical) distance is available from http://maps.google.at.

2.2 Descriptive statistics

Table 1 reports some descriptive statistics including a correlation matrix. On average, an away team scores (concedes) about 1.16 (1.71) goals, with a minimum of zero (zero) and a maximum of 9 (8) goals. The average distance of a team to a foreign playing venue is around 370 kilometers. Table 2 summarizes the main characteristics of the included football teams along with information about distances between the home location and the foreign playing venues.[3] The teams are sorted by their average distance to the other playing venues. The average football team stood in the Bundesliga for ten seasons (see column 1 in Table 2) with a maximum value of 21

[3]The full bilateral distance matrix can be found in Oberhofer et al. (2008).

Table 1: Descriptive statistics and correlation matrix

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Scored goals	(1)	1.0000							
Conceded goals	(2)	−0.0396	1.0000						
Distance	(3)	−0.0066	0.0162	1.0000					
Distance^2	(4)	−0.0032	0.0101	0.9623	1.0000				
Match attendance to capacity	(5)	0.0238	−0.0306	−0.0253	0.0032	1.0000			
Opponent scored goals$^{b)}$	(6)	−0.0543	0.0802	0.0194	0.0256	0.0746	1.0000		
Opponent conceded goals$^{b)}$	(7)	0.0677	−0.0479	0.0017	−0.0047	−0.1434	0.1679	1.0000	
Number of coaches per season	(8)	−0.0255	0.0415	−0.0293	−0.0258	0.0185	0.0701	0.0657	1.0000
Mean		1.16	1.71	0.37	176.36	0.68	6.33	6.63	1.22
Std. Dev.		1.13	1.36	0.20	156.96	0.27	3.28	3.35	0.53
Min		0	0	0	0	0.06	0	0	1
Max		9	8	0.80	648.03	1.10$^{a)}$	20	23	4

Notes: The descriptive statistics and correlations are based on 6,389 observations. Distance figures are displayed in 1,000 kilometers. $^{a)}$The maximum value of attendances to stadium capacity is above 100 percent if the home team changes its location due to extraordinary demand (e.g., in case of local derbies).$^{b)}$Equal to the sum of scored and conceded goals of the opponent in the past five rounds previous to the actual game.

seasons (six teams) and a minimum of one season (five clubs).[4] Columns 2 and 3 report each team's best and worst rank at the end of the playing season. Accordingly, there are only five teams that won the championship at least once within the sample period (1.FC Kaiserslautern, Bayern Muenchen, Borussia Dortmund, VfB Stuttgart and Werder Bremen).

Columns 4 and 5 of Table 2 show the offensive and defensive abilities of each team. Accordingly, the average guest team scores approximately 1.2 goals. The corresponding value for conceded goals is slightly above 1.7. We observe a negative goal difference for all teams except one (Bayern Muenchen) and only two teams are close to a balanced score (Bayer 04 Leverkusen and Werder Bremen). The maximum goal difference is around -1.9 (FC Homburg), indicating that this team concedes almost two goals more than it scores in the average away game.

Further details on the distribution of scored and conceded goals are depicted in Figure 1. Two features of the data deserve special attention. Firstly, for most of the away games we observe zero or one goals scored (in about 70 percent of all games; the share of zeroes is about 33 percent). This is not the case for conceded goals, where we mainly observe one or two goals (about 55 percent) and a relatively low share of zeroes (about 20 percent). Secondly, for scored goals we have a much lower variation than for conceded goals (in the sample the corresponding standard deviations are 1.13 and 1.36, respectively; see Table 1).

Information about the average geographical distance of a team to the other playing venues is reported in column 6 of Table 2. The average distance to other locations is around 368 kilometers, lying within a range of 542 kilometers (Blau-Weiß 90 Berlin) and 252 kilometers (Fortuna Duesseldorf).[5] The question of interest in our context is whether team performance

[4]The German football league system was formed in 1963. Since then, the structure and organization of the league system has changed frequently. In each season of our observational period the Bundesliga encompasses 18 teams (the exception is playing season 1991-92 with 20 teams due to the German reunification). Each team plays against every other team once at home and once away, which gives 34 rounds (1991-92: 38 rounds). The three (1991-92: four) teams at the bottom of the end of year ranking are descended to the Second Bundesliga, while the top three (1991-92: two) teams of the Second Bundesliga are promoted.

[5]The maximum bilateral distance is 805 kilometers (Hansa Rostock against Karlsruher SC and SC Freiburg against Hertha BSC Berlin) (see Table A2 in the Appendix of Oberhofer et al., 2008).

Table 2: Team performance and distance in the Bundesliga, averages over 1986-87 - 2006-07

Club	No. of seasons	Rank[a]		Goals[b]		Distance[b]	Capacity	Coaches[d]
	(max. 21)	Best	Worst	Scored	Conceded		utilization[c]	
Blau-Weiß 90 Berlin	1	18	18	0.94	2.65	541.77	0.30	1.00
Hansa Rostock	11	6	18	1.01	1.79	533.67	0.71	1.75
Bayern Muenchen	21	1	10	1.57	1.20	532.76	0.94	1.36
Energie Cottbus	4	13	18	0.79	1.88	527.48	0.74	1.00
TSV 1860 Muenchen	10	4	17	1.19	1.79	524.72	0.76	1.30
Dynamo Dresden	4	13	18	0.73	2.01	523.13	0.51	1.60
SpVgg Unterhaching	2	10	16	0.94	2.09	513.00	0.70	1.00
Hertha BSC Berlin	11	3	18	1.18	1.78	487.98	0.77	1.64
SC Freiburg	10	3	18	1.04	1.95	480.51	0.71	1.00
Hamburger SV	21	2	13	1.23	1.68	453.95	0.70	1.55
FC St. Pauli	6	12	18	0.85	1.86	441.74	0.55	1.33
VfB Leipzig	1	18	18	0.71	2.41	437.06	0.50	3.00
SSV Ulm 1846	1	16	16	0.81	2.31	406.06	0.77	1.00
1.FC Nuernberg	14	5	17	1.03	1.77	405.03	0.59	1.53
Werder Bremen	21	1	13	1.35	1.40	395.59	0.69	1.18
VfB Stuttgart	21	1	15	1.25	1.61	388.71	0.68	1.41
VfL Wolfsburg	10	6	15	1.08	1.84	375.58	0.73	1.50
1.FC Kaiserslautern	19	1	16	1.21	1.76	357.71	0.66	1.40
1.FC Saarbruecken	1	18	18	1.06	2.38	356.50	0.48	1.00
Stuttgarter Kickers	2	17	17	1.46	2.31	354.83	0.35	1.00
Alemannia Aachen	1	17	17	1.06	1.94	347.77	0.85	2.00
Karlsruher SC	11	6	16	1.09	1.78	343.45	0.53	1.08
FC Homburg	3	11	18	0.61	2.47	337.33	0.30	2.67
1.FSV Mainz 05	3	11	16	1.02	1.70	329.82	0.84	1.00
Hannover 96	7	10	18	1.03	1.67	327.56	0.68	1.71
Arminia Bielefeld	7	12	18	0.97	1.79	308.90	0.73	1.43
Borussia M'Gladbach	19	3	18	1.11	1.87	301.78	0.74	1.80
Schalke 04	18	2	18	1.10	1.68	296.38	0.79	1.58
MSV Duisburg	8	8	19	0.99	1.86	292.79	0.66	1.78
Eintracht Frankfurt	16	3	17	1.07	1.73	291.38	0.64	1.82
Bayer 04 Leverkusen	21	2	15	1.41	1.45	285.08	0.63	1.41
Borussia Dortmund	21	1	13	1.33	1.51	284.49	0.78	1.09
VfL Bochum 1848	16	5	18	1.15	1.93	278.57	0.59	1.24
SV Waldhof Mannheim	4	12	17	0.84	2.00	277.06	0.33	1.25
1.FC Koeln	16	2	18	1.17	1.70	276.21	0.69	2.00
Bayer 05 Uerdingen	8	8	18	0.92	1.78	275.28	0.43	1.63
Wattenscheid 09	4	11	17	1.12	2.22	259.35	0.46	1.20
Fortuna Duesseldorf	6	9	20	0.89	1.99	252.16	0.52	2.29
Average	*10*	–	–	*1.16*	*1.71*	*368.33*	*0.68*	*1.22*

Notes: [a] Rank at the end of the playing season. [b] Average over all away games and playing seasons. [c] Match attendances to stadium capacity, average over all away games and playing seasons. [d] Number of coaches per season (average over all playing seasons). Distance is measured in kilometers.

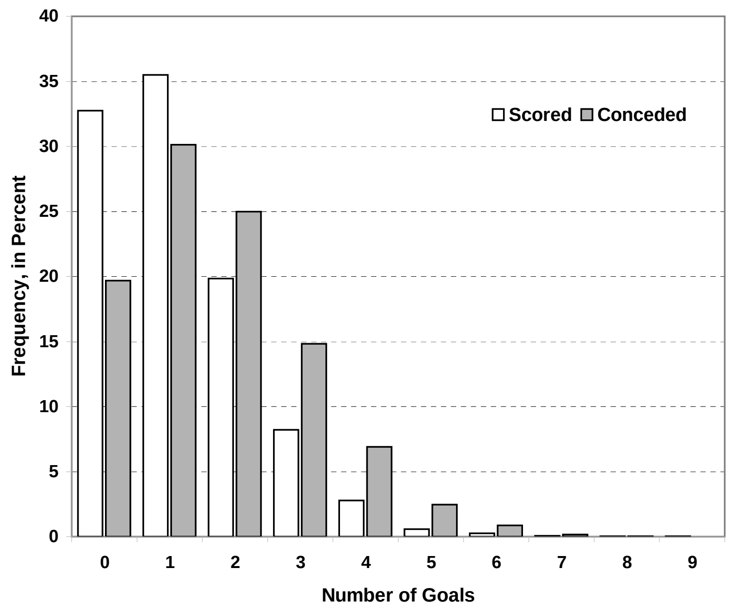
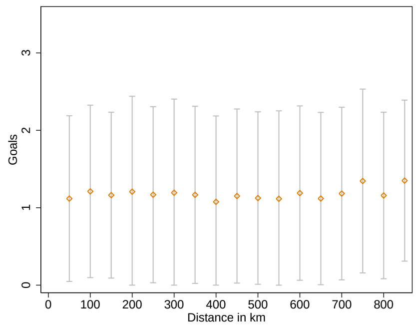


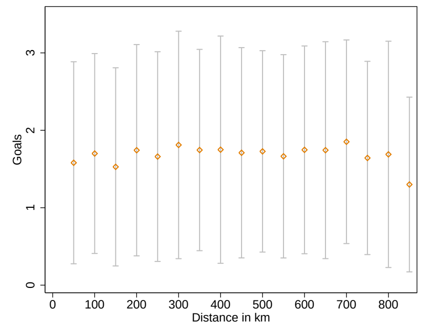
Figure 1: Distribution of scored and conceded goals (away games)

is systematically affected by the geographical distance to the foreign playing venue. However, Table 2 does not allow to answer this question definitely. For instance, if we use the clubs' best end of season rank as a performance measure within the group of relatively distant teams, we can find ones that are highly successful (e.g., Bayern Muenchen or Hamburger SV) and others that are quite ineffective (e.g., Dynamo Dresden or Energie Cottbus). Similarly, focusing on the averages of scored and conceded goals and taking the group of teams that are relatively close to each other, we can observe, for example, teams with a high amount of scored goals and others with a relatively low score. Examples for the former (latter) ones are Bayer 04 Leverkusen and Borussia Dortmund (SV Waldhof Mannheim and Fortuna Duesseldorf).

To gain additional insights into the relationship between team performance and distance we provide Figure 2. Specifically, we draw scored goals (Figure 2a) and conceded goals (Figure 2b) against distance, where the whole sample is clustered into 50 kilometer cohorts. The entries in the figures indicate mean values of goals (scored and conceded) for each distance cohort, and the whiskers illustrate the corresponding standard deviations.



(a)



(b)

Figure 2: Distance and (a) scored goals, and (b) conceded goals

The graphical inspection of the figures tends to support the following conclusions. Firstly, a comparison between Figures 2a and 2b confirms the empirical picture from above that there are fewer goals scored than conceded, irrespective of whether a team is close or relatively distant to other playing venues. Secondly, goals scored (conceded) seem to be negatively (positively) related to distance, as expected (by and large, this pattern seems to hold also for standard deviations). Additionally, the mean entries of Figures 2a and 2b suggest a non-monotonic impact of distance on team performance, which should be accounted for in our empirical model.

Finally, columns 7 and 8 of Table 2 inform about the capacity utilization and the number of coaches per season. Both variables are included as controls in the empirical analysis below. Thereby, capacity utilization measures the pressure that a guest team is faced with when playing in a foreign venue. Accordingly, the capacity utilization of an average away game is around 68 percent. Again, we observe a large variation of this variable, ranging from a minimum of about 30 percent (Blau-Weiß 90 Berlin and FC Homburg) up to a maximum of approximately 94 percent (Bayern Muenchen). Similarly, for the number of coaches per season we observe a considerable variation over the covered teams. An entry of one in Table 2 indicates that the team never fired its coach during a season. Apart from teams that stood in the Bundesliga for only one or two seasons, there is only one team with a Bundesliga history of more than five years and no changes of the team's coach during the playing season (SC Freiburg). Close to this are teams like Borussia Dortmund and Karlsruher SC with values around 1.1. At the other extreme, teams like VfB Leipzig, FC Homburg and Fortuna Duesseldorf fired on average their head coaches more than twice in a season.

3 Empirical Analysis

3.1 Specification and Estimation

To estimate the impact of distance on team performance we regress scored as well as conceded goals in away games on distance and other control variables. By their very nature, these variables are event counts, i.e., number of goals within a fixed playing time. Therefore, we apply a count data framework (see Long, 1997; Cameron & Trivedi, 1998; Winkelmann, 2003). The standard approach to analyze count processes is the *Poisson regression model*,[6] which assumes that the occurrence y_i of an event is drawn from a Poisson distribution with parameter λ (scale parameter)

$$\text{Prob}(Y = y_i|\lambda) = \frac{e^{-\lambda}\lambda^{y_i}}{y_i!}, \quad \lambda \in \mathbb{R}^+, y_i = 0, 1, 2, \ldots, N, \qquad (1)$$

where Y is a non-negative random variable (i.e., scored and conceded goals). Note that the Poisson distribution is equidispersed, i.e., $\text{E}(Y) = \text{Var}(Y) = \lambda$.[7]

The Poisson regression model is derived from (1) by parameterizing the relationship between the scale parameter and the explanatory variables. The most common way to parameterize λ is the exponential mean formulation (see Cameron & Trivedi, 2005), which, in our case, is given by

$$\lambda_{ij,rs} = \text{E}(y_{ij,rs}|\mathbf{X}) = \exp(\mathbf{X}\boldsymbol{\beta}), \qquad (2)$$

[6]The Poisson distribution is also a widely accepted device to investigate the distribution of the number of goals in sports involving two competing teams (see Maher, 1982; Lee, 1997; Baxter & Stevenson, 1988; Rue & Salvesen, 2000)

[7]For this reason the Poisson model is often viewed as too restrictive (see Cameron & Trivedi, 1998; Winkelmann, 2003). A natural way to proceed is to estimate a negative binomial model, which relaxes the equidispersion assumption. The negative binomial model further allows to test for equidispersion (see Cameron & Trivedi, 1998, pp. 77). Applying the negative binomial model, we obtain almost the same parameter estimates as for the Poisson model. Further, testing for equidispersion we are not able to reject this assumption (see Karlis & Ntzoufras, 2000, for a similar result from the Greek Football League). In the working paper version of this paper we demonstrate that the observed count outcomes for scored and conceded goals are close to the predicted Poisson distributions with identical means (see Oberhofer et al., 2008, for further details) .

where i denotes the i^{th} guest team, j is the j^{th} home team (then ij is a bilateral relationship, i.e., one specific away game) and r stands for a specific round in playing season s. $\mathbf{X}$ indicates a matrix of guest team ($\mathbf{x}_i$), home team ($\mathbf{x}_j$) and team-pair specific ($\mathbf{x}_{ij}$) vectors of covariates (including the constant). The coefficient vector $\boldsymbol{\beta}$ is estimated via (quasi) maximum likelihood.

Regarding the explanatory variables, we firstly include our main variable of interest, i.e., distance, which is the only team-pair specific covariate in our empirical model. From the discussion above (see Figure 2), we suspect that distance exerts a non-monotonic impact on team performance and incorporate squared distance in addition to the simple (linear) distance term.[8]

The remaining explanatory variables are guest and home team specific. Firstly, we include the number of coaches of the guest team within a season until the matchday. This variable might capture the mental abilities of a team, and, to some extent, also the physical constitution of the players (e.g., via different training methods). Further, the coach is responsible for the playing strategy in a game. Following previous research, we would argue that the performance of a team decreases with the number of coach changes, especially for teams with an excessive hiring and firing strategy (see, e.g., Audas et al., 2002; Koning, 2003).

Secondly, the ratio of match attendance to total stadium capacity at the playing venue controls for the pressure that a guest team is faced with when playing in a foreign venue (see, Nevill et al., 1996, for a related analysis of the effects of match attendances on home team advantage). Here, we would expect that the away team performance is affected via two distinct channels. On the one hand, a higher capacity utilization increases the mental stress of the players and the guest team, leading to fewer scored and more conceded goals. On the other hand, the capacity utilization might be anticipated by a more defensive behavior of the guest team. If such a strategy is successful, we would expect a lower score of conceded goals. Moreover, a team with a special focus on the defense tends to score less goals. Taking these aspects together, the overall impact of capacity utilization on team performance remains ambiguous.

[8]We also experienced with higher order polynomials, but it turned out that the corresponding parameter estimates are insignificant. Therefore, we decided to include only the squared distance term along with the linear one.

Thirdly, we account for the offensive and defensive capabilities of the home team, which is measured by the sum of scored and conceded goals of the opponent in the past five rounds (home and away) before the considered game (see, Carmichael et. al, 2000, for a similar approach).[9] Accordingly, a high number of scored goals in the past five rounds indicates strong offensive skills of the opponent, while a high score of conceded goals points to a weak defensive performance of the home team. Since the opponent's abilities are thought to capture only within season variation, we set these variables at zero in the first round of a season. If the guest team is playing against an opponent with a strong offense it is more likely that it concedes more goals, all else equal. The effect of a home team's offensive strength on the guest team's offensive performance, however, is less clear. On the one hand, opponents with strong offensive abilities tend to be more vulnerable to counter attacks, leading to more scored goals for the guest team. On the other hand, an opponent with a strong offense might be anticipated by the guest team via a more defensive strategy, which is usually accompanied by a lower number of scored goals. Similarly, we predict a negative impact of the opponent's defensive abilities on scored goals (i.e., the guest team scores more goals if the defense of the home team is weak), while the effect on the guest team's defensive performance is ambiguous. If the home team's priority is on scoring goals rather than on avoiding conceded ones, we would expect that the guest team concedes on average more goals. Otherwise, we cannot infer a clear relationship between the home team's defensive abilities and the guest team's defensive performance.

Given our data at hand (bilateral relationships for each round and playing season), we use two alternative versions of (2): In *Model A* we include fixed effects for guest teams, home teams and seasons. Guest and home team specific effects capture unobserved characteristics of a team that are not changing over time (e.g., the management style, strategic orientation, long-term financial resources). The fixed season effects encompass common effects that all teams are exposed to in a specific season (e.g., changes in player payment schemes or the decomposition of transfer fee controls like the Bosman case).

[9] Our estimation results are rather insensitive to changes of this variable. For instance, using the opponent's performance in the last three rounds rather than in the last five rounds leaves our parameter estimates virtually unchanged.

Model B additionally incorporates interaction terms between guest team and season effects as well as home team and season effects. It further takes round specific effects into account. Including interactions between guest team (home team) and season effects allows to control for a team specific time trend. For instance, it might be argued that some teams are less interested in short-term success, but have a long-term strategy in mind (e.g., to win the championship within a five or ten year horizon). Others might only be interested in avoiding a relegation from the Bundesliga. In any case, such effects are mainly embodied by the interaction terms. The fixed round effects capture common effects within a specific round (e.g., it is often claimed that the physical and mental abilities of teams are changing over the course of a season).

Overall, we estimate 94 dummy variables in Model A and 774 ones in Model B. Obviously, Model A is a nested version of Model B. Notice that our Poisson regression model as formulated in Models A and B includes variables with bilateral variation (i.e., distance and distance squared) and team-specific characteristics of home and guest teams (e.g., the guest team's number of coaches or the home team's match attendance to capacity) along with a bunch of (home and guest) team-specific and time-specific fixed effects (fixed season and round effects).[10]

3.2 Empirical Results

Table 3 summarizes our empirical findings regarding scored as well as conceded goals. For each dependent variable, we provide results for Models A and B as discussed above. As can be seen from Table 3, our empirical model seems well specified. The R^2-measures reported in the lower block of the table are relatively high,[11] and the fixed effects are highly significant in almost all specifications.

[10] The similarity to a standard gravity model is obvious here. For instance, in the trade literature bilateral trade volumes at a given point of time are explained by the bilateral distance, relative factor endowments between two economies (as measured by the GDP per capita), the relative size of two countries (mainly measured by the home and host-specific GDP), overall market size (the sum of the GDP of two countries) as well as host, home and time fixed effects. See, Egger (2000), for a prominent example of gravity specifications in the panel data context.

[11] See, Cameron & Windmeijer (1996) for a comprehensive discussion of various R^2 measures for count data models.

Most of the control variables enter significantly and take on the expected sign, especially for the parsimonious models (Model A). Taking conceded goals, for instance, we observe significantly positive parameter estimates for the number of coaches and the opponent's ability to score goals, indicating that a guest team's performance in terms of conceded goals is negatively influenced by these variables. Similarly, the guest team is more likely to be successful in scoring goals if the opponent has relatively weak defensive abilities (see Model A for scored goals). Regarding match attendance to capacity we obtain insignificant parameter estimates throughout. One reason for this finding might be that the two effects discussed above (i.e., mental pressure and anticipatory behavior) outweigh each other.

For Model B, we generally observe a less clear picture about the explanatory variables. However, this is not really surprising given the large number of dummy variables included in these regressions. Apart from bilateral distance, all of our explanatory variables are guest team and/or home team specific and are, therefore, likely to be captured by the corresponding fixed effects (as well as by the interaction terms with seasons). This, in turn, makes it difficult to isolate the pure impact of these variables on team performance. As can be seen from the lower block of Table 3, however, the additional fixed effects (interaction terms and round effects) are highly significant throughout. Further, a likelihood ratio test based on the likelihood ratios of the last line in Table 3 tends to reject the restrictions underlying the nested Models A (i.e., that the interaction terms and the round effects are jointly equal to zero). Therefore, we would generally prefer Models B over Models A. Nevertheless, Table 3 also points to the fact that the impact of distance and its square is stable over both model types, so that it does not make a real difference which model type is chosen to illustrate the importance of distance on team performance.[12]

In line with most of the (empirical) gravity studies (mentioned in footnote 1), we find a significantly negative association between distance and conceded goals. Hence, our estimation results suggest that the defensive ability of a team is negatively associated with distance. A significantly pos-

[12] To check the sensitivity of our results, we re-estimated our models using time distance rather than geographical distance. The corresponding data are available at `http://maps.google.at`. It turns out that the estimated impact of distance on team performance remained unchanged. This is not really surprising, given that time distance and geographical distance are highly correlated (the correlation coefficient is around 0.99).

Table 3: Estimation results: Scored and conceded goals

Variable	Scored goals		Conceded goals	
	Model A	Model B	Model A	Model B
Distance	-0.154	-0.156	0.457^{**}	0.350^{*}
	(0.233)	(0.227)	(0.193)	(0.185)
Distance^2	0.156	0.103	-0.466^{*}	-0.421^{*}
	(0.299)	(0.287)	(0.249)	(0.236)
Match attendance to capacity	0.014	-0.056	0.049	-0.128
	(0.081)	(0.103)	(0.062)	(0.080)
Opponent scored goals	-0.013^{***}	-0.012^{**}	0.005^{*}	-0.021^{***}
	(0.004)	(0.005)	(0.003)	(0.004)
Opponent conceded goals	0.013^{***}	-0.014^{***}	-0.005	0.000
	(0.004)	(0.005)	(0.003)	(0.004)
Number of coaches per season	-0.019	0.137^{***}	0.050^{***}	-0.052^{*}
	(0.024)	(0.036)	(0.018)	(0.027)
Observations	6,389	6,389	6,389	6,389
Pseudo R^2	0.022	0.074	0.024	0.072
Cragg-Uhler R^2	0.063	0.201	0.079	0.219
Fixed Effects (F-Test)				
Team	147.95^{***}	65.92^{***}	157.31^{***}	126.72^{***}
Opponent	97.64^{***}	67.74^{***}	178.84^{***}	77.63^{***}
Season	37.54^{**}	19.85	58.94^{***}	46.77^{***}
Team×Season	-	533.82^{***}	-	585.24^{***}
Opponent×Season	-	518.87^{***}	-	591.21^{***}
Round	-	89.43^{***}	-	83.31^{***}
Log-likelihood	$-8,838.2$	$-8,364.0$	$-10,242.1$	$-9,738.5$

Notes: Parameter estimates for fixed effects and the constant are not reported. White (1990) robust standard errors in parentheses. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

itive quadratic distance term indicates that the negative impact of distance becomes less important as the distance to the foreign playing venue becomes larger.

From the coefficient vectors of Table 3 we are able to calculate the marginal effects of distance. For this purpose, we take the first derivative of (2) with respect to the distance variable x_{ij}

$$\frac{\partial \mathrm{E}(y_{ij,rs}|\mathbf{X})}{\partial x_{ij}} = \exp(\mathbf{X}\widehat{\boldsymbol{\beta}})(\widehat{\beta}_{1,x_{ij}} + 2\widehat{\beta}_{2,x_{ij}} x_{ij}). \tag{3}$$

Holding all control variables (including the fixed effects) constant at their mean values, we derive a marginal effect for conceded goals in Model A of about 0.0019, evaluated at the mean value of distance (measured in 1,000 kilometers). In other words, an additional distance of 100 kilometers to the playing venue is associated with 0.019 additional conceded goals. The corresponding marginal effects for other locations in the distribution of distance are reported in Table 4. Accordingly, the marginal effect of distance on conceded goals turns out to be positive for most parts of the distance distribution. The exceptions are distances above the 3$^{\mathrm{rd}}$ quartile, where we obtain negative marginal effects. Generally, we obtain significant marginal effects of distance on the defensive abilities of a team below the mean (Model A) and below the 25 percent quartile (Model B), respectively. This finding suggests that distance to foreign playing venues mainly harms low-distance traveling teams.

Setting (3) equal to zero allows to compute the 'critical' distance, where the marginal effect of distance on conceded goals changes from positive to negative. For instance, considering the parameter estimates from Model A, we obtain a critical distance of $\tilde{x}_{ij} = -\frac{\widehat{\beta}_{1,x_{ij}}}{2\widehat{\beta}_{2,x_{ij}}} = -\frac{0.457}{2(-0.466)} \approx 0.49$ (= 490 kilometers) for conceded goals. The corresponding value for Model B is around 416 kilometers. In other words, the maximum impact of distance on conceded goals is roughly around 450 kilometers.

Regarding scored goals, we are not able to identify any significant effects of distance (see Tables 3 and 4). The distribution of scored and conceded goals depicted in Figure 1 might help to explain this finding. There, a decrease in team performance can be illustrated graphically by a movement from the left to the right for goals conceded, and by a movement in the

Table 4: Marginal effects (impact of 100 kilometers in additional distance)

	Distance (in km)	Scored goals		Conceded goals	
		Model A	Model B	Model A	Model B
Mean	368.3	−0.004	−0.008	0.019	0.006
		(0.620)	(0.297)	(0.067)	(0.517)
Median	364	−0.005	−0.009	0.020	0.007
		(0.608)	(0.292)	(0.058)	(0.479)
Lower 25 percent quartile	220	−0.010	−0.012	0.042	0.027
		(0.471)	(0.340)	(0.008)	(0.079)
Upper 75 percent quartile	543	0.002	−0.005	−0.008	−0.018
		(0.904)	(0.721)	(0.648)	(0.288)
Lower 1 percentile	15	−0.017	−0.017	0.075	0.055
		(0.507)	(0.484)	(0.017)	(0.059)
Upper 99 percentile	774	0.010	0.0003	−0.044	−0.049
		(0.730)	(0.991)	(0.212)	(0.130)

Notes: p-values in parentheses.

opposite direction for scored goals. Therefore, for scored (conceded) goals we would expect an increase (decrease) in the share of a low number of goals as the distance between the home location and the foreign playing venue becomes larger. However, in the case of scored goals we have a relatively large share of zeroes (around 33 percent), forming a natural lower bound for a decrease in a team's offensive performance. This, together with a much lower variation for scored goals than for conceded ones, might induce upward biased standard errors and, therefore, insignificant estimation results.

3.3 Extensions and discussion

Given the ambiguous results for scored goals, it might be useful to focus on the outcome of the game (i.e., win, draw or defeat) as a measure of the overall success of a football team. Not to lose, to win or at least to achieve a draw can be seen as the ultimate aim of a football team.[13] We define two alternative binary variables accounting for the game's outcome: the first one is set at one if the away team loses or achieves a draw, and at zero otherwise (i.e., if the team wins); the second one takes entry one if the away team loses, and zero otherwise (i.e., if the away team achieves a win or a draw). Then,

[13] Alternatively, one might refer to the goal difference (scored minus conceded goals) in this regard. However, it turns out that there is no unambiguous way to estimate the scale parameters of the resulting Poission difference distribution using (continious) covariates (for further details see, Karlis & Ntzoufras, 2000).

we estimate a conditional logit model including our distance variables, the controls and the fixed effects on the right hand side to investigate the effect of distance on the probability of away game failure.

The logit estimates are reported in Table 5. Generally, the models seem well specified in terms of the R^2 and the significance of the fixed effects. The control variables enter as expected or in a similar fashion as in Table 3. For the distance terms, we are only able to estimate significant effects for the second variant of the dependent variable, i.e., whether a team loses (in this case, the dummy variable has entry one). With regard to this specification, the estimation results in Table 5 suggest that the probability of being defeated is positively affected by distance. We find a negative impact of the squared distance term, indicating that the effect on team performance is most severe for playing venues relatively close to the home location.

Our empirical findings from this exercise together with the ones from Table 3 let us conclude that distance exerts a systematic, non-monotonic influence on the performance of professional sports teams. Basically, we would provide three broad explanations for these findings. The first one has to do with the *physical* constitution of the players. Obviously, traveling to a foreign playing venue is more cumbersome when the foreign location is relatively far away. For instance, there is evidence from sports medicine that the immune system of professional football players and, consequently, their sensitivity to physical diseases is systematically affected by the frequency of exhaustive journeys (see, Gabriel & Kindermann, 1997; Bury et al., 1998; Nieman & Pedersen 1999). A second, potentially more important explanation points to the *psychological* role of distance as triggered, for instance, by less familiar living conditions at foreign playing locations or simply because the players are physically disconnected from their families and their social environments. Accordingly, we would expect that the players' mental health is affected by distance, especially when they are staying at relatively distant foreign playing locations for a longer time period. Thirdly, the *organizational* preparation of traveling to foreign locations might explain the observed non-monotonic impact of distance on a team's performance. For instance, if the venue of the away game is relatively close to the home location, it might be that teams arrive at the same day, and are, therefore, faced with a potentially cumbersome journey. We conducted qualitative in-

Table 5: Probability of defeats and draws in away games (logit models)

Variable	**Defeat or draw in away games**		**Defeat in away games**	
	Model A	Model B	Model A	Model B
Distance	0.267	0.063	1.075^{**}	1.241^{**}
	(0.608)	(0.707)	(0.522)	(0.585)
Distance^2	-0.318	-0.136	-1.463^{**}	-1.729^{**}
	(0.778)	(0.888)	(0.673)	(0.742)
Match attendance to capacity	-0.076	-0.176	0.248	0.167
	(0.205)	(0.306)	(0.171)	(0.264)
Opponent scored goals	0.042^{***}	0.021	0.021^{**}	-0.039^{***}
	(0.010)	(0.015)	(0.009)	(0.013)
Opponent conceded goals	-0.038^{***}	0.006	-0.014^{*}	0.028^{**}
	(0.010)	(0.014)	(0.008)	(0.012)
Number of coaches per season	-0.011	-0.564^{***}	0.120^{**}	-0.404^{***}
	(0.062)	(0.114)	(0.053)	(0.091)
Observations	6,389	6,072	6,389	6,389
Pseudo R^2	0.060	0.179	0.059	0.170
Cragg-Uhler R^2	0.096	0.271	0.105	0.280
Fixed Effects (F-Test)				
Team	131.20^{***}	$1,812.74^{***}$	173.08^{***}	603.82^{***}
Opponent	108.64^{***}	49.81^{*}	158.94^{***}	55.6^{**}
Season	21.80	177.83^{***}	40.172^{***}	33.8^{**}
Team×Season	-	$2,213.42^{***}$	-	980.8^{***}
Opponent×Season	-	577.53^{***}	-	394.2^{***}
Round	-	53.41^{**}	-	50.6^{*}
Log-likelihood	$-3,316.3$	$-2,823.1$	$-4,163.2$	$3,671.0$

Notes: Parameter estimates for fixed effects and the constant are not reported. White (1990) robust standard errors in parentheses. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

terviews with coaches, team and traveling managers, and medical services providers of some Bundesliga teams about personal experiences regarding the impact of traveling activities on team performance. Most of them share the view that the players' performance in away games is potentially influenced by distance and that it might be especially worse for long-distance travels. Often used strategies to circumvent this problem are to travel by airplane or to arrive one or two days before the matchday.[14] We come back to this issue below.

Unfortunately, most of these explanations remain speculative in the sense that they cannot be tested directly with our data at hand. However, there are two issues on how a football team treats a potential disadvantage from distance that can be addressed at least indirectly with our data. Firstly, it might be that teams have learned to deal with possible disadvantages from traveling to distant locations. In this case, we would expect that the impact of distance on team performance is vanishing over the course of the years. Secondly, it would be obvious that experience plays a crucial role in treating with disadvantages from distance. Then, more experienced clubs would be less vulnerable to distance.

The first question can be answered by including interaction terms between the distance variable and the fixed year effects in the Poisson and the logit models from Tables 3 and 5. To make an interpretation of the results easier, we leave out the quadratic distance term and rely on the parsimonious Models *A* from Tables 3 and 5.[15] The estimation results are presented in Table 6. To save space, we only focus on the distance effect and suppress the outcome of the controls as well as the additional test statistics from Tables 3 and 5. The theoretically predicted sign of the distance effect is indicated in the first line of the table. The second line reports the previous estimation results of the (linear) distance term as estimated in Tables 3 and 5. A confirmation of the theoretical prediction is denoted by a circle, where loaded ones indicate significance at least at the 10 percent level. The lower part of

[14]We are grateful to the respective responsible persons mentioned in the acknowledgements who provided their personal expertise on the impact of traveling activities on team performance.

[15]Technically, we estimate a variable coefficient model, where each year exhibits its own distance effect (see, Hsiao, 2003). Adding additional interaction terms between distance squared and the fixed time effects would imply that we cannot interpret the year-by-year effect of distance on team performance.

the table summarizes the effect of (linear) distance on team performance at each playing season between 1986/87 and 2006/07 separately.

We firstly can see that the effect of distance on conceded and on scored goals appears to be significant in some seasons and insignificant in other ones. Further, a first inspection of the (loaded) entries indicates that the estimated overall impact of distance on team performance is not driven by a specific year. More importantly, however, we are not able to identify a systematic pattern in the sense that the impact of distance becomes somehow weaker or stronger over time. This is the case for conceded goals, but also for scored ones, where we observed an insignificant overall effect in Table 3. Similar holds for a team's overall success (as measured by the loss and the loss/draw probabilities in columns 3 and 4 of the table), where we are not able to observe a systematic time trend. Overall, the evidence presented in Table 6 suggests that there are no learning effects with regard to the role of distance on team performance.

To analyze the second question on the role of experience for the observed impact of distance on team performance, we incorporate an interaction term between the distance variable and the number of years a football team stood in the Bundesliga between the playing seasons 1986/87 and 2006/07 (see the first column in Table 2). Again, we focus on the parsimonious versions of our specifications (i.e., Models A) and we leave out the quadratic distance term to ensure an easier interpretation of the results. In the presence of experience effects we would expect a positive (negative) sign on the interaction term for scored (conceded) goals, and a negative one for the probabilities to achieve a loss or a loss/draw.[16] In all of the models we find the expected signs for the interaction terms, but they are insignificant throughout.[17] Obviously,

[16]For instance, in Table 5 we found that distance increases the probability of a loss for a given away game (i.e., we observed a positive parameter estimate). If this impact is systematically influenced by the presence of experienced (and, implicitly, less experienced teams), we would expect an even lower parameter estimate for the distance variable (i.e., experience lowers the vulnerability to distance). This, in turn, translates into a negative parameter estimate for the interaction term between distance and experience (number of seasons within the Bundesliga).

[17]To save space we suppress the corresponding estimation results, but they are available from the authors upon request. We also applied an alternative strategy to identify any experience effects by defining an interaction term between distance and a dummy variable taking entry one if a specific season-within-league threshold is exceeded. Thereby, we experienced with different levels of the threshold (i.e., one, three, five and ten years). However, we were unable to find significant experience effects again.

Table 6: The impact of distance over time

Season	**Poisson Models from Table 3**		**Logit Models from Table 5**	
	(1)	(2)	(3)	(4)
Expectation	-	+	+	+
1986-87 - 2006-07[a)]	○	●	○	●
1986-87	○		○	
1987-88	○	●	●	○
1988-89	●		○	
1989-90	●	○	○	○
1990-91	●	●		
1991-92	○	○		●
1992-93		○	●	
1993-94	○	○		
1994-95	●	●	●	
1995-96		○		●
1996-97		●		●
1997-98		○		
1998-99		●	●	●
1999-00	○	○	●	○
2000-01				
2001-02	●	●	●	●
2002-03	○	○		○
2003-04		●	●	
2004-05	●	○	●	●
2005-06		○		
2006-07		●		

Notes: (1) Goals scored. (2) Goals conceded. (3) Defeat or draw probability. (4) Defeat probability. • indicates a confirmation of the theoretical expectation at least at the 10 percent significance level; ∘ indicates a confirmation but insignificant parameter estimates. [a)] Sign of the parameter estimates from Models A in Tables 3 and 5, respectively.

the estimated relationship between distance and team performance seems to be unaffected by the composition of experienced and less experienced teams within a specific playing season.

To some extent, this conclusion has been confirmed by our qualitative interviews with team and team-travel managers. Indeed, most of them told us that they consider longer distance journeys as a potential disadvantage of team performance, irrespective of whether the team was experienced or not. Some of them defined a proper internal 'critical distance' in the sense that they prepare away games beyond this critical point with special precaution. The interesting point here was that the majority determined this problematic distance in-between 400 and 500 kilometers, which is strikingly in line with our empirical findings. For journeys beyond this distance, most of the clubs are traveling by airplane or - for reasons of convenience - by train. If flight connections are insufficient, some of the (experienced and less experienced) teams charter aircrafts. If teams are traveling by train, some team managers told us that they order their official team bus to be just in time at the foreign train station to provide the team players a familiar environment. As another precautionary measure, already noted above, most of the Bundesliga teams arrive one or two days before the game, especially at very distant foreign locations. In this case, team managers often try to arrange their training sessions at the foreign playing venue one or two days before the match to become more familiar with the away stadium in general and the playing field in particular.

Anyway, it seems to be well recognized by the team and travel managers of the Bundesliga teams that the away performance of their teams might be affected by the distance to the foreign playing locations. They take account for such potential disadvantages in very different ways, but our estimation results suggest that any disadvantages from distance cannot be eliminated completely. From this, one may conclude that professional sports teams are inherently confronted with decreased team performance as the distance to foreign playing venues increases. One remaining candidate to explain such an effect are psychological factors influencing the individual health and mental strength of the team players.

4 Conclusions

The importance of distance on individual behavior is well documented in the economic literature. This paper analyzes the role of distance on professional team performance. More precisely, we argue that a sports team might be less successful if the playing venue is relatively far away from the home location. To test this hypothesis empirically we use data from the German Football Premier League (Erste Bundesliga), including data of 38 professional football teams between the playing seasons 1986-87 and 2006-07. Team performance is measured by the propensity to score and to concede goals and by the outcome of a game (i.e., the probability of a loss or a loss/draw), which might be viewed as the ultimate aim of a football team. Thereby, we only focus on away games. Empirically, we apply a standard gravity model as proposed by the empirical trade literature and extend this framework to event count data (i.e., goals within a specific time period). To isolate the impact of distance, we control for variables that are typically viewed as decisive for the offensive and defensive performance of a football team (e.g., the offensive and defensive strength of the opponent).

Our findings suggest that distance exerts a significantly negative and non-monotonic impact on a football team's defensive performance. In other words, the guest team's success to prevent a goal decreases the further away the playing venue is from the home location. However, the impact of distance is non-monotonic, indicating that the performance of an away team becomes worse up to a certain distance. Beyond this 'critical' point (estimated at around 450 kilometers), the team's defensive behavior improves again. Focusing on the outcome of the game as a potentially more adequate measure of a football team's overall performance, we observe a significantly positive and non-monotonic impact of distance on the probability to lose the away game. These findings are in line with our expectations from above, and, qualitatively, also confirm the empirical evidence from the aforementioned fields of economic interest.

One potential explanation for our findings could be that a longer journey is prepared more carefully in the sense that the team arrives one or two days earlier or take the airplane when traveling to the foreign playing venue. Further, estimating the distance effect on a year-by-year basis, we are not able to observe a trend for a vanishing importance of distance on team performance. Similarly, it seems that team experience (as measured by the number of seasons a team stood in the Bundesliga) is not influential for any distance effects. It seems that distance is an inherent phenomenon in explaining professional team performance, and, more generally, it points to the well known fact that success in sports depends to a large part on psychological parameters that can be not fully controlled for by the team and travel managers of the football teams.

The primer goal of the paper was to quantify the impact of distance on team performance. Although we are clearly able to identify significant distance effects, it must be admitted that we have to be cautious when providing possible explanations for this finding. For instance, with our (even comprehensive) data at hand it is impossible to discriminate between purely physical, psychological and also organizational causes of the observed disadvantages from distance. Such an analysis requires more detailed information on the special circumstances of a given away game. Hopefully, such data will be available in the near future, so that we can provide additional insights on the impact of distance on team performance.

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