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Playing Like the Home Team: An Economic Investigation into Home Advantage in Football

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Abstract

Home advantage in football varies over time. Existing theories of home advantage struggle to explain this time-series variation. We argue that the decline in home advantage in English football since the mid-1980s was partly caused by the advent of televised football. We argue that the increase in live television coverage of football matches has worked to incentivize players to not to shirk when playing in away games, as supporters can now more effectively monitor their efforts. We test this hypothesis using both time-series and panel-data econometrics.

Keywords: home advantage, shirking, moral hazard

Introduction

Home advantage is a well-established and long-lasting phenomenon in team sports; a team competing in familiar surroundings, controlling for ability, wins more than 50% of the time. In domestic football leagues, there remains a strong advantage to being at home in all countries, subject to some variation, as Pollard (2006) shows. Explanations vary considerably for football, from transportation costs, through implicit referee bias to the level of testosterone in players.[1]

Despite the number of possible factors cited by researchers, there has been little research on the mechanism generating a systematic advantage for home teams in football. Economics, and principle agent analysis in particular, is well suited to analyzing this problem. What are the incentives affecting a professional football player each week? Do they contribute to making the team more or less likely to succeed? We propose a mechanism through which supporters and television combine to affect home advantage. This model suggests that the ability of supporters to monitor effort of football players in both home and away matches in the TV and internet era means that no longer can a player shirk on away games and expect to still be a firm favorite with the supporters.[2]

We test this and other hypotheses by exploiting recent advances in modeling football match outcomes to control for team ability in measuring home advantage, before using this output in time-series and panel data models. In particular this paper intro-

duces a novel way of modeling match outcomes, which provides a measure of home advantage that controls for the defensive and offensive strength of each team in each season. We find that existing explanations can only explain part of the variation in home advantage, and that our monitoring hypothesis has support in the data.

The outline of the rest of the paper is as follows. In the following section the literature on home advantage is critically reviewed, before the next section introduces a simple theoretical framework. The following section contains an econometric analysis of home advantage motivated by the new and existing theories, followed by the conclusion.

Causes of Home Advantage

Home advantage is a complex phenomenon and it does not seem possible to identify a single factor responsible for the pattern of home advantage we observe across different sports, and different leagues, through time. Figure 1 plots, for all four English professional football divisions, two common measures of home advantage.[3] On the top panel, the percentage of all available points that are won by the home side proportional to the available points won by the away side is plotted, and on the bottom, the number of football matches each season that are won by the home side is expressed as a ratio of the number of matches won by the away side. Figure 2 plots the English values against those of other major European football playing nations, thus providing a benchmark for international comparisons. Controlling for all other factors, such as ability, one would expect that home teams win as many matches as they lose; as such, even allowing for the existence of the draws, both these ratios should be around unity.

At first glance, the four English leagues appear to show a fairly consistent picture: home advantage is declining steadily. Around the turn of the 20th century, and well into the inter-war years, the home side won more than twice as many matches as the away side, and amassed nearly three times as many points. By the 1990s and the turn of the 21st century, this ratio has dropped to only just over 1.5. It appears that the extent of home advantage has been declining throughout the history of professional football. This is true for the lower three divisions of English football; however, it appears that for the Premiership, home advantage has been declining in shifts, and has remained quite stable for lengthy periods of time. Since the late 1980s, the ratio of home superiority appears to have stabilized, having fallen from a high in the mid-1970s.

Travel fatigue and rule advantages have been proposed as factors contributing toward explaining home advantage. Players have to make long journeys, and particularly for lower divisions, the journey takes place on the day of the match. In 2007-08, Carlisle United, one of the most remotely located football clubs, won 16 consecutive home matches, and Portsmouth, similarly remote on the South Coast, are perennially strong at home.[4] However, Figure 1 offers some initial evidence to the contrary; between 1921 and 1958, the Third Division (labeled League One, its current name) was split into North and South sections, hence reducing substantially the distance traveled by competing teams. However, from Figure 1, the League One series is consistently higher than all other divisions, suggesting stronger home advantage in these regional divisions over the period. After 1958, bar one season in the 1970s, the League One and Two series (the North and South divisions became two national leagues in 1958) are indistinguishable from the top two divisions, suggesting that home advantage fell back in line after the divisions stopped being regional, and once distances traveled increased.

The most studied factor is crowd support and crowd size. Nevill et al. (1996), considering just one season of English football, find attendance to be a significant factor, but Pollard and Pollard (2005), cast doubt on the crowd hypothesis by considering more than one season, albeit without any statistical analysis. From Figure 1 home advantage in the Premiership, where crowds, on average, are largest, is not distinctly different from other divisions, and additionally Figure 3 plots home advantage against average attendance in the English Premiership between 1947 and 2007, and there is little relationship between the two.[5] It actually appears like home advantage has slightly declined since the mid-1970s, while attendances have risen dramatically, almost achieving 1950s levels.

Another possible cause is refereeing bias. As well as, or instead of, influencing the behavior of players, crowd size may also affect the decisions of the officials. Nevill et al. (1996) found that the number of sending offs and penalties favored the home-side. Sutter and Kocher (2004) confirms a bias toward the home side in decisions on penalty awards and end-of-game injury time in the German Bundesliga. Boyko et al. (2007) find refereeing decisions and crowd size are the two significant variables that determine home advantage in the English Premiership.[6] It is unclear whether these studies adequately control for endogeneity problems. Teams may win more home matches because they are simply more successful and more successful teams have higher attendances. If the ability of the team in question is not adequately controlled for, this will bias the results in a predictable direction. Similarly, the referee effect Boyko et al. and Sutter and Kocher (2004) find may be explained by the amount of attacking that good

Figure 1

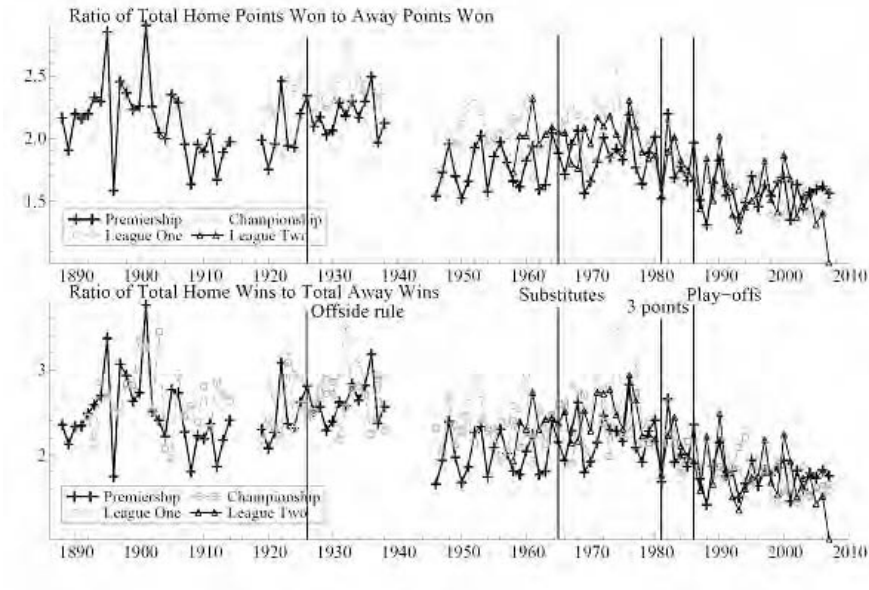

Figure 1: Plots of two common measures of home advantage for all four English football divisions, 1888-2007. Top panel is the percentage of games won by the home team, and bottom panel is the percentage of total points available won by the home side. Important dates in football history are noted on the plot also.

Figure 2

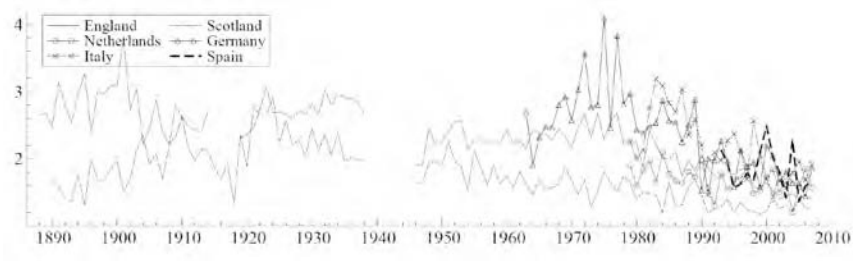

Figure 2: Plots of the percentage of matches won by the home side for various European countries.

Figure 3

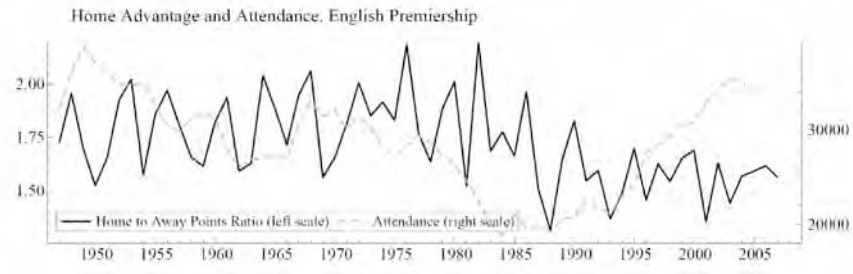

Figure 3: Plot of home advantage (ratio of home points to away points won, left scale), and average attendance (right scale) for the English Premiership, 1947–2007.

sides do; the more attacking a team does, the more likely referees award decisions in their favor, particularly penalty kicks. Good sides win more home matches, and also receive more decisions from the referee; the two may be correlated, but the direction of causation is ambiguous.

Another possible hypothesis is that the degree of competition in a league will affect how much home advantage exists; Forrest et al. (2005) suggest that that home advantage is positively related to competitiveness. Competitive balance in a football league can be calculated using any of the competition measures developed in industrial economics, and papers such as Brandes and Franck (2007) do just this. Figure 4 plots two measures of competition in a division; the left panel is the Herfindahl index, and the bottom panel the CR5 index, which measures how dominant the top (biggest) five clubs (firms) in a division (industry) are (see Koning, 2000). These two measures show that since the mid-1980s, the Premiership has become less competitive, while competitiveness in the Championship, accounting for the three-points-for-a-win effect on the standard deviation measure, has remained stable, but home advantage has fallen in both. This suggests that there may be something more than simply the competitiveness argument dictating changes in home advantage.

Finally, it has been claimed that home advantage may have a deeper cause. Perhaps a biological one? Neave and Wolfson (2003) find that players record higher levels of

Figure 4

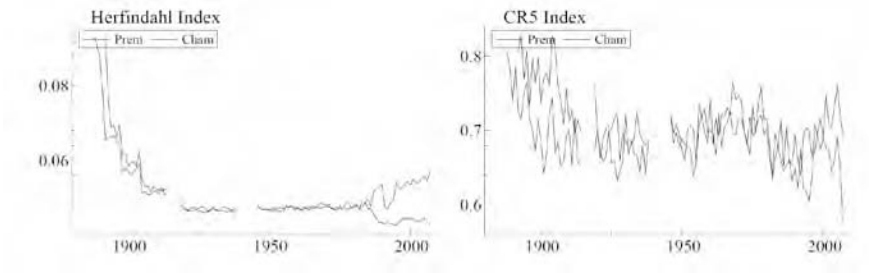

Figure 4: Measures of the competitiveness of the top two divisions of English football; left panel is the Herfindahl Index (higher means less competitive), right panel is the CR5 measure.

salivary testosterone before a home game then they do prior to away games. Testosterone levels were also higher before important games between particular rivals. The authors attribute this effect to an innate instinct males have to defend their own territory. But their small-scale experiment has not been scaled up, and does not establish a direct link between testosterone levels and performance. Furthermore, static explanations of the existence of home advantage such as this cannot explain why home advantage varies between sports, or why it has varied over time.

Pollard and Pollard (2005) and Jacklin (2005) consider the extent to which home advantage has varied over time. The former investigates the home points ratio without controlling for team ability. The latter uses post-war data from 1946 onward, whereas in this paper we consider data back to 1888. Jacklin specifically considers the effect of two events in English soccer history: the introduction of substitutes in 1965 (before this teams could not replace injured players), and the introduction of three points for a win in 1981. He finds that the introduction of substitutes increased the extent of home advantage, whereas the advent of three points for a win diminished it. However, Jacklin was unable to pin down the beginning of the decline in home advantage to a particular year; instead his estimates range from between 1981 and 1987. Furthermore, from his plots of the ratio of home wins to away wins (his Figure 2), it appears that the decline began during the early 1970s.

The main difficulty in identifying a cause of home advantage is in specifying a mechanism that causes a particular factor to affect home sides or away sides more. Jacklin (2005) argues the change in points system, from two points for a win to three, significantly undermined home advantage. All teams attempt to win their home games, and according to this argument, in the two-points era, the away side often played for a draw. The increase in 'cost' of drawing a game as a result of the move to three points for a win thus had an asymmetric effect because it encouraged attacking play for away teams.

Can this explain the decline of home advantage? The incentives facing the away side apply just as much to the home side, so it is unclear that three points should have adversely affected home advantage. This explanation depends on the away team changing tactics and playing more offensive football, and it would predict less draws and more home and away wins. However, the number of home wins in the Premiership remained unaffected until later in the 1980s, while the number of draws

Figure 5

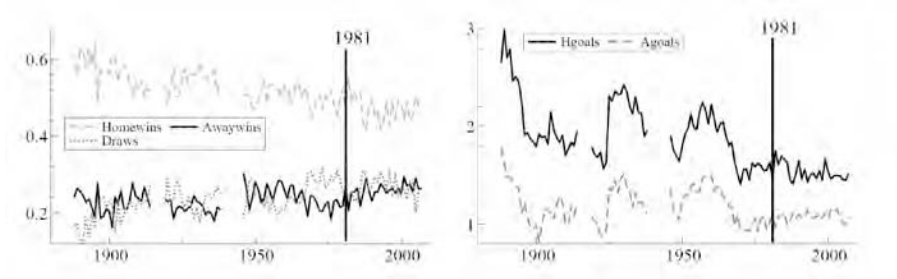

Figure 5: Plot of the proportion of home wins, away wins, and draws in the top division of English football since 1888 (left panel), and the number of goals per game in the top division (right panel).

Figure 6

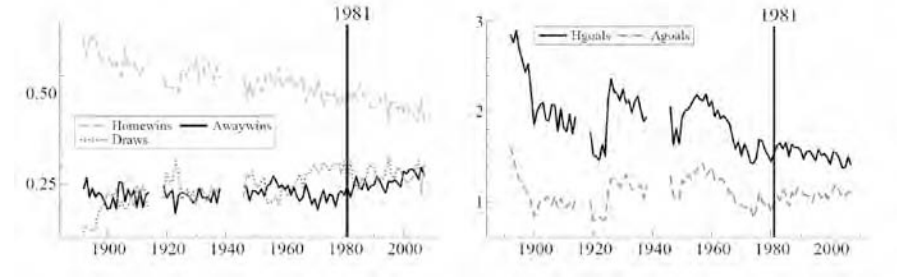

Figure 6: Plot of the proportion of home wins, away wins, and draws in the second division of English football since 1892 (left panel), and the number of goals per game in the second division (right panel).

displays no obvious trend from Figure 5. Figure 2, which plots the ratio of home wins to away wins for various European countries, lends even less support: Germany, Italy, and Scotland only adopted three points for a win in the mid-1990s, by which time the most drastic decline in home advantage had taken place in these countries.

Figures 5 and 6 plot the percentage of home wins, away wins, and draws for the top two divisions of English soccer, alongside the goals per game for these divisions for all the years of their existence.[7] A solid vertical bar represents the 1981-82 season, when three points for a win was introduced. The proportion of matches finishing as home wins does not appear to be affected by the three-point change; for the lower divisions the steady decline in the proportion of home wins simply continues unabated, while in the top flight there is no discernible affect of the change. There does appear to be a change in 1986-87 season, a level shift downwards, but it would be hard to argue this was a result of the three-point introduction five years earlier. Furthermore, the top flight upward trend in away wins that persists to this day had begun before 1975, while the number of draws shows no effect of three points: it has been fluctuating around the highest mean level in its entire history since the late 1960s. The same can be said for draws and away victories in the other three divisions, and in those divisions home wins have been steadily declining throughout.

An alternative hypothesis is that there are more draws now compared to the 1950s because there are considerably fewer goals per game. All plots show that the 1950s were a golden age in terms of goal scoring. Another prediction of increased away attacking play would be more away goals being scored (and also more home goals since away defenses are less solid). But as with wins, 1981–82 does not appear to affect either home or away goals. Rather, again 1986–87 appears to be something of a watershed, although away goals are unaffected.

An Alternative Hypothesis Regarding Home Advantage

The Monitoring Hypothesis

The literature on team performance and the theory of the firm can illuminate an additional channel through which playing at home can affect performance. The mechanism through which this channel operates is player motivation. It is not so much that playing at home directly motivates players; this cannot be ruled out, but it also cannot be tested. Rather, our hypothesis is that the presence of home supporters counteracts the incentive each individual player has to put in slightly less effort in a team game than if he or she would if being judged on individual performance alone.

A football club is a firm where the players are employees and the supporters are, in effect, consumers purchasing the performance of the team (Sloane, 1971; Szymanski & Smith, 1997). This purchase is a bundled one. Supporters get utility when they see their team put in a good performance, but even if they missed the game, they also get utility from being able to boast about the league position of their team, or if a rival team has been defeated.

In team sports it is difficult or impossible to parse out the marginal contribution of each individual player to this bundled product. This means that team sports are characterized by production externalities. The logic behind this was first laid out by Alchian and Demsetz (1972). These externalities create a 'cover' for shirking as Miller (1992) puts it. If one player improves his performance, this not only benefits him but benefits his team members as well. Similarly if one player reduces the amount of effort he is putting in, not only does his performance suffer, but so does the performance of the other players on the team. In football the externality problem is exacerbated by the fact that there is no common metric for evaluating player performance. This means that it is impossible to supply the right individual incentives to ensure optimal performance (Holmstrom, 1999).

The phenomenon of shirking in group tasks is widely documented in the management and psychology literature where it is termed "social loafing" (see Latane et al., 1979; Karau & Williams, 1981; Liden et al., 2004). It is also prevalent in a number of team sports. Miles and Greenberg (1993), for instance, found that in competitive swimming performance within teams lagged behind individual performance, confirming the shirking or "social loafing" hypothesis. They found that this problem was ameliorated when poor performance was punished. The prevalence or perceived prevalence of shirking among baseball players is examined by Krautmann (1990), Maxcy et al. (2002), Knowles et al. (2003), Marburger (2003) and Berri and Krautmann (2006).[8] This phenomenon has not been extensively discussed in the literature on football.[9]

One exception to this is McMaster (1997), who discusses the incentive players have to shirk in the context of a wider set of agency problems football clubs face. He argues that "despite performance being assessed on the basis of team success, the contribution of each individual is relatively easy to assess . . . there are constraints on the ability of players to shirk or free ride, since there is an absence of informational asymmetries" (McMaster, 1997, p. 27). This argument misstates the moral hazard problem created by externalities in production: the incentive to shirk results less from asymmetric information than from unverifiable information (Tirole, 1999). If information can be measured or described in a way that can be verified by a third party then it can be included in a contract. But if performance depends on factors that are impossible to describe in such a way that be independently verified then any performance-related contract will be necessarily incomplete.

The incentive to shirk, therefore, exists. Effort is costly and that playing football professionally is physically and mentally draining. Players can play up to 60 competitive games a year and it naturally makes sense for them to ration their strength when they can. The compensation packages clubs offer to players recognizes the problem of motivating player performance and deterring individual players from shirking. Football clubs routinely use performance-based contracts to motivate players. But these contracts can only include objectively verifiable information. Bonuses for wins, goals, assists, clean sheets, and other forms of performance-related pay are attempts to elicit the highest level of performance possible over time. Overall performance, however, is difficult to measure since it cannot be described by a single sufficient statistic such as goals scored.[10] Performance is dependent on a host of different variables, some of which are not amenable to statistical representation, and transaction costs preclude designing individual contracts that condition on a larger set of performance measures.

The effort a player puts into a game is roughly observable. The problem of asymmetric information in this sense is muted. The manager, the coaches, and the fans can often see when a player is shirking: a player may not be making the runs off the ball that are required of him or an attacking player may fail to help out in defense; it is not difficult to spot inattentive defenders who risk playing opposition players onside.[11] Though this information is observable, it is not verifiable and therefore cannot form part of an incentive contract. Players who fail to meet the stipulated terms of their contract can be fined or fired. Verifiable forms of shirking such as a failing to attend a training session can be deterred by suitably specified contracts. But since this is not possible when shirking is unverified, an informal rather than formal system of incentives is required.

As Alchian and Demsetz (1972) argued, when production takes place in teams, and inputs are costly to verify, it is necessary to monitor individual performance because each member of a team has an incentive to shirk, i.e. to put in less effort than his fellow team members if he can get away with it. Monitoring performance is of course the purview of the manager. So is motivation, and it is the task of the manager to create a sense of camaraderie and team spirit.[12] Successful managers do precisely this. But, in many cases, the ability of managers to single out particular players for criticism is limited.[13] We claim that another way of ensuring that players play well is supporter pressure. Football fans watching a game live can easily detect when a player is shirking. They can see whether players are making appropriate runs or whether or not they are shirking.

This argument does not rely upon discounting monitoring by managers or coaches; rather we claim that the ability of the manager to monitor players is imperfect, and his ability to sanction players he thinks are shirking is limited. Therefore, monitoring by fans augments monitoring by the manager. Fans are comparatively cheap monitors since they have internalized the benefits of sporting success. Furthermore, they can impose different kinds of informal sanctions of players they disapprove of. This, we suggest, is one of the roles fans perform in professional football. As a result players put more effort in, and play better when they are being watched by their own fans. Players who do visibly shirk are signaled out by the fans. Moreover, players who are unpopular with the fans almost inevitably leave the club.

This provides a potential explanation for the phenomenon of home advantage. Fans as a whole are better able to monitor individual player performance in home games than in away games because a far higher proportion of fans attend home games relative to away games. More specifically, they are better able to measure the effort an individual player exerts in a home game. Therefore, average player performance will be higher at home games because shirking is more effectively deterred in home games. Our explanation does not discount the role of managers. Rather we think that successful managers are those that can overcome these incentives. But we think that these incentives do in fact exist.

If a fan does not attend an away game, he can easily find the result of the game, read a match report, and perhaps watch highlights on television. All of this gives him an idea of how well the team as a whole performed but less of an impression about how each individual player performed. Therefore, it is likely that some level of home advantage will always exist. This argument can potentially predict the time-path of home advantage since it suggests that innovations such as televised games and the internet will reduce the advantage a home side enjoys, at least to the extent that such technologies enable fans to monitor the performance of individual players. In the next section we develop this hypothesis more formally.

Pressure from supporters can also undercut performance. Our argument is perfectly consistent with Dohmen (2008) finding that during penalty shootouts the probability of home players 'choking' or missing the penalty altogether is higher than for visiting players. The penalty shootout stage of a knock-out game is qualitatively very different from league football: each kick is potentially decisive. In high pressure situations, it is plausible that high expectations can adversely affect performance. Therefore, we find it unsurprisingly that teams can enjoy home advantage in league football and home disadvantage in penalty competitions.

Predictions of the Monitoring Hypothesis

In the context of a sport like football, the performance of individual players is difficult to monitor. In this section we develop a simple theoretic model that captures this insight. Drawing on insights from multi-task principle agent theory, we show that when monitoring ability varies across environments, relative performance is distorted (Holmstrom & Milgrom, 1991).

There are two environments: *Home* and *Away*. The environments vary according to the monitoring technology. Since a higher proportion of fans attend home games than attend away games, they are better able to evaluate the performance of individual play-

ers at *Home* than they can away from home. Note we do not assume that fans care more about home performance than they do about performances away from home. The only variation is in the monitoring technology.

Denote the amount of points a team expects to win in a league, by $E(P)= E(P^H)+E(P^A)$ where superscripts denote home and away, respectively. Conditional on team ability, we argue that the number of points a number obtains depends on the amount of the effort the players as a team put into the performance. Therefore, we can write, $E(P)= E(P[\mathbf{e}|x])$ as a function of team effort $\mathbf{e}$ where $\mathbf{e}$ is a vector comprising $\{\mathbf{e}_1,\mathbf{e}_2,...,\mathbf{e}_n\}$, conditional on a number of exogenous variables $\boldsymbol{x}$, where there are n players in the team.

Players choose the level of effort to put into a game $e \in (0, 1)$. Effort, however, is costly. The cost of exerting effort is given by $c(\mathbf{e}_i)$ where $c`(\mathbf{e}_i) < 0$. The utility of player i is therefore given by,

$$\max u_i = w - c(e_i) \tag{1}$$

If effort is perfectly measurable and each individual's wage packet depends solely on the effort they expend and $w = w(\mathbf{e}_i)$ then each player equates marginal benefits with marginal costs. In this case each player puts in the optimal amount of effort into each game as given by: $w`(\mathrm{e}_i)= c`(\mathrm{e}_i)$. Denote the amount of effort e that solves this equation e^*

We assume that players are paid according to how much the fans value them and that this in turn depends on how much effort they are perceived as putting in on the pitch.[14] These assumptions are captured by the following relationship between wages and effort.

$$w(e) = (1 - \mu)e_i + \mu\varepsilon_i. \tag{2}$$

where ε_i is an error term uniformly distributed along (0, 1) and μ is a variable between 0 and 1 reflecting the extent to which a player's performance can be monitored by the fans.

The effort a player i expends in each environment can be denoted by: e_i^H and e_i^A respectively. The ability the fans have to monitor the performance of individual players depends on whether or not they attend the match, or whether or not it is possible to watch the game, or perhaps highlights of the game on television. These factors will determine μ.

We are interested in how players distribute their effort between home and away games. For simplicity consider the following polar cases. At Home we suppose that $\mu = 0$ while at Away, $\mu = 1$. Under these assumptions the first order condition for the optimal of effort a player puts in at home is the same as the first-best efficient level: $w`(\mathbf{e}_i) = c`(\mathbf{e}_i)$. Away from home: the relevant first order condition is: $c`(\mathbf{e}_i) = 0$. Therefore players put in no effort away from home.

$$e^H = e^* \tag{3}$$

$$e^A = 0 \tag{4}$$

More generally, the marginal benefit of expending extra effort is falling in μ. Therefore, so long as μ is lower at home than it is away from home: $\mu^H<\mu^A$, i.e. so long as it more difficult to accurately monitor effort away from home than it is at home, the amount of effort e players exert will be greater at home.

In order to complete this model we have to specify the relationship between the effort players expend in a match and overall team performance. Effort is only one among many possible determinants of match performance. But we expect that if the mechanism we have identified is plausible then, controlling for the overall ability of a team, and other exogenous factors such as the competitiveness of the league, and the distance traveled by each team, the relative advantage of the home team over the away time should depend in part upon the extent to which supporters are able to monitor the performance of individual players. We write this prediction as follows.

Proposition: As the ability to monitor players' performance improves, and μ falls due to increases in the proportion of away fans attending matches, television coverage, or the internet, the ratio of points won at home relative to points won away from home will fall. This states that the proportion of points won at home: $E(P^H)/E(P^A)=[E(P) - E(P^A)]/E(P^A)$ is falling in μ.

$$\frac{\partial\left(E(P^{H})/E\left(P^{A}\right)\right)}{\partial\mu^{A}}<0. \tag{5}$$

One advantage of this hypothesis is that it is compatible with the finding that home advantage is a phenomenon unique to team sports. Tennis players and other individual sportsmen do not experience particular benefits from playing at home because their pay depends solely on their own performance. It is also consistent with the finding that in American sports, home advantage appears strongest in indoor sports such as basketball where the supporters are close to the players.[15]

A second advantage of this explanation is that it is consistent with the views of many supporters as reported by Wolfson et al. (2005), who surveyed a large of number of supporters in an attempt to assess their own view of home advantage and the role of crowd support in explaining home advantage. Comments considered representative include: "Players try harder at home because they are in full view of their own supporters" and "Players are probably keen to put on a better display" when they play at home (Wolfson et al., 2005, p. 369). Football fans clearly perceive their role to one of motivating the players in this light. They do not only encourage good play. They also single out players viewed as "lazy" for special abuse. In the next section, we detail the growth of televised games in the 1980s and 1990s to see whether or not the timing of this expansion coincides with the relative decline of home advantage.

Television Coverage of Football in England

Are the predictions of this hypothesis consistent with the available data? As shown in Table 1 the number of televised games increased throughout the 1980s and 1990s. The current television rights package allows 132 of the 380 matches played in total to be televised live. BSkyB paid £1.7bn for the right to show 92 of those matches. Highlighting the massive inflation in TV rights packages, in 1983-1985 the BBC and ITV paid just £5.2m to cover 10 matches per season between 1983 and 1985. However, no games were televised in the 1985–86 season due to industrial action. Therefore, it was only in 1986, that the number of matches televised more than doubled from 6 to 14. From November 1988 onward live football appeared on the television most Sundays each season. We, therefore, associate the period from around the mid-1980s onward as a new regime, one in which monitoring is less costly for supporters. Even if

Table 1: Number of matches televised per season in the English Premiership. Source: FA Premier League and BBC News

	1983	1985	1986	1988	1992	1997	2001	2004	2007
Length of contract (years)	2	0.5	2	4	5	4	3	3	3
Broadcaster	BBC/ITV	BBC	BBC/ITV	ITV	BSkyB	BSkyB	BSkyB	BSkyB	BSkyB/Setanta
Rights fee (£m)	5.2	1.9	6.3	44	191.5	670	1,100	1,024	1,700
Number of live matches per season	10	4	14	18	60	60	60	132	132

a team is not playing live, the increased possibility of highlights being shown on television increases the probability shirking can be detected; hence, we believe that this is part of the reason why this period in English football is one characterized by a falling home advantage, at least for the top division of English football, where the overwhelming majority of television coverage and television money has been focused.

There exists a complementary mechanism that would link increased television coverage to reduced home advantage. TV coverage has brought with it large sums of money. Players are paid more and this means that the financial cost of being caught shirking has increased commensurately. If players were already investing maximal effort in their home matches, the only arena in which they could increase their effort to reflect the increased cost of shirking would be in away matches.

The changing composition of the fan base strengthens our argument. Supporters are the customers of a football club; they ultimately pay the wages of the players. The phenomenon of home advantage can arise because football is essentially a bundled product. When a supporter buys a ticket she cares about an individually weighted sum of the entertainment she is going to get simply from watching a good football match and the result. Casual footballer supporters may attend a home game simply hoping for a good game. Other fans are more interested in the result; they want to see their team perform well over the course of the season. To the extent that a proportion of football supporters fall with the former category, then players always have an incentive to ration their effort in favor of home rather than away performance since more fans watch home games. If a player invests an additional amount of effort in an away game then less fans of the former type will appreciate it. This suggests that players are simply giving fans what they want by playing better at home.

Both mechanisms have been strengthened by the globalization of football. A higher proportion of fans now live far away from the home ground of their team and instead support them by watching them on television. The connection between the home fan and the player remuneration has been weakened. Labor markets in football have become more flexible and players move clubs more regularly. Both these developments have the effect of sharpening the career concerns players face: increasing their incentive to play consistently home and away.

Econometric Analysis

We now turn to data analysis to attempt to quantify the roles these various factors may have played. First we describe the data before we analyze it using formal time series and panel data methods to investigate the causes of home advantage.

The Data

Football data is widely available on the internet; www.soccerbase.com provides data back to the beginning of the English and Scottish Football Leagues, and hence provides a rich

store of data on home advantage. Data can also be found on the website for the major European leagues since around 2000, and further back for Italy (1990) and Germany (1963).[16] Time series of individual team performances for a given season can be constructed once the data is extracted from the website. Attendance data is found at www.european-football-statistics.co.uk/ back to 1947 for each team but this is only the season average. Soccerbase stores attendances for individual Premiership and Football League matches back to 1992; an extension of this work envisaged is to run the bivariate Poisson model above including attendance, and distance visiting team has traveled, as regressors and test their significance. The distances that teams travel are calculated using data from www.postcode.org.uk; the postcode area for each team (e. g., SW1 for Fulham) can be used to get a measure of the distance between each football stadium in England.

Following Pollard and Pollard (2005) and Jacklin (2005), we consider the time-series dimension of the data. Each season provides a large amount of information on home advantage; the Premiership in England is played over 380 games, and by considering any of these three measures, some handle on home advantage can be gained. Furthermore, by considering each division over a large number of years, one can detect whether home advantage has been changing over the years.

Table 2: Mean and variance of goals scored in English football matches, 1990-2008.

		Goals		
Period	Moment	H	A	Total
1990-2008	Mean	1.5	1.1	2.6
1990-2008	Variance	1.5	1.1	2.7

Measuring Home Advantage

A number of measures to capture home advantage have been used in the literature; Attrill et al. (2008) and Nevill et al. (1996) use the percentage of a team's matches that are won, while others, such as Pollard and Pollard (2005), have used the ratio of points won to total available points because a draw (a tied match) is worth a point in football. Boyko et al. (2007) use the goal differential in Premiership matches, controlled for the average attacking strength of the home and away teams. Boyko et al. also model match outcome using a Probit model to try to measure home advantage, while Clarke and Norman (1995) use a linear regression model.

Measures of efficacy at home, such as ratio of total home points won, are not particularly informative. If a team is effective both at home and away, it is probably a simply strong side. Taking the ratio of home success to away success gives some idea of just how much more effective a team is at home, and may control to some extent for team ability.[17] Furthermore, this ratio of home to away performance seems much closer to the relevant variable of interest: it is not interesting per se that a team wins many home matches; the variation in home performance relative to away performance is what defines home bias.

Nonetheless, it is not clear how well measures that do not explicitly model match outcome can control from the ability of the teams competing in any given match. In recent years methods of modeling match outcomes in football have progressed consid-

erably; Dixon and Robinson (1998) consider a two-dimensional birth process for goal arrival in football matches that they showed to work effectively for English football, while Karlis and Ntzoufras (2003) developed bivariate Poisson regression models to capture the arrival of goals. Goals in football matches appear to follow a Poisson process, as their variance is approximately equal to their mean; Table 2 shows that indeed, for English football since 1990, the Poisson approximation appears a very good one, as the mean and variance are very close to each other for each team's goals (H and A), and for total goals. The dependence between these two processes must be accounted for though: the probability of one team scoring a goal depends on the opposition faced. The bivariate Poisson model captures this, and provides a way of modeling football match outcomes that is relevant for the current context; by estimating bivariate Poisson models for each football season since 1888, we can derive a measure of home advantage that adequately controls for team ability.

We thus model a team's rate of goal arrival in match i as a Poisson distributed variable, with an intensity parameter λ. We specify three random variables, $X_{1,i}$, $X_{2,i}$ and $X_{3,i}$ as independently Poisson distributed with parameter $\lambda_{\kappa,i}$, $\kappa = 1, 2, 3$, and defining $X_i = X_{1,i} + X_{3,i}$ and $Y_i = X_{1,i} + X_{3,i}$, then X_i and Y_i jointly follow a bivariate Poisson distribution BP ($\lambda_{1,i}, \lambda_{2,i}, \lambda_{3,i}$) with density function:

$$P_{X_i,Y_i}(x_i, y_i) = P(X_i = x_i, Y_i = y_i) = \exp\{-(\lambda_{1,i} + \lambda_{2,i} + \lambda_{3,i})\} \frac{\lambda_{1,i}^{x_i}}{x_i!} \frac{\lambda_{2,i}^{y_i}}{y_i!} \sum_{k=0}^{\min(x_i, y_i)} \binom{x_i}{k} \binom{y_i}{k} k! \left(\frac{\lambda_{3,i}}{\lambda_{1,i}\lambda_{2,i}}\right)^k. \quad (6)$$

Then $E(X_i) = \lambda_{1,i} + \lambda_{3,i}$, and $E(Y_{i,i}) = \lambda_{2,i} + \lambda_{3,i}$, while $Cov(X_i, Y_i) = \lambda_{3,i}$. Hence $\lambda_{3,i}$ captures the dependence between the goal arrival rates of the two teams competing in a match. With $\lambda_{3,i} = 0$, then (6) reduces to two independent Poisson distributions, a double Poisson distribution. To capture additional factors that might affect the goal arrival rates of the teams, such as weather conditions, vectors of explanatory variables $w_{\kappa,i}$ can be introduced, and a bivariate Poisson regression can be run:

$$\begin{aligned} &(X_i, Y_i) \sim BP(\lambda_{1,i}, \lambda_{2,i}, \lambda_{3,i}), \\ &\log(\lambda_{\kappa,i}) = \beta_\kappa w_{\kappa,i} \qquad \kappa = 1, 2, 3. \end{aligned} \quad (7)$$

The $w_{\kappa,i}$ are specific to the match and parameter being estimated, while β_κ is the vector of regression coefficients. The regression models run for the three parameters are, where h_i denotes the home team, and a_i the away team:

$$\log(\lambda_{1,i}) = \mu_1 + \beta_{1,1} h_i + \beta_{2,1} a_i, \quad (8)$$

$$\log(\lambda_{2,i}) = \mu_2 + \beta_{1,2} a_i + \beta_{2,2} h_i, \quad (9)$$

$$\log(\lambda_{3,i}) = \mu_3 + \gamma_1 h_i + \gamma_2 a_i. \quad (10)$$

So $\lambda_{1,i}$ is estimated based on home goals in a game, and hence gives parameter estimates for $\beta_{1,1}$ and $\beta_{2,1}$, home attacking ability and away defensive ability respectively, while $\lambda_{2,i}$ is estimated based on the away goals scored in a game, giving equivalent parameter estimates for home defense and away attack. The covariance parameter λ_3 is allowed to vary based on which team is playing at home or away in the given match. The specification of the regression model can be altered to differing effects; by setting $\mu_3 = \gamma_1 = \gamma_2 = 0$ in (10) no dependence between the two goal arrival rates due to char-

acteristics of the competing teams is assumed. In football, this seems unlikely, and as such, in our models, we impose no restrictions on (10).

The measure of home advantage for a given season derived from this model is $H_t^{BP} = \tilde{\mu}_{t1} - \tilde{\mu}_{t2}$ notably the difference in the intensity rates for home and away goals, when the attacking and defensive proficiency of each team has been controlled for. This measure can be criticized; the constant term in any regression can be badly estimated for many reasons, not least omitted variables. Furthermore, Table 3 in the Appendix shows that in the early years of English football, the Poisson assumption was less valid: pre-WW2 goals were considerably over-dispersed, although after the war the mean and variance of goals converge.[18] Nonetheless, this measure does come from what is an approximately appropriate statistical model for goal arrival, and explicitly controls for home and away team ability in both attack and defense. Further, as Table 3 only contains the mean and variance of goals, it checks the validity of a simple univariate Poisson model, not accounting for team strengths or the dependence between the individual teams' scoring intensities that is possible with the bivariate Poisson regression model.

Using every season since each division was formed in the English football league this model was estimated, and the resulting time series for the top two divisions are plotted in Figure 7, alongside the home-to-away win ratio. The two measures show considerable similarity throughout, although H^{BP} has a smaller variance.

For both the divisions, the upward trend apparent between the wars in the home-to-away points ratio is absent in H^{BP}, and throughout, H^{BP} seems less erratic than the home-to-away win ratio, perhaps because it better controls for ability. Nonetheless, the plateau effect noted earlier in the Premiership remains when ability is controlled for, while the continuous decline in lower division home advantage also remains. Overall, the Bivariate Poisson measure appears effective at measuring home advantage, and as such we use this new measure in our time series econometric model in the next section.

Figure 7

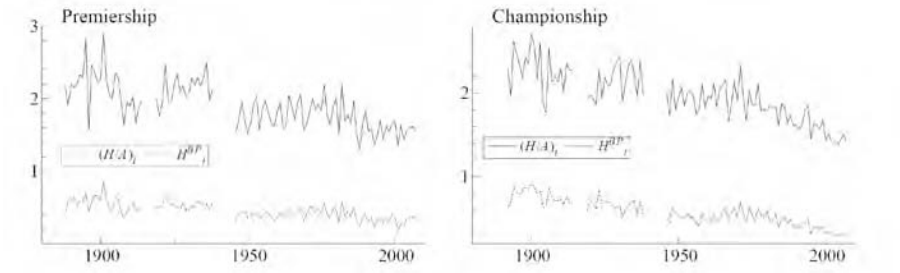

Figure 7: Comparison of measures of the home advantage in the top two divisions of English football. $(H/A)_t$ is the home-to-away-win ratio, and H^{BP} is the bivariate Poisson measure. Premiership (top division) is in the left panel, Championship (second division) right panel.

Time Series Analysis

An aggregate time series model can be used to attempt to explain the variation in home advantage witnessed over the history of English football. Our main hypothesis is that increased TV coverage enabled supporters to much better monitor shirking; to measure

this, a dummy variable taking the value zero before 1987, and unity afterward, is created. While a variable containing the number of matches televised per season from Table 1, or a variable with the price paid by television companies could be used, we take a simple binary variable to reflect our belief that the increased televising of football ushered in a new era of monitorability on the part of supporters; we believe that regular live television, as became a feature after around 1987, constitutes a structural break in home advantage, and this hypothesis can be investigated by testing the significance of the TV variable. Naturally, other interpretations are possible for a simple dummy variable like our TV variable; other plausible interpretations are discussed in the Conclusion.

The models in this section are selected using Autometrics (Doornik, 2006), which is a model selection algorithm that builds on the 'general-to-specific' statistical modeling theory of Hendry (1995). The algorithm requires a general well-specified econometric model that covers all possible theories of determination for the variable of interest (here, home advantage). The model must be well specified in that the residuals satisfy the assumption of Normality placed upon them; then confidence can be had that nothing systematic has been missed in attempting to explain the phenomena.[19] Then variables can be omitted if they are insignificant (using t and F tests), and provided that the resulting model passes all the diagnostic checks. When no further reduction is possible, a candidate model has been found. At this point one can either choose to average remaining models, or select between them; we choose to select one particular model (Hendry & Reade, 2007).

At an aggregate level, the hypotheses set out in earlier sections can now be tested. The first model considered regresses our Bivariate Poisson measure of home advantage in the Premiership on its own lag, seasonal average attendance, average total distance between clubs in the Premiership each season, a measure of the competitiveness of the Premiership each season (the CR5 measure), and our TV variable capturing the entering of the new TV age in English football. We focus on the Premiership because the vast majority of TV attention has been focused on this division.[20] Because attendance data is only available from 1947 onward, the sample is restricted, with the lagged dependent variable, to 60 observations 1948-2007:

$$\begin{aligned}
\mathsf{H}^{\mathsf{BP}}_{\mathsf{t}} &= \underset{(0.21)}{0.46} - \underset{(0.13)}{0.03}\,\mathsf{H}^{\mathsf{BP}}_{\mathsf{t-1}} - \underset{(0.04)}{0.12}\,\mathsf{TV}_{\mathsf{t}} + \underset{(0.000002)}{0.000002}\mathsf{Attendance}_{\mathsf{t}} \\
&\quad + \underset{(0.0002)}{0.00007}\mathsf{CR5}_{\mathsf{t}} + \underset{(0.00005)}{0.00004}\mathsf{Distance}_{\mathsf{t}} + \widehat{\varepsilon}_{\mathsf{t}}, \\
\widehat{\sigma} &= 0.08, \qquad \mathsf{R}^2 = 0.32, \qquad F(5,54) = 5.24[0.001]^{**}, \quad \mathsf{DW} = 1.92, \\
\mathsf{F}_{\mathsf{AR(2)}}(2,52) &= 0.62[0.54], \quad \mathsf{F}_{\mathsf{ARCH(1)}}(1,52) = 0.60[0.44], \\
\chi^2_{\mathsf{Normality}}(2) &= 0.18[0.92], \quad \mathsf{F}_{\mathsf{Hetero}}(9,44) = 1.28[0.26].
\end{aligned}$$

First, the regression model comfortably satisfies all the assumptions placed upon it; the null hypothesis that the residuals are independently Normally distributed cannot be rejected. This tells us that we can be confident about the output of the model and that the standard errors for the coefficients are well-behaved. Second, the only significant variable is the TV effect. An examination of Figure 7 should give some indication of why: there does appear to be a break after about 1986; after this point, the mean home-to-away points ratio drops to around 1.5 from about 1.75. As can be seen, attendance has no discernable affect at this level of aggregation, and neither do distance

traveled, or the competitiveness of the division. The significance of TV parameter supports the monitoring hypothesis. A structural shift in the pattern and extent of home advantage occurred at around the same time that TV became prominent in English football. The model can satisfactorily be reduced down; omitting the insignificant variables does not alter the diagnostic test output, giving a post-war model depending solely on the TV dummy. However, if attendance can safely be omitted, then our sample can be extended back to 1888, and our regression re-run.[21]

The full-sample model, which is selected using Autometrics, is:

$$\begin{aligned} \mathsf{H}_t^{\mathsf{BP}} &= \underset{(0.03)}{0.70} - \underset{(0.02)}{0.11}\,\mathsf{PostWar}_t - \underset{(0.02)}{0.10}\,\mathsf{TV}_t - \underset{(0.00001)}{0.00004}\mathsf{Distance}_t \\ &\quad + \underset{(0.07)}{0.29}\,1901_t - \underset{(0.07)}{0.22}\,1908_t + \underset{(0.07)}{0.19}\,1965_t + \widehat{\varepsilon}_t. \\ \mathsf{F}(6,93) &= 36.44[0.000]^{**}, \quad \mathsf{R}^2 = 0.68, \quad \mathsf{DW} = 2.06. \\ \mathsf{F}_{\mathsf{AR}(2)}(2,99) &= 0.04[0.96], \quad \mathsf{F}_{\mathsf{ARCH}(1)}(1,99) = 0.002[0.97]. \\ \chi^2_{\mathsf{Normality}}(2) &= 0.21[0.90], \quad \mathsf{F}_{\mathsf{Hetero}}(7,93) = 0.32[0.94]. \end{aligned}$$

The model is well specified, and explains twice as much of the variation in home advantage than the post-war model could. It is notable how easily the diagnostic tests are passed by our model; this seems to suggest that any variation above these constant levels is white noise, perhaps explaining why many investigators have found difficulty attempting to explain home advantage. There is a post-war effect, which can be seen in the plots in Figure 7, reducing home advantage by about 16%, while the TV effect appears to be there again, and reduces home advantage by around a further 16%.

The measure of competitiveness was found to be insignificant, but the measure of distance is significant and negative, which is slightly surprising. It seems likely, however, that any causality found here is spurious; when the English football league began, the 12 competing teams were all from the Midlands and the North West of England, and the average distance traveled was 916 miles; by the First World War this number reached 2,500 miles, and by 1921 this rose to above 3,000 miles, and post-Second World War the number appears to oscillate around 3,500 miles per team. During this same period home advantage has declined; it was very strong before the First World War, and appears to have declined somewhat by the inter-war period (when ability is controlled for, see Figure 7), before falling again after the Second World War. It is difficult to imagine any causal link between these two variables, given the sign of the coefficient, and hence it appears safer to assume the correlation is reflecting some other, omitted variable.[22] Finally, three outliers were found (by searching for standardized residuals larger than 2.5) for the seasons 1901-02, 1908-09, and 1965-66, the latter coinciding with the advent of substitutions in English football.[23]

Thus, our time series analysis has suggested that the TV monitoring hypothesis may have some tentative support in the data, as a structural break does exist around the time we hypothesize television began to exert a serious effect on footballers in England. We have also confirmed the difficulty in explaining home advantage; there appears to be little variation above simple white noise, when structural breaks for the Second World War, and the television era are accounted for. Although we are unable to explain the mechanism behind the Second World War shift, we have provided a plausible mechanism for explaining the TV shift.

Panel Data Analysis

In this section we develop an econometric model that uses panel data techniques to explore the causes of home advantage in more detail. Panel data techniques allow us to increase the explanatory power of the model by making use of cross-sectional data that was lost in the aggregate time series model. The data sources mentioned above provide a panel dataset with 155 cross-sectional units (football clubs), with up to 61 time-series observations (1947-2007), although for a number of the clubs, not all 61 seasons have data available on attendance or playing record, but overall the unbalanced panel dataset has 4,769 observations.[24]

Ideally, individual matches would be modeled to try and capture the effect of television, by including a dummy variable taking unity for any televised match. Dohmen (2008) is able to do this for German football since 1963, but sadly to the authors' best knowledge no resource exists that logs all televised matches in English soccer back to 1986 (and earlier).[25] Additionally, attendance data is difficult to find for individual matches much further back than 1992, particularly for lower divisions. As a result, our measure is somewhat blunt, and may suffer from a lack of power. On other hand, we suggest that just the presence of television enacted a regime change in English soccer. From the late-1980s onward many games not shown on live television were nonetheless illicitly recorded on video for scouting and training purposes. Post-1986 players knew that the probability of observation had increased since one of their team's away matches at any point might be televised, hence we feel such a season-long dummy is appropriate. Our regression analysis ought to be viewed bearing this in mind; it is likely that any significant effect reported here understates the true impact of TV.

While using the bivariate Poisson measure of home advantage constructed in this paper for panel analysis would be preferable, the Poisson measure is at the season-long, division-wide level which is inappropriate as we use club-level analysis in our panel dataset.[26] The distribution of home advantage measured by the ratio of home points to away points, due to the non-negativity constraint, is quite non-Normal. For regression purposes, as this variable will be the dependent variable in the panel data analysis, it seems wise to transform this variable to induce a more Normal distribution; the logarithm of the home-to-away points ratio, achieves this. Additionally, the log-linear model gives potentially more interesting interpretations of regression coefficients in terms of percentage changes and elasticities.

For each football club and season, a number of variables can be constructed from the data already amassed and analyzed thus far. Average attendance for the season, a variable that varies greatly from season to season within and between clubs, distance traveled by a club in a particular season, the divisional home advantage for a particular season (does the club simply follow the divisional trend in its home performances?), how competitive the division is in a given season, and whether or not the club is under television exposure (defined as the Premiership after 1986, as in the time-series model above). We control for ability in this model by including the team's attacking and defensive strength parameters from the bivariate Poisson model estimated earlier for every season and every division.[27]

The resulting panel data model is estimated using the Within Groups transformation using DPD in OxMetrics (Doornik & Hendry, 2007, Section IV), and was arrived at after estimating a model with lagged dependent variables and lags of all the inde-

pendent variables alongside their contemporaneous values. All the variables dated *t -1* were insignificant, and hence were omitted. The resulting model is:

$$\begin{aligned}\log \mathrm{H}_t &= \underset{(0.008)}{0.101}\ \log \mathrm{GenHomeAdv}_t + \underset{(0.008)}{0.024}\ \log \mathrm{Distance}_t + \underset{(0.007)}{0.604}\ \log \\ &\quad - \underset{(0.006)}{0.595}\ \log \mathrm{AwinR}_t - \underset{(0.008)}{0.017}\ \mathrm{PremTV}_t \\ &\quad - \underset{(0.007)}{0.022}\ \mathrm{Div2}_t - \underset{(0.008)}{0.025}\ \mathrm{Div3}_t - \underset{(0.010)}{0.038}\ \mathrm{Div4}_t\end{aligned}$$

$$\begin{aligned}\sigma &= 0.13, \quad \mathrm{R}^2 = 0.87, \quad \mathrm{RSS} = 78.77, \quad \mathrm{TSS} = 602.74, \\ \chi^2_{\text{Joint sig.}}(12) &= 1.698e+04[0.00]^{**}, \quad \chi^2_{\text{J.dummy sig.}}(162) = 963.1[0.000]^{**}, \\ AR(1)_{\mathrm{N}(0,1)} &= 1.77[0.08], \quad AR(2)_{\mathrm{N}(0,1)} = 1.61[0.11].\end{aligned}$$

The model output shows that the model is reasonably well specified; there is no evidence of autocorrelation in errors. Furthermore, evidence of the usefulness of allowing variation between clubs is shown by the Wald test of joint significance of dummy variables for each club, which at 963.1 overwhelmingly rejects the null that these effects are insignificant.[28] The model is also able to explain 87% of the variation in seasonal home advantage per club, shown by the R^2 statistic.

Having argued that the panel data model is of reasonable quality, we can now discuss the implications of the model, as unlike in the time-series model, a number of interesting variables are significant. It appears that teams follow the general trend for a given season; if other teams around them are displaying strong home advantage, controlling for ability, they also will; for a 10% increase in the Poisson home advantage measure for that team's division, the team's home-to-away-win ratio will increase by 0.96%. Distance matters, with a one percent increase in the distance traveled in a given season by the average visiting club to the home team stadium increasing the ratio of home-to-away points by 0.019%; teams in remote areas are generally renowned for being strong at home but not traveling well. Both these effects are small but significant, particularly given the variation in the distance traveled measure.

Match attendance appears to be significant but the size of the coefficient is tiny: a 10% increase in attendance reduces home advantage by 0.08%. This does not offer particularly strong support to the Nevill et al. (1996) attendance effect hypothesis, and potentially supports the skepticism of Pollard and Pollard (2005), who argues the attendance effect could plausibly be of either sign. Moreover, it undermines the strong attendance effects via the referee-decision mechanism promoted by Dohmen (2008) or Boyko et al. (2007) although we are using season-long data, not individual matches.

A number of regressors were insignificant and thus omitted, such as the controlling factors for team ability, attacking (**AttStrength**) and defensive strength (**DefStrength**).[29] However, ability is factored into the general home-advantage regressor, which is significant. Also of interest is the lack of a significant competitiveness effect; both measures plotted in Figure 4 are insignificant and omitted from the final presented model.[30]

The effects of winning home and away matches offset each other; the dependent variable is the home-to-away points ratio; a 1% increase in the home win increases the home-to-away points ratio by 0.6%, while a 1% increase in the away win ratio decreases the home-to-away points ratio.[31]

This also shows that the impact of drawn games is small on our measure of home advantage.

The model also documents the historic degree of home advantage in a particular division by the Div parameters, which take unity if the club is in a particular division; the reference division is the Premiership, so the reported coefficients show the difference between the top flight and that particular division. The Premiership seems to have the strongest home-to-away point ratios; 2.2% higher than the Championship, 2.5% higher than League One, and 3.8% higher than League Two. This stands in contrast to the absence of any divisional effect that Clarke and Norman (1995) find, but seems plausible from a careful inspection of Figure 7. Figure 7 also shows the impact of the plateau effect in the Premiership: since around 2000 the Premiership's home advantage measure has been higher than the other three divisions.

The TV effect is marginally significant, with a t-ratio of just above 2; the home-to-away points ratio is 1.7% lower for each team competing in the Premiership after the big increase in TV coverage in the late 1980s.[32] So regardless of which team is in the Premiership, it appears that the increased TV coverage incentivizes players to put increased effort in away from home. A less significant estimate for the TV variable is perhaps not surprising given the earlier discussion about the potential lack of power in the measure. Given this, the TV effect in our panel model lends more support to the hypothesis proposed in this paper of a monitoring effect for home advantage.

Discussion and Conclusions

We have examined two econometric models, both of which lend support to the hypothesis of a structural break taking place in home advantage at about the time that live television coverage of English football substantially increased. However, we now need to establish that the structural break cannot be accounted for by any other possible explanation. The clear break in the data series on home advantage, also visible in the studies of Jacklin (2005) and Pollard and Pollard (2005), could be interpreted in a number of other ways. At least three competing explanations could be offered:

1. The end of terracing in English stadia. The Hillsbrough disaster of 1989, when 96 Liverpool supporters were killed, led to the banning of standing areas at stadia in the top two divisions in English football. It may be the case that the huge investment in stadia after this ruling led to much more pleasant surrounds for visiting teams to perform in. Moving to a new stadium can be thought of as a just such as an investment, and Pollard (2005) indeed finds that moving to a new stadium reduces home advantage. However, the ban on standing areas only came into effect in 1994 in the top two divisions, with the phasing out beginning in 1989, which suggests any effect of this incident would have come later than around 1987, ruling it out as an explanation.
2. The three-points-for-a-win rule taking effect. This is the Jacklin (2005) hypothesis, and it is extensively discussed in Section 2. This hypothesis predicts a fall in the number of draws, which did not in fact occur. Furthermore, the structure break in the data appears at the wrong time for this hypothesis to work. Nor is there empirical support for this hypothesis from other European football leagues.
3. The introduction of play-offs to decide promotion (primarily) and relegation (less often). In 1986-87, instead of the top three sides in the Championship being pro-

moted to the Premiership, the top two were promoted, with the subsequent three teams competing in a play-off competition with the third-from-last placed team in the Premiership, at the completion of the standard league season.[33] The most documented effect of this change was that often teams of poorer quality were promoted, because promotion became dependent on a team winning a single match, as opposed to gaining the most points over 46 league matches. However, this does not seem a likely explanation for the sudden change in the attacking ability of home sides, and the defensive ability of away sides, as the playoffs only affected one side competing in the top division each season.[34]

We, therefore, claim that no credible alternative hypothesis for the decline in home advantage in football has thus far been advanced. The monitoring hypothesis does provide a partial explanation of the trend toward lower home advantages in Premiership football in England.

It complements more gradual changes that have also led to a gradual eroding of home advantage. Away sides, for instance, now invest more money in transport facilities and in accommodation.

Home advantage exists in a number of different manifestations and in a number of different sports for a number of different reasons. A host of factors from patriotism, to the higher funding can example the strong medal performance of the country hosting the Olympic Games, for instance. Home advantage is particularly marked in team sports. This suggests that an additional factor unique to team sports may be behind part of the phenomenon. One explanation for this is that the presence of home supporters helps to alleviate the problem of externalities in teams. Our empirical analysis has found support for the hypothesis that players are motivated to exert more effort in home matches because they are being monitored by their fans. Certainly it is the only factor we have considered that can account for the significance of the post-1986 dummy variable.

It is important to note that our hypothesis merely offers a plausible explanation of a fall in home advantage, not its actual level. Nonetheless, the hypothesis can account for some of the difference in home and away performances. Even in televised games, monitoring is still imperfect: movement of players off the ball is harder to observe on television than it is at the game because the view of the spectator is restricted to wherever the television cameras happens to be focused. We have not ruled out the importance of additional but unmeasurable factors, such as familiarity with the home ground, which surely impact upon the level of home advantage.

The different evolutions of home advantage in lower divisions, and abroad (from Figure 2 German teams stand out as displaying remarkably strong home advantage during the 1970s before a drastic drop around 1990) suggest that other factors are at work. There are other factors that may explain the different evolutions of home advantage in different divisions. The make-up of crowds has changed over the post-war years, as traditional regional industries decline, and entry prices increase. The latter development has helped turn spectators away from being supporters, willing to encourage their team on to greater things, into consumers, expectant of teams to do great things for them. It may also be lower divisions, and smaller crowds, where this effect is felt strongest, as vocal views of individual fans are more audible, making for a more intimidating atmosphere for home players.

What are the implications of our argument? First, the decline in home advantage that took place in the late 1980s and early 1990s will not be reversed since there is little sign of any reversal in TV coverage. Second, the results do give some indication of the role of supporters in professional football. While they do not have any actual executive power, the evidence suggest that in football, the consumer/supporter remains sovereign. Finally, whether it is productive for football clubs to act upon this and attempt to improve their away records by, for example, providing free live TV feed to their supporters for every game, is not clear, since if all clubs attempt similar measures, then if successful, this means that all teams will win less home matches as a result. There are only a certain number of points available to football clubs competing in a league.

Naturally, as more and more data becomes available, and as methods for modeling football match outcomes continue to improve, we expect that clearer measures of either hypothesis will be put forward. For example, we suspect that the shirking hypothesis will gain more support if data can be found on numbers of away supporters attending football matches historically. We excitedly await such future studies.

References

Alchian, A. A., & Demsetz, H. (1972). Production, information costs, and economic organization. *American Economic Review*, *62*(5), 777-795.

Attrill, M. J., Gresty, K. A., Hill, R. A., & Barton, R. A. (2008). Red shirt colour is associated with long-term team success in English football. *Journal of Sports Sciences*, *26*(6), 577-582.

Audas, R., Dobson, S., & Goddard, J. (1997). Team performance and managerial change in the English Football League. *Economic Affairs*, *17*(3), 30-37.

Berri, D. J., & Krautmann, A. C. (2006). Shirking on the court: Testing for the incentive effects of guaranteed pay. *Economic Inquiry*, *44*(3), 536-546.

Boyko, R. H., Boyko, A. R., & Boyko, M. G. (2007). Referee bias contributes to home advantage in English Premiership Football. *Journal of Sports Sciences*, *25*(11), 1185-1194.

Brandes, L., & Franck, E. (2007). Who made who who? An empirical analysis of competitive balance in European soccer leagues. *Eastern Economic Journal*, *33*(3), 379-403.

Clarke, S. R., & Norman, J. M. (1995). Home ground advantage of individual clubs in English soccer. *The Statistician*, *44*(4), 509-521.

Dixon, M. J., & Robinson, M. E. (1998). A birth process model for association football matches. *The Statistician*, *47*(3), 523-538.

Dohmen, T. J. (2008). The influence of social forces: Evidence from the behavior of football referees. *Economic Inquiry*, *46*(3), 411-424.

Doornik, J. A. (2006). *Autometrics: Further applications of automatic model selection.* Mimeo, Nuffield College.

Doornik, J. A., & Hendry, D. F. (2007). Modelling dynamic systems using PcGive 12: Volume III. London: Timberlake Consultants Press.

Forrest, D., Beaumont, J., Goddard, J., & Simmons, R. (2005). Home advantage and the debate about competitive balance in professional sports leagues. *Journal of Sports Sciences*, *23*(4), 439-445.

Hendry, D. F. (1995). Dynamic econometrics, advanced texts in econometrics. Oxford: Oxford University Press.

Hendry, D. F., & Krolzig, H.-M. (2001). Automatic econometric model selection using PcGets. London: Timberlake Consultants Ltd.

Hendry, D. F., & Krolzig, H.-M. (2005). The properties of automatic GETS modeling. *Economic Journal*, *115*(502), C32-C61.

Hendry, D. F., & Reade, J. J. (2007). *Modeling and forecasting using model averaging.* Working papers, Department of Economics, University of Oxford.

Holmstrom, B. (1999). The firm as a subeconomy. *Journal of Law, Economics and Organization*, *15*(1), 74-102.

Holmstrom, B., & Milgrom, P. (1991). Multitask principal-agent analyses: Incentive contracts, asset ownership, and job design. *Journal of Law, Economics and Organization*, *7*(0), 24-52.

Jacklin, P. B. (2005). Temporal changes in home advantage in English football since the second world war: What explains improved away performance? *Journal of Sports Sciences*, *23*(7), 669-679.

Johnston, R. (2008). On referee bias, crowd size, and home advantage in the English Soccer Premiership. *Journal of Sports Sciences*, *26*(6), 563-568.

Karau, S. J., & Williams, K. D. (1981). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology*, *40*, 681-706.

Karlis, D., & Ntzoufras, I. (2003). Analysis of sports data using bivariate poisson models. *Journal of the Royal Statistical Society (Statistician)*, *52*, 381-393.

Knowles, G., Murray, J., Sherony, K., & Haupert, M. (2003). Shirking in Major League Baseball in the era of the reserve clause. *NINE: A Journal of Baseball History and Culture*, *12*(1), 59-71.

Koning, R. H. (2000). Balance in competition in Dutch soccer. *The Statistician*, *49*(3), 419-431.

Krautmann, A. C. (1990). Shirking or stochastic productivity in Major League Baseball? *Southern Economic Journal*, *56*(4), 961-968.

Krautmann, A. C. (1993). Shirking or stochastic productivity in Major League Baseball: Reply. *Southern Economic Journal*, 60(1), 241-243.

Latane, B., Williams K., & Harkins, S. (1979). Many hands make light the work: the causes and consequences of social loafing. *Journal of Personality and Social Psychology*, *37*(6), 822-832.

Liden, R. C., Wayne, S. J., Jaworski, R. A., & Bennett, N. (2004). Social loafing: A field investigation. *Journal of Management*, *30*(2), 285-304.

Marburger, D. R. (2003). Does the assignment of property rights encourage or discourage shirking?: Evidence from Major League Baseball. *Journal of Sports Economics*, *4*(1), 19-34.

Maxcy, J. G., Fort, R. .D., & Krautmann, A. C. (2002). The effectiveness of incentive mechanisms in Major League Baseball. *Journal of Sports Economics*, *3*(3), 246-255.

McHale, I., & Scarf, P. (2007). Modelling soccer matches using bivariate discrete distributions with general dependence structure. *Statistica Neerlandica*, *61*(4), 432-445.

McMaster, R. (1997). The market for corporate control in professional football: Is there an agency problem? *Economic Affairs*, *17*(3), 25-29.

Miles, J. A., & Greenberg, J. (1993). Using punishment threats to attenuate social loafing effects among swimmers. *Organizational Behavior and Human Decision Processes*, *56*(2), 246-265.

Miller, G. J. (1992). *Managerial dilemmas, the political economy of hierarchy.* Cambridge, MA: Cambridge University Press.

Nalebuff, B. J., & Stiglitz, J. E. (1983). Prizes and incentives: Towards a general theory of compensation and competition. *The Bell Journal of Economics*, *14*(1), 21-43.

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

Nevill, A. M., Newell, S. M., & Gale, S. (1996). Factors associated with home advantage in English and Scottish soccer matches. *Journal of Sports Sciences*, *14*(2), 181-186.

Pollard, R. (2005). Evidence of a reduced home advantage when a team moves to a new stadium. *Journal of Sports Sciences*, *20*(12), 969-973.

Pollard, R. (2006). Worldwide regional variations in home advantage in association football. *Journal of Sports Sciences*, *24*(3), 231-240.

Pollard, R., & Pollard, G. (2005). Long-term trends in home advantage in professional team sports in North America and England (1876 -2003). *Journal of Sports Sciences*, *23*(4), 337-350.

Sloane, P. J. (1971). The economics of professional football: The football club as a utility maximiser. *Scottish Journal of Political Economy*, *18*(2), 121-46.

Sutter, M., & Kocher, M. G. (2004). Favoritism of agents—The case of referees' home bias. *Journal of Economic Psychology*, *25*(4), 461-469.

Szymanski, S., & Smith, R. (1997). The English football industry: Profit, performance and industrial structure. *International Review of Applied Economics*, *11*(1), 135-153.

Tirole, J. (1999). Incomplete contracts: Where do we stand? *Econometrica*, *67*(4), 741-781.

Wolfson, S., Wakelin, D., & Lewis, M. (2005). Football supporters' perceptions of their role in the home advantage. *Journal of Sports Sciences*, *23*(4), 365-374.

Endnotes

[1] In this paper, by football we refer throughout to association football or soccer, as opposed to American football.

[2] The terms spectator, supporter, and fan will be used interchangeably to refer to people that devote their allegiance to a particular team. Secondly, in the UK, the term manager is used to describe what might elsewhere be called the coach, or the head coach, and so we use the term manager to describe the member of the coaching team who has overall executive power.

[3] For a more detailed historical exposition of the origins of the English football league, see Pollard and Pollard (2005). Additionally, in 1992 English football underwent a restructuring, after which the First Division became known as the Premiership. Subsequent renamings mean that the division below the Premiership is called the Championship, with the third flight of English football now known at League One, and the fourth division is League Two. In this paper the most recent names for divisions, where possible, will be used throughout.

[4] Anecdotal evidence is, however, as always, flimsy; the team with the longest unbeaten home run in English football history (86 matches) is Chelsea, a club located in central London.

[5] An OLS regression of home advantage on attendance yields a tiny regression coefficient of 0.000003, which is insignificant with a t-ratio of 0.552.

[6] Johnston (2008) refutes these findings on a slightly more general dataset, by additionally controlling for stadium capacity; many of the stadia considered in the Boyko et al. study are full week in, week out.

[7] The pattern in the third and fourth divisions closely resemble that of the second division in Figure 6 and so those plots are not reported.

[8] Krautmann (1990, 1993) emphasizes how random shocks affect the performance of Major League Baseball players. He argues that this accounts for the perception that successful baseball players shirk after receiving long-term contracts.

[9] Audas et al. (1997) note that football is characterized by a team production function but they do not follow up this idea.

[10] The consequences of performance contracts conditioning on a single statistic is outlined in Nalebuff and Stiglitz (1983).

[11] The argument could also apply to the risk of being injured. Supporters like players who are willing to make vital tackles at the risk of perhaps getting injured themselves. There is an externality here since it is the individual player who bears the risk of injury but it is the team as a whole that shares the benefit of his vital interception. This mechanism complements the more general production externality associated with effort.

[12] A sense of team cohesion has been found to deter shirking in other sports (Miles & Greenberg, 1993).

[13] Such behavior is, appropriately or not, deemed by fans to be detrimental for team spirit if undertaken by a manager.

[14] Players are paid by clubs but we assume that clubs only retain players that the fans want to see at the club. Players who re perceived as shirking do not have their contracts renewed.

[15] Pollard and Pollard (2005) finds that home advantage in basketball is currently about 60 percent.

[16] Another even more comprehensive source of international football results can be found at www.rsssf.com.

[17] If team ability is a multiplicative effect, then taking the ratio of home and away performance should mean the ability factors cancel. Jacklin (2005) also uses the ratio of home-to-away points won.

[18] Mixture-distribution models have been constructed to account for different types of dependence, notably by McHale and Scarf (2007).

[19] This does not necessarily mean no further significant variables will found if one searches hard enough. It means though that the inference on the included variables will satisfy the confidence intervals placed around it.

[20] The TV variable is also significant in the Championship model, but smaller due to the smaller TV exposure in that division, and also due to the different dynamics of home advantage in that division apparent in Figure 7.

[21] This of course assumes that were attendance available as a variable back to 1888, it would not be relevant even over the longer sample. The experience with the distance variable suggests that this kind of stationarity might not be a good assumption.

[22] If the home-to-away points ratio is used as the dependent variable in place of the Bivariate Poisson measure, the only difference is that this variable is found to be insignificant, since again from Figure 7, the inter-war period shows a sizeable increase in home advantage.

[23] Dummy variables are introduced to cover outliers as their magnitude may mask variation in the remaining observations, distorting inference.

[24] 36% of clubs have all 61 observations, while 68% have between 30 or more observations, while only 6% of clubs have 10 or fewer observations.

[25] The actual results exist, and have been used above to get the Poisson measure of home advantage for a given season back to 1888.

[26] While constructing a home advantage measure for each club is surely feasible, we relegate this undertaking to future research.

[27] This is done using the β parameters in (8) and (9).

[28] Time dummies are also jointly significant, but the same effect is captured by the TV effect after the mid-1980s; the small number of time dummies that were significant came in the 1950s and 1960s predominantly. For brevity, the (155) individual and (60) time specific dummies are not reported.

[29] This result holds regardless of the panel-data model specification.

[30] Both had negative, but insignificant effects, with t-ratios of 1.28 and 1.33 for the Herfindahl and CR5 measures, respectively.

[31] In the Premiership, where a team plays 19 matches currently at home in a season, then an extra win means a 5.3% increase in the home win ratio, and a 3.2% increase in the home-to-away points ratio.

[32] For clarity we should re-emphasize that the TV variable takes 1 if a team is in the Premiership after 1986, and zero otherwise.

[33] From the 1988–89 season onwards, the third-last-placed Premiership club was replaced by the sixth placed Championship club in the competition.

[34] It is perhaps plausible that having one less guaranteed promotion spot meant re-promotion after demotion from the top flight became less probable, hence causing sides to be more cautious; however again, it seems odd that this might affect home sides and not away sides.

Authors' Note

We would like to acknowledge useful comments from the editor and two anonymous referees at the *IJSF*, and the participants of the Nuffield Conference on Football in the Social Sciences, October 2008.

Appendix A

Table 3: Mean and variance of goals scored in English football matches. 1888-2008.

		Goals		
Period	Moment	H	A	Total
1888-1899	Mean	2.4	1.3	3.7
1888-1899	Variance	3.4	1.6	4.5
1900-1909	Mean	1.9	1.0	3.0
1900-1909	Variance	2.4	1.2	3.4
1910-1919	Mean	1.8	1.0	2.9
1910-1919	Variance	2.2	1.2	3.2
1920-1929	Mean	2.0	1.1	3.1
1920-1929	Variance	2.5	1.2	3.9
1930-1939	Mean	2.2	1.2	3.4
1930-1939	Variance	2.7	1.4	4.1
1940-1949	Mean	1.8	1.1	2.9
1940-1949	Variance	2.2	1.3	3.4
1950-1959	Mean	2.0	1.2	3.2
1950-1959	Variance	2.3	1.3	3.6
1960-1969	Mean	1.9	1.2	3.1
1960-1969	Variance	2.1	1.3	3.5
1970-1979	Mean	1.6	1.0	2.5
1970-1979	Variance	1.6	1.0	2.7
1980-1989	Mean	1.6	1.1	2.7
1980-1989	Variance	1.7	1.1	2.8
1990-2008	Mean	1.5	1.1	2.6
1990-2008	Variance	1.5	1.1	2.7