"A gravity model to explain the flows away of football fans. A panel data analysis"

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ABSTRACT

This study breaks new ground by examining determinants of away fan travel in a professional football league. Using data from two consecutive seasons of the Spanish league, a gravity model is estimated based on a three-dimensional panel to discuss the effects of a number of factors that influence the flows of away fans. Results evidence the importance of factors such as distance between locations, the day or time the match is played, and uncertainty concerning the visiting team's current form. Joint interpretation of all these factors by the clubs and by those organising the competition may help to reshape their management strategies, which would result in increased flows of away supporters and an increase in sports clubs' revenues from this concept.

1. Introduction

Analysis of attendance at professional sporting events is one of the topics to have received most attention in the empirical literature on sports economics in various areas such as sports management, sports marketing or sports sociology since Rottenberg (1956) first provided a full description of which factors explain attendance at baseball matches and posited the kinds of variables to be taken into account when analysing the demand function of professional sports (Cairns, 1990; Douvis, 2014).

Since then, the number of studies has increased substantially (Schreyer & Ansari, 2021) to embrace a wide range of contexts and study motives. Greater accessibility to data has led to the appearance of analyses of different leagues, sports and geographical areas. Most research into attendance at sports events initially focused on sport in the United States, such as baseball (Baade & Tiehen, 1990), American football (Doyle et al., 1980) or hockey (Jones, 1984). Yet over the last few decades, interest has spread to other areas such as Europe (Baimbridge et al., 1995; Carmichael et al., 1999), Australia (Borland & Lye, 1992) or Asia (Watanabe et al., 2019).

The approach adopted in most of these studies is to estimate a demand function that includes the usual independent variables, such as ticket prices or fans' income. However, other variables inherent to the sector, and which help to reflect the implicitly disperse nature of a sports event as a service consumed by fans, have also been included. These aim to achieve one of the principal goals of this line of research; namely, to understand the relative importance of the demographic, socio-economic or management factors that influence attendance at a sporting event in a given context. As a result, research into attendance at sporting events would help to explain how demand for an event may vary due to changes in the organisation of a competition or as a result of a shift in the social or economicconditions of the target population. Understanding this would be of great value to those responsible for managing the sport when it comes to maximising revenue from ticket sales.

Yet one of the main limitations of the previously mentioned studies is that they fail to distinguish between fans in terms of their place of origin. Existing literature explores which factors drive demand for sporting events but fails to bear in mind whether the fans attending the event are home or away team supporters or whether they hail from one place or another. There is a lack of studies analysing which factors determine fan travel from one place to another to watch top level team sporting events. In other words, the topic has not been addressed from the perspective of the visiting fan. To the best of our knowledge, only (Hunt & Lewis, 1976), for baseball in the United States, distinguish between local and visiting supporters. However, their study only estimates a demand function for subsequent inclusion in the equation that estimated a baseball club's revenue. The authors only considered as determining factors the current form of the away team, the stage of the season when the match was played, and the number of star players in the team, neglecting a host of other factors which were included in subsequent research into the sport. The remaining studies into the topic have overlooked what impact travelling supporters might have on stadium attendance. Some analyses have included distance as a determining factor in attendance (Dobson & Goddard, 1992; Dragin-Jensen et al., 2018; Schreyer et al., 2018; Winfree et al., 2004), but have not focused on visiting supporters or, at least, on distinguishing them from local supporters. As a result, it is not possible to gauge the true influence of which factors impact away supporter travel. Other studies addressing away supporter behaviour have been carried out in an effort to model the motivations behind their trips (McManus, 2020) but have adopted an approach concerned more with psychological behaviour than with a travel motivation focus.

Although away supporter presence at the stadium represents a lower proportion than that of local fans in relative terms, the number of supporters who travel to see their team may provide an important spur for local economies. Moreover, the motivation to travel may not only be determined exclusively by the sporting event, since this might be complementary to the trip, with the subsequent impact it could have on other sectors of the economy. The concept of multi- purpose trip (Smith, 1971) might prove to be particularly relevant in this area of study, which is normally associated to other kinds of tourism such as nature or cultural space tourism (Mendelsohn et al., 1992). Nevertheless, the literature concerning supporters' travel motivations is contradictory. Whereas authors such as Ertas et al. (2019) conclude that the only motivation driving fans of the Turkish team Fenerbahce when travelling was to support their team (at least for big matches), other authors believe there is a strong link between supporters travelling and other tourist trip motivations (Bason, 2022), particularly when attending smaller scale events. In any case, the majority of authors agree that flows of visiting supporters can make a major contribution to local economies, which is important, bearing in mind that reactivating local economies will be one of the major challenges facing post-Covid society, with tourism emerging as one of the drivers for certain sectors that have been hardest hit by the global pandemic.

We propose a model which, to the best of our knowledge, has not previously been used by any authors in studies addressing attendance at sporting events. We use a gravity model at a national scale, Spain in this case, which is able to interpret the most relevant significant variables that determine supporters' decisions concerning whether to travel or not to follow their team when they are playing away. The sporting events posited as the subject matter are football competitions in Spain. The key role played by Spanish football clubs in Europe and the world is shown through a number of milestones, such as the country having four of its teams in UEFA's top ten ranking, by having two of the three clubs that generate most revenue in Europe (Barnard et al., 2018) or by its teams having won six Champions Leagues and seven Europa Leagues out of the last ten.

A wide range of variables has been taken into account and considered simultaneously in order to gauge what impact they have on supporters' travel. We thus construct an equilibrium model which takes into consideration not only demand factors, as occurs in the extant literature, but also variables related to supply. In turn, great importance is attached to how far away a city is from the teams they are facing. We aim to ascertain which factors encourage fans to travel or not to see their team play away. Analysis and interpretation concerning the elasticities of these variables is one of the aspects which can most help organisers in their decision-making.

In order to achieve these goals, the paper is organised as follows. The first section describes the geographical area of the study that provides the subject matter and the characteristics of the competition in which the analysis is framed. We then put forward the model and the proposed explanatory factors. The results of the model are then presented together with a discussion thereof. Finally, conclusions are provided.

2. Materials and methods

2.1. *Study site*

The Spanish football league is one of the most important in the world, both in sporting as well as in financial terms. According to the International Federation of Football, History and Statistics, it has been among the top three leagues worldwide for several decades. In financial terms, it comes second only to the English Premier League at a global scale. As for other sports, only the North-American football (NFL), baseball (MLB), basketball (NBA), and hockey (NHL) (Barnard et al., 2019) leagues generate more revenue. This has led to football in Spain becoming an important economic and social activity. Close to 90% of people in the country confess to being football fans, and over 14.3 million fans attended first and second division Spanish football league matches in the 2017–2018 season. Economic impact studies reveal just how important this is. The direct impact accounts for 0.61% of domestic GDP, related to what was spent by fans, businesses and other agents on products and services linked to professional football. With regard to the indirect impact, this accounts for 0.49% of domestic GDP, associated to the effects generated on the supply chain at various levels. Finally, the induced impact could reach 0.27% of domestic GDP. The weight of professional football in the Spanish economy would therefore amount to some 15,688 million euros, equivalent to 1.37% of equivalent GDP at market prices.

As regards its structure, professional football in Spain comprises the top two divisions, which are both organised by LaLiga, a private sports association, made up of the 20 first division (La Liga Santander) and 22 second division (LaLiga Smartbank) clubs. Although the competition has histori- cally been dominated by two teams (Real Madrid and Barcelona), another seven teams have been crowned champions at least once in their history. The system of competition is similar in the first and second division. In the case of the first division, the competition is held between 20 teams who face one another in 38 fixtures.

2.2. Data and model

The proposed model, known as the gravity model or gravity equation model is based on Newton's law of universal gravitation. This model was first adapted to other disciplines in the late 19th century when (Ravenstein, 1885) used it to study migratory flows. The push and pull factors between territories are created by the different living conditions in the various areas, where distance acts as a key aspect. Throughout the 20th century and early part of the 21st century its use became widespread in this field (Karemera et al., 2000; Millington, 1994), although it has also been employed in various fields such as the analysis of investment flows at an international scale (Sanchez-Segura & Hernandez, 2020) or the analysis of bilateral trade movements between countries (Kahouli & Maktouf, 2014; Sapir, 1981), which is where a number of authors established the microeconomic fundaments of the equilibrium model (Anderson, 1979; Bergstrand, 1985).

Cesario (1973, 1975) was the first to apply the model to the field of leisure and estimated a demand function for natural spaces based on a set of push and pull motivations in the area of recreation in Pennsylvania (USA), taking into account 10 "counties" of origin and five parks that are the destina- tion. Distance, defined in terms of travel cost and accessibility of the regions, tended to diminish the effect of these forces. Later on, it has also been used in other studies, at both a national and international level, in such wide-ranging areas as inflows to shopping centres (Baker, 2000), concert attendance (Deichmann, 2014), or mushroom picking tourism (de Frutos Madrazo et al., 2019).

Adaptation of Cesario's model to our case study is structured as follows. We denote as i each one of the 44 teams which play at home in the two seasons analysed. We denote as j the 40 teams about whose supporters we have away trip information in each season, which is denoted as t, where t = 2017–2018 and 2018–2019. In this way, i represents the teams of the places where the matches are held ("destination" to use the term applied in the gravity model), j the home clubs of the away fans ("origin" to use the term applied in the gravity model) and t the sports season.

In order to model the pull forces of destination i and push forces of each origin j, we adapt the microeconomic concepts developed by (Anderson, 1979) and (Bergstrand, 1985). We define push forces as those variables that have a direct relation with the visiting team and which act as an incentive for their fans to travel, and pull forces as those which are related to the local team and which increase the motivation of visiting supporters to come and see a football match. There is another set of factors that cannot be framed in either of the previous ones and which also form part of the adaptation of the original models. They are not confined exclusively to either the local team or the visiting team, since they do not depend directly on either of them or may be decided by an external agent, such as La Liga, who are the competition organisers.

Based on these premises, the proposed gravity equation would be set out as follows. Let $LTICKETS_{ijt}$ be the number of tickets bought by the fans of away team j when visiting local team i during season t, expressed in logarithms. A gravity equation can thus be modelled, as follows:

$$
\begin{aligned}
LTICKETS_{ijt} = {} & \beta_0 + \beta_1 LEASONHOLDER_{jt} + \beta_2 LPOPULATION_{jt} + \beta_3 AVAERAGE_{ijt} \\
& + \beta_4 LINCOME_{jt} + \beta_5 LPRICE_{ijt} + \beta_6 ACHIEVEMENTS_{jt} \\
& + \beta_7 LAVERAGEATTENDANCE_{it} + \beta_8 LRAIN_{ijt} + \beta_9 LDISTANCE_{ij} \\
& + \beta_{10} SATURDAY_{ijt} + \beta_{11} SUNDAY_{ijt} + \beta_{12} KICKOFF_{ijt} + \beta_{13} DIVISION_{ijt} \\
& + \beta_{14} SEASON_t + \beta_{15} COMPETITIVE\ BALANCE_{ijt} \\
& + \beta_{16} COMPETITIVE\ INTENSITY_{ijt} + \beta_{17} ROUND_{ijt} + \beta_{18} LPA_{ijt} \\
& + \beta_{19} LPD_{ijt} + v_{ijt}
\end{aligned}
$$

Where v_{ijt} is a composite error term, defined as $v_{ijt} = \mu_{ij} + \varepsilon_{ijt}$. μ_{ij} captures the unobserved heterogeneity across home and away teams, i.e., the home-away specific effects, and ε_{ijt} the idiosyncratic error term. We assume that $u_{ij} \sim N(0, \sigma_u^2)$ and $\varepsilon_{ijt} \sim N(0, \sigma_\varepsilon^2)$.

Commencing with the push forces, we first consider the social mass of the visiting club, measured using the logarithm of the number of season-ticket holders (LSEASONHOLDER) each team j has in each season t. The lack of literature dealing with visiting supporters means there are no studies referencing a similar variable, although (de Santana & da Silva, 2009) did report that the greater the number of fans a team has, the greater the demand to see the match should be. Secondly, we also include the size of each team's location as the logarithm of each location's population j in each season t (LPOPULATION). In this latter variable, and following the suggestion made by (Garcia & Rodriguez, 2002), when a city has more than one team, the population is divided proportionately to the number of season-ticket holders each club has. Its effect should be positive, in line with other previous studies dealing with attendance at sporting events in various sports (Baimbridge et al., 1995; Ferreira & Bravo, 2007) and which conclude that the size of the population has a positive impact on attendance at sporting events.

Thirdly, we propose the current form of the away team, which we measure based on the average number of points won in the three previous matches played by team j in season t (AVERAGE), adapting (Reilly, 2015). In the Spanish league, teams earn three points for a win, one for a draw, and none for a defeat. We expect to find a positive relation between supporter motivation to travel and their team's recent results. If the team is getting better results, fans will be more motivated to travel to watch their team play. Finally, we include the per capita rent of the visiting team's place of origin, measured as the logarithm of income (LINCOME). This is also expected to have a positive effect on fans travelling, in line with previous studies (Simmons, 1996), although we also find research that presents football as an inferior good (Bird, 1982), or authors who obtain contradictory results depending on the model applied (Falter & Pérignon, 2000). As regards the pull forces, the one which has most drawn the attention of researchers is the ticket price fixed by the local club (in our case, measured in logarithms, LPRICE). Many authors have encountered serious difficulties when measuring ticket price. Some have used the mean price of tickets on sale, others the mean price of tickets actually sold or the minimum price of tickets on sale. (Villar & Guerrero, 2009) suggest that the best measure is the mean weighted price of tickets on sale, as it provides information about the various kinds of prices available at a match. Lack of information has led to the previously mentioned solutions. In the case in hand, visiting supporters tend to have tickets available that offer little price variability. When different prices are available, the mean is calculated, and when there are no fans travelling and clubs do not provide information about ticket prices the mean price of season t is taken. With regard to its effect, in accordance with microeconomic theory, a negative influence of price is expected on away team supporter attendance, although (Ferreira & Bravo, 2007) point out that the real cost of going to a match should not be confined to the ticket price but should include other costs such as parking, transport, or the purchase of food and drinks.

We also consider the local team's history as another key pull factor. This quality of the local team is referenced to the start of the season, regardless of the most recent performance prior to the match in question since this is a variable that most authors feel remains constant throughout the season. To calculate this, different alternatives have been used such as the teams' budget (Falter & Pérignon, 2000), the presence of a particular superstar in a team (Humphreys & Johnson, 2020; Jones, 1984) or the presence of international players (Kuypers, 1996). (Buraimo et al., 2018) reject the use of budgets since this might lead us to misinterpret the distance between large and small clubs, particularly if talented players prefer to play in bigger and more glamorous teams even though this might mean making less money. We aim to measure the pull of the local team through a new indicator that weights the number of seasons the team has played in the top flight and the number of major national and international trophies each team i in season t has won over the years (ACHIEVEMENTS). We expect a positive relation with attracting supporters to the stadiums. To calculate this indicator, we consider as determining factors for measuring the local team's pull the number of seasons it has been playing in the first division, the number of Spanish Cups it has won, the number of league titles won and, finally the number of times it has won the UEFA Champions League, considering that each one of these factors does not have the same importance in the team's history. The decision to include these variables in the form of an indicator is because in the preliminary versions of the model, the variables—when included separately—did not prove to be significant, in contrast to other studies (Gasparetto et al., 2020), where the number of domestic trophies won did prove to be significant. In order to solve this problem, we developed a synthetic index that included the four variables proposed, using the principal components technique to allocate the weight to be assigned to each of the variables in the synthetic indicator objectively. Principal component analysis yields only one component with an eigenvalue greater than 1 that captures 77% of the information. The coefficients of the component score allow us to calculate the values of the achievement indicator as follows: 0.25*Years in first division+0.313*Number of Leaques won+0.274*Number of UEFA Champions League won +0.297*Number of Spanish cups won.

We also include average attendance at the stadium in relation to the ground's capacity (LAVERAGEATTENDANCE), such that we expect the greater this value, the greater the attraction for visiting spectators, and the higher the number of supporters who will travel. Some authors (Baranzini et al., 2008) also consider the stadium's capacity in absolute terms, and find a positive relation between this and attendance, although others suggest it should only be taken into account because it limits attendance and might lead to a biased or truncated demand function (El Hodiri & Quirk, 1975). In the seasons analysed, we see how only a small percentage of matches were sold out (4.5%), suggesting that demand from visiting fans is not restricted by the stadium's capacity.

Finally, previous studies suggest that weather should also be considered. Favourable weather conditions are linked to higher attendances at sporting events, particularly when these are held outdoors. This is the line taken by (Iho & Heikkilä, 2010) or (Feddersen & Rott, 2011), who examine weather conditions as determining factors of attendance at sporting events. In order to reflect this factor, rainfall in cubic millimetres on the match day is included in logarithmic mode (LRAIN).

Yet away supporter travel may also be influenced by a set of variables that have no direct relation either with the visiting fans' team or home town, or with the destination's team or town, or might have an equal relation to both. Within this group, we find variables such as distance, time and day the match is played, the division and the season, or the uncertainty surrounding the outcome of the match, and which might also include the stage of the season.

As regards the first, the distance, expressed in logarithms, between the cities facing each other is a particularly sensitive variable when applying a gravity model (LDISTANCE). The Newtonian equation suggests that as the distance between bodies increases, forces decrease. As a result, it is expected that the greater the distance between two cities whose teams are involved, the fewer supporters will travel. Previous studies have followed this line (Forrest et al., 2005; Winfree et al., 2004), and although they do not distinguish between local supporters and visiting supporters, they do suggest that a greater distance between the teams playing the match is negatively related to attendance. Authors such as Schreyer et al. (2018) support a non-linear effect of this variable on attendance, which advocates its inclusion in logarithmic mode.

In order to study what influence the day and time of the match might have, which are arranged by the competition organisers, we include two dummy (binary) variables that distinguish between whether the match is played on a Saturday, a Sunday or on a weekday (DiDomizio & Caruso, 2015). Playing the match on a weekday is expected to have a negative impact on fans travelling. The kick-off time (KICKOFF) is also expected to have a negative impact on travel. The later a match is played, the fewer visiting supporters are expected to attend (Krumer, 2020), as this would entail either a greater cost for travelling supporters, who would be forced to spend a night away from home, thus increasing the cost of the trip, or travelling in the very early hours of the morning. Which division is involved, reflected through a dummy variable (DIVISION) that takes the value 1 if it is a first division match and 0 if it is a second division match, is also expected to exert an influence, through a greater number of fans travelling to see first division compared to second division matches.Unobserved year-specific effects are controlled by a dummy variable (SEASON) that takes the value 1 for the 2018–2019 season and value the value 0 for the 2017–2018 season.

Finally, the uncertainty of the result also merits more thorough analysis as it is one of the most commonly cited factors in prior literature, where there are many studies which have sought to evaluate its influence on attendance at sporting events (Humphreys & Miceli, 2020). (Rottenberg, 1956) was the first author to consider the impact of uncertainty on the demand for sporting events, although (Cairns, 1987) was the first to reflect on this term. Uncertainty has been measured in a number of different ways. (Kuypers, 1996) suggests taking into account the number of matches left until the end of the season and the number of points the team trails the leader by on each match day, while (Forrest et al., 2005) take account of the absolute value of the difference between the points won per match by the local team up to that point minus the points per match of the visiting team. (Hart et al., 1975) use the absolute value of the difference in positions in the league prior to the match, while other studies (Bond & Addesa, 2019; Peel & Thomas, 1992) propose measuring it through the odds offered by the bookmakers, and which reflect how those betting think the result will turn out, based on each team's chances of winning. Following (Janssens & Késenne, 1987), we opted to distinguish between two kinds of uncertainty. First, medium term uncertainty, measured by the stage of the season when the match is played (ROUND) together with a set of variables related to the intensity of the competition when the match is played (Hautbois et al., 2022; Scelles et al., 2013). We first include the variable COMPETITIVE BALANCE, measured as the difference in points between the visiting team and the local team prior to each match. Secondly, we include the variable COMPETITIVE INTENSITY, measured for the visiting team as the smallest difference in points with its most immediate competitor who is in a "different situation" before the match. "different situation" refers to the differing objectives each team pursues and has a chance of achieving, such as winning the competition, qualifying for the Champions League, qualifying for the UEFA League, maintaining a mid-table position, or not getting relegated. For teams in the second division, this would be getting promoted as champions, getting promoted, reaching the promotion play-off places, staying mid table, or not getting relegated.

Secondly, short-term match uncertainty, which is measured through bookmakers' decimal odds, and which is the method used in recent decades by many authors (Buraimo, 2014). As regards the stage of the season, authors such as (Parshakov & Baidina, 2017), conclude that demand for football matches is similar throughout, whereas others such as (de Santana & da Silva, 2009) suggest that it does prove influential, with stadium attendances increasing at the end of the season. On the other hand, short-term uncertainty is one of the aspects that has given rise to the most diverse conclusions in studies addressing attendance at sporting events. Some studies indicate that increased uncertainty leads to increased demand (Artero & Bandrés, 2018; DiDomizio, 2010; Forrest et al., 2005) while others conclude that it has no effect (Buraimo, 2008; Caruso et al., 2019). Others report that uncertainty reduces attendance because what fans want is to see their team win (Gasparetto & Barajas, 2018).

In our case, we converted the decimal odds into probabilities by calculating 1/decimal odds, including in the model the probability of a draw and the probability of an away win in logarithmic mode. The number of travelling away supporters should show a positive correlation with the prob- ability of an away victory (LPA) and a negative correlation with the probability of a draw (LPD), if what the fan wants is for their team to win. If, in contrast, the supporter values the uncertainty of the result, then the opposite will occur.

In any case, our initial hypothesis is that supporters who travel to follow their team do not value positively the uncertainty of the match but are more likely to travel the greater the chance is that their team will win. In this regard, the decision to attend sporting events is grounded on a consumer choice model based on maximising the utility that depends on two components: the usual one, based on consumption of the product, plus a second, which may be positive or negative depending on the result of the event compared to the result expected ex ante by the consumer, which allows the uncertainty of the result to be introduced into the model. The implications initially accepted in the literature, in the sense that the uncertainty surrounding the outcome enhances the appeal of the match for the consumer, are justified provided that the marginal utility of an unexpected victory is greater than or equal to an unexpected defeat. In contrast, when the latter is greater than the marginal utility of an unexpected victory (risk aversion), attendance increases the lower the uncertainty regarding the outcome of the match. This occurs when supporters have to take the trouble of travelling from one place to another to see a match in situ.

In the seasons analysed (2017–2018 and 2018–2019), 44 teams from 39 different towns and cities were involved, taking part in the first and second divisions in the seasons in question. Several sources of information were used to gather all the data needed to apply the proposed gravity model. Both the number of tickets purchased by the supporters on each away trip as well as the price thereof were obtained through direct contact with each club. Of the teams involved in the study, corresponding to matches in the regular season, three failed to send data, another did not receive any away supporters during the seasons in question due to work being done at the stadium, while one other team went into liquidation. It should be noted that we did not take into account reserve or B team matches since these teams are not deemed to have their own specific supporters. Nor did we consider matches for which there were no travelling fans due to the reasons given previously. In addition, for one match there were no away supporters because work was being carried out on the stadium, two clubs did not send each other tickets for safety reasons, and one match was played behind closed doors.

Obtaining this kind of information concerning ticket sales at a segmented level is normally very difficult (Kringstad et al., 2018). We therefore followed a strict procedure for collecting this information club by club, taking into account the following aspects. Firstly, the information is as accurate as the clubs wished to send it. The only information not available was for tickets bought on the black market. This concerned a small part of the matches analysed, since very few of those played were sold out (less than 5%). Secondly, not only did we include tickets sold to away supporters in their home town before they went to the match but also tickets that might have been purchased on the day of the match in the city in question; in this case, the regulations state that supporters have to be located in the away fans' area. Thirdly, the information received was very accurate, since all the clubs were contacted using the same procedure (directly one by one through their ticketing department). The response rate was very high and all of the clubs—except one—sent the requested information. With all of the information received, we checked its reliability, and virtually all the responses corresponded to exact numbers of ticket sales and were not approximate or rounded up figures. Given that there is currently no reliable alternative data source that centralises and concentrates all of this information, we believe that the database obtained with regard to the dependent variable represents a milestone, and responds faithfully to the concept of "away supporters travelling to each match."

However, the authors would like to point out that the dependent variable could be subject to a drawback when analysing fan mobility. One potential limitation concerns the possibility that the number of tickets bought by away team fans could be restricted by the stadium capacity. This might happen if the match played were sold out, in which case the dependent variable would be censored. Unfortunately, we would not be able to know the censored value, such that applying censored models would therefore not be feasible. As mentioned, the number of matches that are sold out in La Liga is very small, in contrast to other competitions, where stadiums are full more often, such as in the case of the English Premier League or the UEFA Champions League. In these competitions, capacity restric- tions have led the organizers to take the decision to mandatorily reserve 5% of the seats for the visiting team, but this is not the case in the Spanish LaLiga.

All aspects related to the organisation of each match (division, season, week, date, time, current form, team position and whether the visiting team had something to play for) were obtained through the BeSoccer application.

Data on attendance, trophies won, number of season-ticket holders, and stadium capacity were obtained through the information available in LaLiga. Data concerning rainfall in cubic millimetres were obtained through the National Meteorology Agency and are taken from the nearest meteorological station to the ground where the match was played on the day it was held. As regards population size and data on income, this was obtained from the National Institute of Statistics, and the distance between cities was provided by the Ministry of Transport. The betting odds prior to each match were provided by the online gambling firm Bet365.

Table 1 provides the main statistics concerning the variables included in the model, together with a description of the model variables, and Table 2 the correlation matrix. As can be seen, the sample is an unbalanced panel of 1,392 observations. As mentioned earlier, there are no data available for some matches due to several reasons. In addition, not every home-away pair remains the same in each year because in each season three first division teams are relegated to the second division, three second division teams are promoted to the first division and four second division teams are relegated to the division below and are replaced by teams that come up.

The distribution of the number of tickets bought by away teams during both seasons by division is presented in Figure 1. The scatter plot of away fans and home stadium capacity is shown in Figure 2. As we can see, the correlation between these two variables is low. In fact, the linear correlation coefficient between visiting fans and stadium capacity is only 0.07.

Before moving on to the results, the authors would like to point out that the dependent variable could be subject to a drawback when analysing fan mobility. One potential limitation concerns the possibility that the number of tickets bought by away team fans could be restricted by the stadium capacity. This might happen if the match played were sold out, in which case the dependent variable would be censored. Unfortunately, we would not be able to know the censored value, such that applying censored models would therefore not be feasible. As mentioned, the number of matches that are sold out in La Liga is very small, in contrast to other competitions, where stadiums are full more often, such as in the case of the English Premier League or the UEFA Champions League.

Table 1. Descriptive statistics of dependent and independent variables of the panel data model (a).

Variable	Description		Mean	Std. Dev.	Min	Max	Observations
LTICKETS	Logarithm of number of tickets bought by away team fans in each match	Overall	3.6988	2.2417	0.0000	8.3747	*N* = 1,392
		Between		2.2105	0.0000	8.3747	*n* = 996
		Within		0.6746	0.7684	6.6292	*T* = 1.3975
LSEASONHOLDER	Logarithm of number of season-ticket holders of each away team at the beginning of each season	Overall	9.3487	1.3728	1.0986	11.3658	*N* = 1,392
		Between		1.3686	1.0986	11.3658	*n* = 996
		Within		0.4422	5.9860	12.7114	*T* = 1.3975
LPOPULATION	Logarithm of population of the city of away team at the beginning of each season	Overall	12.2515	0.8929	10.2185	14.3193	*N* = 1,392
		Between		0.8804	10.2185	14.3193	*n* = 996
		Within		0.0433	11.4606	13.0424	*T* = 1.3975
AVERAGE	Average number of points won by the away team in the three previous matches	Overall	1.4622	0.7798	0.0000	3.0000	*N* = 1,392
		Between		0.7003	0.0000	3.0000	*n* = 996
		Within		0.4024	−0.0378	2.9622	*T* = 1.3975
LINCOME	Logarithm of per capita income of the city of away team at the beginning of each season	Overall	10.2664	0.1827	9.6625	10.8541	*N* = 1,392
		Between		0.1865	9.8683	10.8541	*n* = 996
		Within		0.0201	9.8351	10.6978	*T* = 1.3975
LPRICE	Logarithm of ticket price fixed by the local team for each match	Overall	3.2257	0.4592	1.9459	5.0106	*N* = 1,392
		Between		0.4320	1.9459	4.8971	*n* = 996
		Within		0.0953	2.4981	3.9534	*T* = 1.3975
ACHIVEMENTS	Composite index of the number of seasons the local team played in the first division and the number of major national and international trophies won over the years at the beginning of each season	Overall	0.0000	1.0000	−0.5514	4.0939	*N* = 1,392
		Between		0.8948	−0.5514	4.0939	*n* = 996
		Within		0.0131	−0.0808	0.0513	*T* = 1.3975
LAVERAGEATTENDANCE	Logarithm of the average attendance at each local team stadium in relation to the stadium capacity at the beginning of each season	Overall	−0.5255	0.2955	−1.3394	−0.0027	*N* = 1,392
		Between		0.3021	−1.3394	−0.0027	*n* = 996
		Within		0.0441	−0.8189	−0.2321	*T* = 1.3975
LRAIN	Logarithm of the rainfall (in mm^3) in the local team´s city on the day of the match	Overall	0.4124	0.8581	0.0000	4.3981	*N* = 1,392
		Between		0.7660	0.0000	4.3981	*n* = 996
		Within		0.4636	−1.4898	2.3146	*T* = 1.3975
LDISTANCE	Logarithm of the distance (in kilometers) between away and local team cities	Overall	6.0000	1.0881	0.0000	7.7236	*N* = 1,392
		Between		1.0543	0.0000	7.7236	*n* = 996
		Within		0.0000	3.1448	8.8552	*T* = 1.3975
SATURDAY	Binary variable (1 if the match was played on Saturday, 0 otherwise)	Overall	0.3700	0.4830	0.0000	1.0000	*N* = 1,392
		Between		0.4368	0.0000	1.0000	*n* = 996
		Within		0.2486	−0.1300	0.8700	*T* = 1.3975

(*Continued*)

Table 1. (Continued).

Variable	Description		Mean	Std. Dev.	Min	Max	Observations
SUNDAY	Binary variable (1 if the match was played on Sunday, 0 otherwise)	Overall	0.4346	0.4959	0.0000	1.0000	$N = 1{,}392$
		Between		0.4414	0.0000	1.0000	$n = 996$
		Within		0.2688	−0.0654	0.9346	$T = 1.3975$
KICK-OFF	Kick-off time of the match	Overall	18.1397	2.7632	12.0000	22.3000	$N = 1{,}392$
		Between		2.4757	12.0000	22.1500	$n = 996$
		Within		1.4020	13.0647	23.2147	$T = 1.3975$
DIVISION	Binary variable (1 if it is a first division match, 0 otherwise)	Overall	0.5395	0.4986	0.0000	1.0000	$N = 1{,}392$
		Between		0.4898	0.0000	1.0000	$n = 996$
		Within		0.0657	0.0395	1.0395	$T = 1.3975$
SEASON	Binary variable (1 if the match was played in the 2018–2019 season, 0 otherwise)	Overall	0.5244	0.4996	0.0000	1.0000	$N = 1{,}392$
		Between		0.3868	0.0000	1.0000	$n = 996$
		Within		0.3773	0.0244	1.0244	$T = 1.3975$
COMPETITIVE BALANCE	Difference in points before the match between away and local teams	Overall	0.2795	12.3970	−44.0000	58.0000	$N = 1{,}392$
		Between		12.1369	−44.0000	58.0000	$n = 996$
		Within		4.7135	−18.7206	19.2795	$T = 1.3975$
COMPETITIVE INTENSITY	Difference in points before the match, for the away team, with the closest competitor with a different situation	Overall	3.1128	3.0816	0.0000	20.0000	$N = 1{,}392$
		Between		2.8683	0.0000	20.0000	$n = 996$
		Within		1.5424	−3.8872	10.1128	$T = 1.3975$
ROUND	Order number of the season day of the match	Overall	20.5187	11.6569	1.0000	42.0000	$N = 1{,}392$
		Between		10.6312	1.0000	42.0000	$n = 996$
		Within		5.9041	0.0187	41.0187	$T = 1.3975$
LPA	Logarithm of the probability of the away team winning before the match	Overall	−1.3753	0.5202	−3.5264	−0.1484	$N = 1{,}392$
		Between		0.5063	−3.3673	−0.1484	$n = 996$
		Within		0.1200	−2.0129	−0.7378	$T = 1.3975$
LPD	Logarithm of the probability of the away team drawing before the match	Overall	−1.2612	0.2387	−2.7081	−0.6931	$N = 1{,}392$
		Between		0.2285	−2.5649	−0.9435	$n = 996$
		Within		0.0595	−1.6793	−0.8431	$T = 1.3975$

Table 2. Correlation matrix.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	LTICKETS	1														
2	LSEASONHOLDER	0.329	1													
3	LPOPULATION	0.201	0.499	1												
4	AVERAGE	0.130	0.083	0.171	1											
5	LINCOME	0.170	0.232	0.271	0.120	1										
6	LPRICE	0.273	0.389	0.367	0.117	0.367	1									
7	ACHIEVEMENTS	0.220	0.155	0.072	0.016	0.148	0.524	1								
8	LAVERAGEATTENDANCE	0.294	0.290	0.156	−0.002	0.244	0.450	0.308	1							
9	LRAIN	−0.093	0.001	0.047	−0.028	0.032	0.037	0.018	0.051	1						
10	LDISTANCE	−0.428	−0.156	−0.054	0.006	−0.070	−0.137	−0.130	−0.196	−0.026	1					
11	COMPETITIVE BALANCE	0.018	0.141	0.216	0.331	0.143	0.046	−0.316	−0.103	−0.029	0.027	1				
12	COMPETITIVE INTENSITY	−0.056	0.023	0.174	−0.037	0.055	0.113	0.022	0.018	0.036	0.014	−0.093	1			
13	ROUND	0.040	−0.041	−0.026	0.027	−0.025	−0.037	−0.024	−0.064	0.052	0.034	−0.001	0.445	1		
14	LPA	0.031	0.257	0.302	0.270	0.159	0.013	−0.551	−0.102	−0.029	0.012	0.692	−0.041	0.013	1	
15	LPD	−0.208	−0.153	−0.113	0.034	−0.145	−0.503	−0.714	−0.361	0.009	0.082	0.318	−0.105	0.023	0.550	1

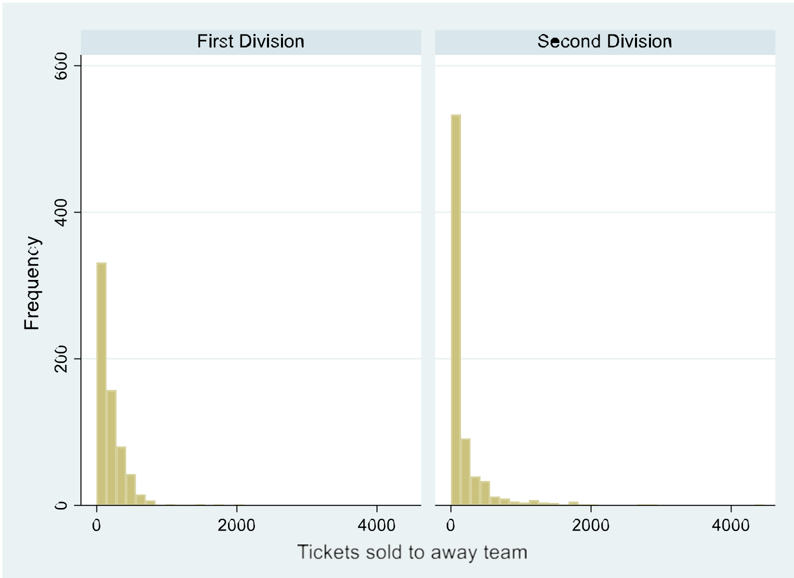

Figure 1. Distribution of tickets sold to away team by division.

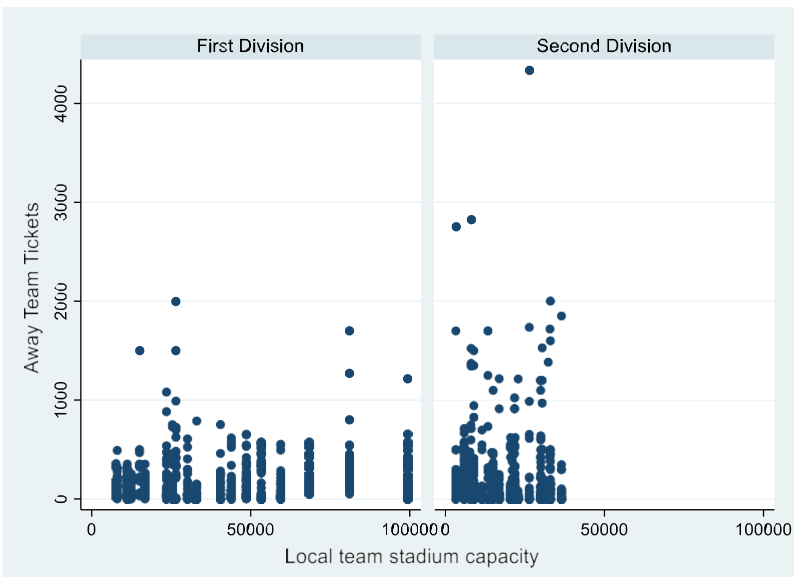

Figure 2. Scatter plot of tickets sold to away team and local team stadium capacity by division.

3. Results

The panel data model specified can be estimated by three different methods: pooled ordinary least square (OLS), fixed effects estimator (FE), and random effects (RE) estimator. The fixed effects estimator will not work well for data for which within-cluster variation is minimal or for slow change over time (Wooldridge, 2010) since the key insight is that if the individual unobserved heterogeneity (in our case, the home-away specific effect) does not change over time, then any change in the dependent variable must be due to influences other than these fixed characteristics (Stock &Watson, 2015). One limitation of the fixed effects estimator is also that the time-invariant variables are dropped and their coefficients not identified. Therefore, we would not be able to estimate the effect of variables whose values do not change over time (Cameron & Trivedi, 2005). In our model, this variable is the distance between the home and away cities, a key variable in a gravity model setting. For these reasons, we only obtained pooled ordinary least squared and random effects estimates. The results are reported in Table 3. In both regressions, in order to have valid statistical inference, panel-robust standard errors are calculated using the cluster-robust covariance estimator, treating each pair ij as a cluster and without assuming specific functional forms for either serial correlation or heteroskedas- ticity (Wooldridge, 2010).

Both regressions provide very similar results in terms of the estimates found and the goodness of fit indicators (R2 and F/χ2). To choose between OLS $_u$or RE effects regressions, we run the Breusch and Pagan Lagrangian multiplier test (LM). The null hypothesis is that the ($\sigma_u^2 = 0$). In other words, there is no significant difference across units ($\mu_{ij} = \mu$). The LM statistic [71.3; p-value = .00] rejects the null hypothesis and concludes that random effects regression is preferred.

Turning to the estimates of the coefficients (Table 3), almost all the selected variables apart from the income of the area from which the away team come and the competitive balance between the away and home team proved significant. In addition, all the variables in the model displayed the expected sign. Specifically, price, distance, kick-off time and division showed an inverse relation with tickets bought by the fans of away teams. Contrastingly, the population and number of season-ticket holders of the visiting team together with their recent form in the competition exert a positive influence. The same is true of the variables reflecting the pulling power of the local team and those related to the date of the match and stage of the season. As regards the variables reflecting the importance of the match, results show that the more that is at stake the greater the number of travelling fans. This behaviour can also be seen for the variable related to the unobserved specific annual effects. Coupled with the model’s good overall fit, all of the above indicate that the model proves valid as a means of interpreting the information generated in the terms posited in the following sections.

Table 3. Panel data regression results for the log of the number of tickets sold to away team.

	Pooled OLS		Random Effects (RE)	
	Coefficient	Standard Error	Coefficient	Standard Error
LSEASONHOLDER	0.259***	0.053	0.200***	0.046
LPOPULATION	0.170**	0.073	0.186**	0.079
AVERAGE	0.302***	0.066	0.237***	0.059
LINCOME	0.186	0.299	0.037	0.322
LPRICE	−0.197	0.166	−0.318*	0.190
ACHIEVEMENTS	0.129*	0.072	0.164*	0.090
LAVERAGEATTENDANCE	0.692**	0.233	0.717**	0.245
LRAIN	−0.030***	0.008	−0.031***	0.007
LDISTANCE	−0.701***	0.058	−0.736***	0.073
SATURDAY	0.579***	0.154	0.583***	0.140
SUNDAY	0.469**	0.153	0.520***	0.135
KICK-OFF	−0.062**	0.020	−0.055**	0.019
DIVISION	−0.384**	0.172	−0.466**	0.180
SEASON	0.246**	0.101	0.186**	0.080
COMPETITIVE BALANCE	−0.008	0.005	−0.007	0.005
COMPETITIVE INTENSITY	−0.100***	0.018	−0.094***	0.016
ROUND	0.025***	0.005	0.021***	0.005
LPA	0.321*	0.167	0.447**	0.184
LPD	−0.990***	0.296	−1.202***	0.337
Constant	1.750	3.209	4.277	3.461
N	1,392		1,392	
R2	0.350		0.350	
F/Chi2	37.387 [*p*-value = .00]		554.9 [*p*-values = .00]	
Rho	0.590			
Breusch-Pagan Test for RE vs Pooled OLS (LM)			71.3 [*p*-value = .00]	

4. Discussion

Starting with the push factors, the visiting team's number of season-ticket holders (LSEASONHOLDER) displays a positive relation to the number of supporters who travel, which concurs with what was previously posited. The greater a club's social mass, the greater should be the number of fans who travel to see the team play away. In addition, a larger size market, measured through the size of the population of origin (LPOPULATION), has a positive influence on away supporter travel, given that teams from larger cities are able to generate a larger number of supporters, such that there will be more supporters willing to travel with the team. This finding does not tie in with (Barajas et al., 2019), who reported no link between stadium attendance and population size in the Brazilian league. However, most studies into European football and other sporting events do suggest a positive significance in this regard (Kringstad et al., 2018)

The greater the average number of points obtained in the three previous matches played by the visiting team (AVERAGE), the greater the number of supporters who will travel, which is explained by the expectations the team generates amongst fans concerning their team's chances of success. Supporters feel that the better the team's current form, the greater the chance of them winning, and so the greater is their desire to follow the team away. These results are in line with those found by (Baranzini et al., 2008) in the Swiss league or (Pawlowski & Anders, 2012) in Germany, although they contradict those reported by (Buraimo et al., 2018) in the Peruvian league or (Reilly, 2015) in the Irish league, where the authors failed to find any link between a team's recent results and stadium attendance. The explanation may be found in the difference between local and visiting supporters: travelling away to watch a team cannot be compared to watching them play at home. Going to away matches involves a greater sacrifice on the part of supporters, and they will only be willing to travel if they feel their team has a chance of success.

What does not prove to be significant, however, is the level of per capita income of the population in the visiting team's city (LINCOME), which is in line with some previous studies addressing sports- related topics. Dobson and Goddard (1995) and Simmons (1996) sought to provide technical explana- tions as to why income is not significant or why in certain cases the value of its elasticity is even negative and found no evidence to support the notion that football is a normal good. In some instances, football has been even understood as an inferior good characterised by the lack of safety or facilities that are very often in poor condition.

As regards the pull factors, the most relevant information for organisers concerns price elasticity (LPRICE). The demand function for the number of travelling fans evidences negative elasticity that is below one, thus reflecting its inelastic nature, which is in line with other preceding studies dealing with attendance at sporting events (Szymanski & Smith, 1997), although we already pointed to the enormous complexity involved in measuring the real cost of attending a match. Although studies generally speak of football as a good with negative elasticities (Bird, 1982; Simmons, 1996), other studies report results where price and attendance are positively related (Jennett, 1984), which might be due to the price of the ticket not reflecting the cost of attending a football match, and even more so in the case of an away match. More specifically, for the case of the Spanish league, (García et al., 2020) also find inelastic price values in their relation to certain characteristics of the demand function such as the quality of the teams, the uncertainty surrounding the result or the kick-off time.

We also found significance between the number of travelling supporters and a further two pull- related variables. First, the weighted index (ACHIEVEMENTS) is seen to have a positive influence on visiting supporters' ticket purchases. Secondly, the percentage of attendance at the local stadium (LAVERAGEATTENDANCE), which measured the pulling power of the local club's social mass, was also positively related to the number of visiting fans. This shows that fans are more drawn to rivals whose supporters are more loyal, which is linked to the atmosphere inside the stadium: football fans would rather travel to stadiums that are relatively full than those with smaller crowds, where the atmosphere may be colder. Finally, the variable LRAIN proved to be significant with the expected sign. Bad weather negatively impacts attendance.

As regards the analysis of those variables that do not depend exclusively on the local team or the visiting team and which therefore cannot be categorised as "push" or "pull," distance (LDISTANCE) displays enormous significance in the presence of away fans at stadiums, which is supported by the proposed gravity equation, indicating that the pulling power of two masses should be inversely proportional to the distance between them. For each percentage point increase in distance, the number of supporters falls by over 6.5%. This is a very important variable in our gravity model, a model which had never previously been applied in research into attendance at sporting events. It reflects the idea that the less the distance involved and, therefore, the closer the geographical proximity of the two teams facing each other, the greater the number of fans who will travel.

The day of the week (SATURDAY and SUNDAY) and the kick-off time (KICKOFF) also prove to be particularly relevant. The results show how playing matches on Saturdays and Sundays has a positive impact on fans travelling, while the kick-off time and number of supporters are inversely related: the later the match kicks off, the fewer fans will travel. Some studies have also reported similar findings in supporter behaviour in general. (Baranzini et al., 2008) suggested that matches played in the Swiss league between 4:00 P.M. and 6:00 P.M. drew bigger crowds and, in an analysis of Europa League matches, (Krumer, 2020) reported how matches starting at 7:00 P.M. had far bigger attendances than those kicking off at 9:00 P.M. Once again, the lack of literature analysing away fans makes any comparisons difficult, although both findings would seem logical in the context studied: Fans have more time available at weekends and prefer to travel when they can make the return journey early.

The division (DIVISION) also influences the number of supporters who travel and as expected, more people travel to see first division than second division matches, which can be seen as an indicator of match quality. For its part, the positive value of the variable which reflects the season (SEASON) indicates that in the 2018–2019 season more fans travelled than in 2017–2018, regardless of the other variables. Together with the existence of unobserved year- specific effects, this result is related to excluding two reserve or B teams from the analysis in the 2017–2018 season since there were not deemed to have their own specific supporters. These teams were relegated at the end of the 2017–2018 season, which might explain part of the difference between the two seasons.

As regards the uncertainty of the outcome, this was first measured in the medium term based on which week the match was played (ROUND) and we observed that as the season progresses the demand to watch teams play away increases. As a result, the closer it is to the end of the season, the greater is fans' motivation to follow their team away, since they will be closer to achieving their objective. As regards the variables related to the intensity of the competition, only COMPETITIVE INTENSITY proved to be significant, and with the expected sign. Therefore, the closer the competitor (the lower the value of the explanatory variable) the greater the uncertainty in the result and the greater the number of fans who will travel. This finding is also in line with those reported in studies carried out for the French league (Hautbois et al., 2022; Scelles et al., 2013).

Short-term uncertainty, measured through the probability of an away win (LPA) and the probability of a draw (LPD), shows that away fan travel increases significantly the greater the likelihood of the visiting team winning, and not when there is greater uncertainty surrounding the outcome. This indicates that what travelling fans really value is the possibility of their team winning, and not the chance of watching a more exciting or less exciting match, which is in line with (Cox, 2015), who concluded for the English Premier League that the lower the uncertainty surrounding a match, the greater the number of spectators who will attend.

5. Conclusions

This study aims to ascertain the influence of a series of factors related to football fans' away travel in one of the most important leagues in the world by conducting a differentiated study of visiting supporter behaviour in the world of football. Using the universal gravity equation, we model the forces that determine away supporter travel for the Spanish league. For the first time, we estimate a gravity model using a three-dimensional panel data model, enabling us to link information on sports, economic and environmental aspects of the team local, the visiting team, or both, to tickets sold to supporters from other cities. The results to emerge provide abundant information that might help those responsible for organising football to take decisions so as to maximise away supporter numbers. It might also offer supporters clubs, as well as football clubs themselves, information regarding what determining factors fans take into account when following their team away from home in order to provide a more efficient organisation of the tickets made available to travelling supporters.

Several factors that have a significant influence on away supporter travel are under the control of the institutions who organise the competition. This might be used in order to optimise away supporter travel over a season. Prominent amongst this group of variables that might be controlled or taken into account by the clubs or professional leagues are the time and day the matches are played, ticket price, distance between cities, uncertainty surrounding the result of the match and the appeal of the stadium. There are currently many determining factors taken into consideration when preparing the fixture lists in the main European leagues so as to maximise revenue, and in this regard the findings to emerge from the present study may prove interesting when arranging fixtures. If those responsible for organising football were able to merge all of these factors they could maximise the level of away fan travel and consequently the amount of revenue that clubs generate through this concept. The volume of away supporter travel decreases with distance and when matches are played at night and on weekdays. In this regard, it would be interesting to combine these factors and to concentrate matches between teams that are further apart on weekdays and leave weekends for matches played between teams from places that are closer to one another. This would also help to boost the economy of the places fans travel to. The same is true of the uncertainty of the match: Fans travel when they feel their team stands a better chance of winning, such that it would prove interesting to schedule matches where an away win is more likely for weekends.

Another set of variables, however, cannot be controlled by these bodies, but should nevertheless be taken into account when planning a season. These concern the appeal of the local team, the current form of the team or the division in which the match is played. Although these are not under the full control of the competition organisers, they should be borne in mind. For example, we have seen how the most successful teams attract a greater number of fans to stadiums, such that scheduling their matches for weekends might provide an incentive for rival fans to travel. Moreover, and taking into account that the day and time of the match are decided several weeks in advance, a team's current form should also be a factor taken into consideration. Teams that are on a good run of form should be scheduled to play at weekends and at times that enable their supporters to travel, whereas those who are going through a bad patch can be scheduled for less favourable times and days.

The authors believe that, to date, clubs in the major leagues have underestimated the potential revenue from ticket sales in recent seasons. However, the current worldwide health situation, which forced all leagues either to play behind closed doors or with very limited spectator numbers, has highlighted the importance of revenue for clubs through this concept. The return of crowds to attend sporting events will witness the reactivation of many clubs' economies, and good planning on their part and on the part of the competitions' organising bodies will prove decisive for the economic future of sports clubs. Maximising away supporter travel will also provide a spur to the local economies of the destinations and offer a boost to a sector as heavily hit as tourism.

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