

Revenue Divergence and Competitive Balance in a Divisional Sports League⁺

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Abstract

The North American model of resource allocation in professional sports leagues is adapted for English (association) football. Comparisons are drawn between the equilibrium allocations of playing talent under objective functions of profit maximisation and win percent maximisation subject to a financial constraint. Empirical revenue functions are reported for 1926-1999. These indicate a shift in the composition of demand favouring big-city teams and an increase in the sensitivity of revenue to performance. An analysis of match results in the FA Cup suggests an increase in competitive imbalance between teams at different levels of the league's divisional hierarchy, as the theory suggests.

JEL Code: L83

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⁺ The authors are indebted to two anonymous referees for helpful comments on an earlier draft of this paper. The usual disclaimer applies.

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I Introduction

In the North American (NA) literature on resource allocation in professional team sports leagues, relative market sizes are the final arbiter of the allocation of playing talent between teams, and therefore of competitive balance (Rottenberg, 1956; El Hodiri and Quirk, 1971; Fort and Quirk, 1995; Vrooman, 1995). Although the standard NA model is demand-driven, the empirical NA literature tends to concentrate on the link between the supply side of the players' labour market and competitive balance. For example, Scully (1989), Fort and Quirk (1995), Vrooman (1995) and Eckard (1998) present empirical tests of the invariance proposition: that the efficient allocation of playing talent does not depend on players' contractual status, and is therefore unaffected by the introduction of free agency. In a recent review of this literature, Eckard (2001) finds that "(t)aken together, the results are consistent with the invariance proposition, namely, balance did not change" (p430).

The present article focuses primarily on demand-side determinants of competitive balance. Specifically, it seeks to demonstrate and draw connections between two empirical propositions concerning professional (association) football (or soccer) in England and Wales:¹ first, between the 1920s and 1990s there was increasing divergence in the base levels of spectator demand enjoyed by teams with distinct identifying characteristics; and second, over the same period there was increasing competitive imbalance within the league as a whole. According to the standard model, the second proposition should follow from the first. Since long-term change in the composition of demand has been a major influence on the historical development of English football, the latter should provide a vehicle for empirical scrutiny of the theory, from a perspective that differs from that of most of the NA literature.

The key distinguishing features of the NA and European models for the organisation of professional team sports have been the subject of some discussion in the recent literature (Hoehn and Szymanski, 1999; Fort, 2000). In the present context, the following five features appear to be most relevant: (i) English football's hierarchical divisional structure² ensures that membership at the highest level is open to any non-league team with sufficient talent to achieve promotion; (ii) win percent, revenue or utility maximisation subject to a financial constraint is widely assumed to describe the motivations of most English football team owners more appropriately than profit maximisation; (iii) full free agency rights for players over the age of 24 were only established relatively recently, following the European Court of Justice's 1995 Bosman ruling; (iv) relaxation of the regulations restricting the employment of foreign players, also due to the Bosman ruling, implies the market for playing talent has recently become international rather than national; and (v) geographical distances between team home towns are small, making segmentation between spectator catchment areas low and travel to home and away fixtures a practical proposition for many fans.

The content and structure of the paper are as follows. Section II discusses the adaptation of the standard NA model of resource allocation into a form suitable for the analysis of English football. Particular attention is paid to the implications for competitive balance of a team objective function of win percent maximisation subject to a financial constraint, rather than profit maximisation. Consideration is also given to the effect of the shape of the revenue function on the comparison between outcomes under these two objective functions. Section III presents estimated revenue functions for English football teams, and draws inferences about the phenomenon of revenue divergence. Section IV discusses the measurement of competitive balance between teams operating at different levels of a hierarchical, divisional

league structure. A statistical analysis of win probabilities in cup ties (in which teams from different divisions meet head-on) is used to identify long-term trends in competitive balance. Section V summarises and concludes.

II Revenue and competitive balance: theoretical considerations

Section II discusses the adaptation of the standard NA model of resource allocation in professional team sports to English football. Previously, the properties of a model of this type under an objective function of win percent maximisation subject to a zero profit (break-even) constraint have been examined by Késenne (1996), who finds that the distribution of playing talent between teams may be more unequal than in the case of profit maximisation. In other contributions based on frameworks similar to the NA model, Hoehn and Szymanski (1999) consider the effect of the participation of the most successful football teams in European competition on competitive balance in domestic leagues, and Késenne (2000) discusses the implications for competitive balance of the introduction of a NA-style salary cap.

At a general level, the institutional, historical and economic characteristics of English football differ from those of the leading NA professional sports in respect of (at least) five major characteristics, as follows.

(i) Membership of the top professional sports leagues in NA is determined by the award of franchises. In contrast English football's Premier League (PL) and Football League (FL) teams compete within a hierarchical divisional structure. At the end of each season, several teams are promoted and relegated between divisions, so divisional membership is determined by competitive prowess. From casual inspection of team revenues data, it is clear that revenue is primarily dependent on each team's position within the league as a whole, rather than

within its own division. Therefore the use of the win ratio as an argument of the revenue function, standard practice in the NA literature, is inappropriate; but it is reasonable to replace the win ratio with team i 's normalised league position $L_i = (n+1-pos_i)/n$, where pos_i is team i 's actual league position (1=top of PL; n =bottom of FL). With the total supply of talent assumed fixed L_i is monotonic in talent, and from this point onward L_i is interpreted directly as a talent measure.³

(ii) Most NA major league sports teams are highly profitable. This is partly due to the restrictions the franchise system imposes on supply, as well as the restraining influence on wage expenditure of salary caps in football and basketball (Quirk and Fort, 1999). A profit maximisation (PM) objective function has been adopted uncontroversially in most of the NA literature. In English football by way of contrast, the intense competitive pressure generated by the league's divisional structure has certainly contributed to the chronic loss-making propensities of most PL and FL teams. Following Sloane (1971), most researchers have argued that win percent, revenue or utility maximisation subject to a financial constraint is a more suitable objective function than PM.

(iii) Full free agency rights for English footballers over the age of 24 were established by the European Court of Justice's (ECJ) 1995 Bosman ruling. Prior to 1995, progress toward free agency was incremental. Before 1963 a player's current team exercised complete discretion as to whether he could move to another team, irrespective of its decision whether or not to extend his present employment contract. In 1963 this discretion became contingent on renewal of the contract. In 1978 an out-of-contract player became entitled to move irrespective of his employer's wishes. His new employer, however, would still be liable to pay compensation in the form of a transfer fee. In 1995 out-of-contract players (over age 24)

became entitled to move with no liability for compensation. Before 1978 teams motivated primarily by winning rather than profit probably had little incentive, and could not be forced, to allow their best players to move. Since 1978 and especially since 1995, mobility (at the behest of players) has increased considerably, with flows of talent naturally reflecting differences between teams' ability-to-pay. A closer relationship between demand shifts and competitive balance might therefore be expected post-1978 than pre-1978.

(iv) Because few (if any) other countries operate professional leagues in the same sports on a comparable scale, product and labour markets in NA (especially at the top level) are effectively closed. In England, a regulation restricting to three the number of non-British players PL and FL teams could field remained in force until 1995, when the ECJ adjudged the application of this provision to EU nationals to be contrary to European employment law. Consequently, post-1995 many more foreign players have been employed, especially in the PL.⁴ An open labour market may suggest a need for the relaxation of the standard model's assumption that the total supply of talent is fixed. The standard closed labour market assumption is however a reasonable description of reality for most of the period under scrutiny, and this assumption is retained in the present article. Open labour market models are discussed elsewhere by Hoehn and Szymanski (1999) and Dobson and Goddard (2001).

(v) The standard model assumes each team's spectator demand is proportional to its home-town population: a reasonable assumption in NA where catchment areas are predominantly local (due to large distances between towns), and all but the largest cities have at most one team in each major league sport. In English football neither of these conditions pertains. Geographical segmentation between catchment areas is less than in NA because distances are shorter. Wherever they reside, regular travel to home and away fixtures is a practical

proposition for many sports fans; and with extensive television coverage of all leading teams available nationally, home-town population is a highly imperfect indicator of each team's popularity. In the model developed below, a set of time-varying individual effects is used to capture all relevant demographic, historical and socio-economic influences, including for example variations in disposable incomes, on each team's base level of spectator demand.

The rest of section II describes an adapted version of the NA model suitable for English football. The basic framework is similar to the one used in a recent paper by Fort and Quirk (2002), who show that under the most general assumptions concerning the properties of the revenue and cost functions, the comparison between competitive balance under assumptions of PM on the one hand, and win percent maximisation subject to a financial constraint (WM from this point onward) on the other, is indeterminate. The present discussion seeks to extend this insight, by drawing a number of specific comparisons between outcomes under PM and WM objective functions, for cases where restrictions are imposed on the revenue and cost functions. It also provides a theoretical basis for the empirical revenue function estimations that are reported in section III.

In the two-team model, team i 's revenue function in terms of its talent, measured by its normalised league position L_i , is $R_i(L_i) = A_i \rho(L_i)$. A_i is an individual effect reflecting team i 's market size and any other (unspecified) determinants of revenue; $A_1 > A_2$ is assumed. The function $\rho(L_i)$ is assumed to be concave, or $\rho''(L_i) < 0$.⁵

Team i 's cost function is $C_i(L_i) = pL_i + F_i$, where p is the cost of an additional unit of talent. Under PM F_i is interpreted as team i 's fixed costs; in the PM case, however, F_i does not influence the equilibrium allocation of playing talent. Under WM F_i can be interpreted as the

sum of team i 's fixed costs and minimum required profit (or maximum tolerable loss). A break-even financial constraint has been widely assumed in the European literature based on WM (Fort and Quirk, 2002). The present formulation affords more flexibility, and depending on the relative magnitudes of team i 's fixed costs and the loss (if any) its owner is prepared to tolerate, F_i can be positive, zero or negative.

Team i 's profit function (incorporating the financial constraint in the WM case) is $\Pi_i(L_i) = R_i(L_i) - C_i(L_i) = A_i \rho(L_i) - pL_i - F_i$. It is useful to define the marginal revenue (per incremental unit of talent employed) and average revenue (per unit of talent employed) functions, $MR_i(L_i) = A_i \rho'(L_i)$ and $AR_i(L_i) = A_i \bar{\rho}(L_i)$, where $\rho'(L_i) = \partial \rho(L_i) / \partial L_i$ and $\bar{\rho}(L_i) = \rho(L_i) / L_i$. The elasticity of revenue with respect to talent is:

$$\varepsilon(L_i) = [\partial R_i(L_i) / \partial L_i] [L_i / R_i(L_i)] = MR_i(L_i) / AR_i(L_i) = \rho'(L_i) / \bar{\rho}(L_i)$$

In this formulation, $\varepsilon(L_i)$ depends on L_i but not on A_i . The direction of the relationship between L_i and $\varepsilon(L_i)$, indicated by the sign of $\varepsilon' = \partial \varepsilon(L_i) / \partial L_i$, plays an important part in the comparisons between the PM and WM equilibria that follow. Each of the three possibilities $\varepsilon' > 0$, $\varepsilon' = 0$ and $\varepsilon' < 0$ is considered below.

Under PM p adjusts to p^* such that $MR_1(L_1^*) = MR_2(L_2^*) = p^*$. $A_1 > A_2$ ensures $L_1^* > L_2^*$. A convenient measure of competitive balance under PM is L_1^* / L_2^* , analogous to the 'ratio of win ratios' measure widely used in the NA literature. If $L_1^* / L_2^* = 1$ both teams are of equal strength. The extent to which L_1^* / L_2^* exceeds unity measures the extent of team 1's dominance over team 2.

In the PM models of Fort and Quirk (1995) and Vrooman (1995), competition becomes more unbalanced if the difference between population sizes increases; in the present case the equivalent condition is an increase in the difference between A_1 and A_2 . This result follows because each team's competitive strength is proportional to its relative market size at the PM equilibrium. Competition also becomes more unbalanced if the elasticity of revenue with respect to win ratio increases; here the equivalent condition is an increase in $\varepsilon(L_i)$. If this elasticity increases, it is efficient for the big-city team to employ more talent and the small-town team less, because the former's revenue gain exceeds the latter's loss.

Under WM p adjusts to p^+ such that: $\Pi_1(L_1^+) = \Pi_2(L_2^+) = 0$ or $AR_1(L_1^+) - F_1/L_1^+ = AR_2(L_2^+) - F_2/L_2^+ = p^+$. Fort and Quirk (2002) show that depending on the precise nature of the revenue and cost assumptions, competition may be more balanced, equally balanced or less balanced under WM than it is under PM. However, by imposing certain restrictions on the revenue and cost functions, specific comparisons can be drawn in a number of particular cases, as follows.

Case 1: $F_1=F_2=0$ (zero fixed costs). The WM equilibrium condition reduces to $AR_1(L_1^+) = AR_2(L_2^+)$. If $\varepsilon(L_i)$ is constant in L_i or $\varepsilon'=0$, competition is equally balanced under WM and PM. It can also be shown that if $\varepsilon(L_i)$ is increasing in L_i or $\varepsilon'>0$, competition is more balanced under WM than under PM; and if $\varepsilon(L_i)$ is decreasing in L_i or $\varepsilon'<0$, competition is less balanced under WM than under PM.⁶

Case 2: $F_1=F_2=F \neq 0$ (non-zero fixed costs are the same for both teams). The WM equilibrium condition simplifies to $AR_1(L_1^+) - F/L_1^+ = AR_2(L_2^+) - F/L_2^+$. If $F>0$ and $\varepsilon' \leq 0$, competition is

less balanced under WM than under PM. If $F < 0$ and $\epsilon' > 0$, competition is more balanced under WM than under PM. In other cases, the comparison between WM and PM is indeterminate.

Case 3: $F_1 \neq F_2$ (non-zero fixed costs differ between teams). If $F_1 < F_2$, $F_2 > 0$ and $\epsilon' \leq 0$, competition is less balanced under WM than under PM. If $F_1 > F_2$, $F_1 > 0$ and $\epsilon' > 0$, competition is more balanced under WM than under PM. In other cases, the comparison between WM and PM is indeterminate.⁷

The estimated revenue functions reported in section III provide empirical evidence concerning the shape of the revenue function for PL and FL member teams, and a specific test to distinguish between the cases $\epsilon' > 0$, $\epsilon' = 0$ and $\epsilon' < 0$. The outcome of this test will also permit a narrowing of the range of empirically relevant comparisons between competitive balance under the PM and WM objective functions.

III Empirical revenue functions for English football

Section III reports empirical counterparts of the theoretical revenue functions developed in section II. The data comprises annual gate revenues for all PL and FL football teams between the 1926-7 and 1998-9 seasons inclusive, obtained from the FL's archives and Football Trust (various issues). For most of this period, gate revenue was by far the most important component of total revenue. Recently, however, the share of gate revenue in total revenue has fallen, and the rate of decline has been faster in the PL than in the FL. For recent years gate revenue data will therefore tend to yield a conservative estimate of the overall extent of revenue divergence.⁸

To describe the main changes in the distribution of revenue between teams with broadly similar demographic, geographic and historical characteristics, Dobson and Goddard (1998) classify the PL and FL member teams into five groups. G1 (Group 1) contains four major London teams that tend to attract significant levels of support from all parts of London and beyond, and ten major teams from five other cities with populations larger than 500,000: Birmingham, Liverpool, Leeds, Manchester and Sheffield. G2 contains teams from northern and midlands cities with populations in the range 250,000-500,000. G3 contains teams from southern towns other than London, and the minor London teams not included in G1. The two remaining groups contain teams from smaller northern and midlands towns, sub-divided into pre-1922 (G4) and post-1922 (G5) league entrants.⁹

Between the 1920s and 1990s there were marked contrasts in fortunes between groups, in terms of both performance and revenue indicators, described in detail by Dobson and Goddard (1998). Summary data are shown in panels (a) and (b) of Table 1. For the purposes of the present discussion, the most important feature is a long-term shift in the composition of demand favouring the big-city teams at the expense of their small-town counterparts. Over the period as a whole this is reflected in an increase in G1's revenue share of more than ten percentage points, while G1's performance was virtually unchanged.

Economists, sociologists and social historians have all attempted to explain this shift in the composition of demand (Dunning et al., 1988; Walvin, 1994; Russell, 1997). The geographical bond between teams and their spectators certainly appears to have been stronger in the first half of the 20th century than subsequently. Prior to the late-1950s financial and logistical constraints militated against regular long-distance travel to sports fixtures for most spectators. Thereafter rising affluence, combined with improvements in public and private

transport enabled big-city teams, in particular, to begin to draw support at a national rather than purely local or regional level, and to drain support from small-town teams. Demographic change also tended to weaken links between communities and their local teams.

Suburbanisation implied population shifts away from urban districts where most stadia were located. Meanwhile the expanding reach of televised football focused public attention on a handful of star players of the most glamorous teams, also favouring the latter at the expense of their less widely exposed small-town counterparts.

The effects of such developments are incorporated into the empirical revenue functions reported below by permitting variation over time and between groups in the revenue function parameters. In the empirical revenue functions, $R_{i,t}$ and $L_{i,t}$ are equivalent to R_i (revenue) and L_i (normalised league position as a measure of talent) as defined in section II; and $r_{i,t} = R_{i,t} / \sum_i R_{i,t}$ is team i 's normalised revenue (actual revenue as a proportion of total league revenue). In view of the importance attached to the uncertainty of outcome hypothesis in the sports economics literature (Humphreys, 2002), the following measure of the closeness of competition within each division in each season is also included as a revenue function covariate: $v_{i,t}$ = the coefficient of variation (standard deviation divided by mean) of the points totals of all teams in team i 's division in season t 's final divisional table. The empirical revenue function specification is as follows:

$$\ln(r_{i,t}) = \alpha_{i,t} + \beta_t \ln(L_{i,t}) + \delta_t [\ln(L_{i,t})]^2 + \phi_t \ln(v_{i,t}) + u_{i,t}$$

where $u_{i,t}$ is a random disturbance term, and $\alpha_{i,t}$, β_t , δ_t and ϕ_t are time-varying revenue function parameters. For estimation, some restrictions on these parameters are required: each is assumed to be polynomial in t .¹⁰ In this formulation, the elasticity of revenue with respect

to league position, the equivalent of $\varepsilon(L_i)$ in section II, is $\beta_t + 2\delta_t \ln(L_{i,t})$. This elasticity is increasing in $L_{i,t}$ if $\delta_t > 0$, constant if $\delta_t = 0$, and decreasing if $\delta_t < 0$.

The revenue function estimation results are reported in Table 1. Panel (c) reports the group mean values of $\exp(\hat{\alpha}_{i,t})$ (the empirical counterparts of the individual effects A_i) for selected seasons. These provide an indication of shifts between the five groups in the composition of aggregate spectator demand for the league as a whole, after controlling for team performance. The increase in the G1 teams' mean value of $\exp(\hat{\alpha}_{i,t})$ over the entire period is unsurprising in view of the increase in G1's revenue share described above, although the upward trend in G1's mean $\exp(\hat{\alpha}_{i,t})$ was reversed during the 1990s. The cross-sectional standard deviation (across all teams) of $\exp(\hat{\alpha}_{i,t})$, denoted $s[\exp(\hat{\alpha}_{i,t})]$, provides a convenient summary measure of divergence between teams in base levels of spectator demand. Panel (d) shows that this measure has increased steadily over time.

Panel (e) of Table 1 shows the estimated values of β_t , δ_t and ϕ_t . All values of $\hat{\beta}_t$ and $\hat{\delta}_t$ are positive and significant at the 1% level, and appear to be well defined. Both of these parameters increased sharply in absolute terms between the 1950s and the 1970s, though more recently there has been a downward drift. The variation over time in the elasticity of revenue with respect to league position is similar. For the league's median team with $L_{i,t} = 0.5$, the values of the estimated elasticity, $\hat{\varepsilon}_t(0.5) = \hat{\beta}_t + 2\hat{\delta}_t \ln(0.5)$, are reported in panel (f). In terms of the discussion in section II, the positive sign of $\hat{\delta}_t$ provides empirical support for the case $\varepsilon' > 0$: the empirical revenue function is more elastic (with respect to league position) for teams near the top of the league than for those near the bottom. For the median team, this

elasticity is estimated to have varied within the range 0.40 to 0.90. Figures 1 and 2 plot the movement in the series $s(\hat{\alpha}_{i,t})$ and $\hat{\epsilon}_t(0.5)$ for the entire 1926-1999 period.

In contrast to the results for β_t and δ_t , the estimates of ϕ_t are not signed consistently, and do not appear to be well defined. In accordance with the uncertainty of outcome hypothesis, negatively signed values of $\hat{\phi}_t$ are obtained for 1926, 1936 and 1949; of these the first two are significant at the 1% level. The remaining values of $\hat{\phi}_t$ are positively signed, and those for 1969, 1979 and 1989 are significant. Overall the empirical results do not appear to support the hypothesis that spectator demand (as reflected in the revenue function) increases if competition at divisional level becomes closer.

Section III concludes by revisiting briefly the comparisons between competitive balance at the PM and WM equilibria that were drawn in section II. The estimation results suggest the range of empirically relevant comparisons can be limited to the case $\epsilon' > 0$. Accordingly these can be re-stated as follows. If $F_1 = F_2 = 0$, competition is more balanced under WM than under PM. If $F_1 = F_2 = F < 0$, competition is more balanced under WM than under PM; if $F_1 = F_2 = F > 0$ the comparison between PM and WM is indeterminate. If $F_1 > F_2$ and $F_1 > 0$, competition is more balanced under WM than under PM. Finally, if $F_1 > F_2$ and $F_1 < 0$ or if $F_1 < F_2$, the comparison between WM and PM is indeterminate. In those cases for which specific conclusions can be drawn WM appears to produce closer competitive balance than PM; but this comparison can not be generalised over all possible cases.

IV Measuring competitive balance using FA Cup match results data

In the empirical NA team sports literature, it is standard practice to measure competitive balance using the cross-sectional variance or standard deviation of the win ratios of member

teams (Fort and Quirk, 1995; Eckard, 1998, 2001; Humphreys, 2002). This procedure is unsuitable for English football, however, because of its divisional competitive structure.

Intra-divisional variation in win ratios may say something about competitive balance across the league as a whole: greater imbalance might be discernible within divisions to some extent. Yet such measures are unlikely to provide a powerful measure. Most of the action is inter- rather than intra-divisional, but inter-division variation is not considered.

However, all PL and FL member teams take part in a competition that does allow direct comparisons between the playing strengths of teams from different divisions. The FA Cup (Football Association Challenge Cup) is a sudden-death knock-out tournament involving both league and non-league teams. For spectators, a major attraction is the cup's propensity to produce shock results, such as the elimination of a PL team by an opponent from the lower reaches of the FL or from non-league.¹¹

Recently, Szymanski (2001) has used FA Cup match attendance data in an effort to identify trends in competitive balance in English football since the 1970s. Analysing cup attendances in matches where a corresponding league fixture (between the same teams in the same season) took place, Szymanski finds that cup attendances declined relative to league attendances. In the demand for sports literature, one version of the uncertainty of outcome hypothesis is that attendances depend on the level of competitive balance between all teams in the competition concerned. Accordingly Szymanski interprets declining cup attendances as signifying increasing inter-divisional competitive imbalance between league teams. League attendances are less affected, because rising competitive imbalance is mainly an inter- rather than an intra-divisional phenomenon. Here, competitive balance is measured directly using match results data, rather than indirectly via a hypothesised relationship with attendance.

In section IV inferences about changes in competitive balance are drawn directly from a statistical investigation of trends in win probabilities in cup matches conditional on league position. Koning (2000) and Dobson and Goddard (2001) use ordered probit regression to model league match results in football. Adapting this approach, the model describing the result of the cup match between home team i and away team j played in season t , denoted $y_{i,j,t}$, is:

$$\begin{aligned}
 \text{Home win} &\Rightarrow y_{i,j,t} = 1 && \text{if} && \mu_2 < y_{i,j,t}^* + \varepsilon_{i,j,t} \\
 \text{Draw} &\Rightarrow y_{i,j,t} = 0.5 && \text{if} && \mu_1 < y_{i,j,t}^* + \varepsilon_{i,j,t} \leq \mu_2 \\
 \text{Away win} &\Rightarrow y_{i,j,t} = 0 && \text{if} && y_{i,j,t}^* + \varepsilon_{i,j,t} \leq \mu_1
 \end{aligned}$$

where $y_{i,j,t}^* = \gamma_{0,t} + \gamma_{1,t} L_{i,t} + \gamma_{2,t} L_{j,t}$; $\varepsilon_{i,j,t}$ is a standard normal disturbance term; $\gamma_{k,t}$ ($k=0,1,2$) are time-varying parameters ($\gamma_{1,t} < 0$ and $\gamma_{2,t} > 0$ are expected) which follow a polynomial functional form;¹² and μ_1 and μ_2 are additional cut-off parameters.

The data comprises FA Cup matches played between the 1921-2 and 2001-2 seasons inclusive (except 1945-6 when the FA Cup was staged but the league was suspended) that were either first matches or (first) replays involving two league member teams, between Round 1 and the quarter-finals (currently Round 6) inclusive. Second and subsequent replays, semi-finals and finals are excluded because these matches are usually played at neutral venues. Match results are recorded after 90 or 120 minutes' play; results of penalty shoot-outs are not recorded.¹³

Since the rules concerning match duration differ between first matches and replays, the parameters of the ordered probit model also differ, and separate estimations are required. The estimated home win, draw and away win probabilities are $h^{(z)}(L_{i,t}, L_{j,t}) = 1 - \Phi(\hat{\mu}_2 - \hat{y}_{i,j,t}^*)$, $d^{(z)}(L_{i,t}, L_{j,t}) = \Phi(\hat{\mu}_2 - \hat{y}_{i,j,t}^*) - \Phi(\hat{\mu}_1 - \hat{y}_{i,j,t}^*)$ and $a^{(z)}(L_{i,t}, L_{j,t}) = \Phi(\hat{\mu}_1 - \hat{y}_{i,j,t}^*)$ respectively, where Φ is the standard normal distribution function; $z=1$ denotes a first match; and $z=2$ denotes a replay. Let $E(y_{i,j,t})$ represent the expected outcome for team i after the first match or after the (first) replay if the first match is drawn, calculated as a probability-weighted average of scores of 1 if team i wins the tie; 0.5 if the tie is level; and 0 if team i loses:

$$E(y_{i,j,t}) = h^{(1)}(L_{i,t}, L_{j,t}) + d^{(1)}(L_{i,t}, L_{j,t})\{a^{(2)}(L_{j,t}, L_{i,t}) + 0.5d^{(2)}(L_{j,t}, L_{i,t})\}$$

If team i initially plays away to team j , the expected outcome for team i is $1 - E(y_{j,i,t})$. Team i 's expected outcome, conditional on league positions but unconditional on which team initially plays at home, is $w_t(L_{i,t}, L_{j,t}) = 0.5\{1 + E(y_{i,j,t}) - E(y_{j,i,t})\}$. Variations over time in $w_t(\bar{L}_i, \bar{L}_j)$ for constant values of \bar{L}_i and \bar{L}_j provide an indication of trends in competitive balance. An alternative summary measure is $s(w_t)$, the cross-sectional standard deviation (across i) of $w_t(L_{i,t}, 0.5)$: the expected outcomes (as defined above) of all teams against the league's median team.

The estimation results are reported in Table 2. Panel (b) reports the estimates of $\gamma_{k,t}$ for the first matches of cup ties for selected seasons. Panel (c) reports the equivalent estimates for replays. In both cases, the decrease over time in the numerical value of $\hat{\gamma}_{0,t}$ controls for a decline in the importance of home advantage, apparent in the summary data reported in panel (a). Meanwhile $\hat{\gamma}_{1,t}$ and $\hat{\gamma}_{2,t}$ both tend to increase in absolute value.¹⁴ Cup results have

therefore become increasingly correlated with league positions. By the end of the period, any given difference in league positions counted for more than it had in earlier times, suggesting increasing competitive imbalance between teams at different levels of the league hierarchy.

Panels (d) and (e) of Table 2 report further summary measures of the trend in competitive balance. Panel (d) reports the trends in $w_t(0.75,0.25)$ and $w_t(0.9,0.1)$: the probabilities of success (after a maximum of 210 minutes) for teams positioned at the 10th and 25th percentile of the league hierarchy, against teams positioned at the 75th and 90th percentiles respectively, conditional on league positions but unconditional on home advantage. These data show that the probability of a shock result declined considerably over the period.

For selected seasons, panel (e) of Table 2 reports $s(w_t)$ as defined above. The full series is plotted in Figure 3. According to the theoretical models described in section II, the trend in $s(w_t)$ shown in Figure 3 should be linked to trends in $s[\exp(\hat{\alpha}_{i,t})]$ and $\hat{\epsilon}_t(0.5)$ shown in Figures 1 and 2. Clearly the long-term trend in all three series is upward, so to this extent the empirical findings are consistent with the theory. There are some inconsistencies, however, in the timing of the principal movements in $s(w_t)$ on the one hand, and $s[\exp(\hat{\alpha}_{i,t})]$ and $\hat{\epsilon}_t(0.5)$ on the other, which rule out the successful estimation of an econometric relationship (in cointegration form) between these series.

This failure is perhaps unsurprising in view of the following: first, the link between the series is established indirectly from the reduced form of a (highly stylised) theoretical model, and not directly through any behavioural relation; second, the link is likely to have been influenced by various changes on the supply side that are not modelled explicitly in the present analysis; and third, the choice of any specific measures of revenue divergence and

competitive balance is to some extent arbitrary. Accordingly, instead of seeking to establish an econometric relationship between $s[\exp(\hat{\alpha}_{i,t})]$, $\hat{\epsilon}_t(0.5)$ and $s(w_t)$, the rest of section IV attempts a less formal interpretation of Figures 1 to 3.

The increase in $s(w_t)$ in the 1920s and 1930s may only be partially attributable to parallel changes in the parameters of the revenue function: although $s[\exp(\hat{\alpha}_{i,t})]$ increased over this period, $\hat{\epsilon}_t(0.5)$ declined. The growth of a more professional ethos in football during the inter-war period provides an alternative, non-demand side interpretation of the tendency for competitive imbalance to increase. The modern-day football manager's job specification, including responsibility for all aspects of team affairs and the acquisition and disposal of players, first began to evolve between the wars (Walvin, 1994). As the style of management of the leading teams (in particular) moved onto a more professional footing, it is unsurprising to find the emergence of a larger competitive gap between these teams and the rest.

The second significant increase in competitive balance beginning in the late-1970s was both preceded and accompanied by pronounced increases in $s[\exp(\hat{\alpha}_{i,t})]$ and $\hat{\epsilon}_t(0.5)$. The peculiarities of pre-1978 contractual arrangements (see section II) may explain why these demand shifts did not feed through immediately into rising competitive imbalance during the 1960s and most of the 1970s. Before 1978 a lack of player mobility may have helped keep the lid on the damaging consequences for competitive balance of the shifting composition of spectator demand.¹⁵ After 1978, when out-of-contract players secured the right to initiate a transfer and restraints on player mobility were eased, competitive imbalance started to rise. During the 1990s, the rate of growth in $s(w_t)$ accelerated while growth in $s[\exp(\hat{\alpha}_{i,t})]$ slowed, and $\hat{\epsilon}_t(0.5)$ dropped back to 1960s levels. Post-1995 adjustments to the distribution

of playing talent following Bosman, especially due to the relaxation of restrictions on the employment of foreign talent, might be partly responsible for this further rise in competitive imbalance. However, as noted above it is also likely that the gate revenue data understates the full extent of revenue divergence in the 1990s. Therefore further change in the composition of demand, not fully reflected in $s(w_t)$, may also have contributed to rising competitive imbalance during this period.

V Conclusion

The theoretical model of resource allocation in professional sports leagues widely used in North America suggests that competitive balance is demand-driven. Ultimately, the allocation of playing talent between teams is dependent on each team's relative market size. This article has considered the adaptation of theoretical models developed in North America to English (association) football. Empirical football team revenue functions have been reported, estimated using annual data from the 1920s to the 1990s. A direct measure of competitive balance between teams at all levels of the league's divisional hierarchy, based on a statistical analysis of match results cup competition, has been developed.

The theoretical model predicts that under profit maximising assumptions, competition will become more unbalanced, either if there is divergence between teams' base levels of spectator demand, or if the elasticity of team revenue with respect to league position increases. Empirically, both of these conditions have been met. Big-city teams experienced an increase in their base levels of demand relative to their small-town counterparts, and there was divergence in revenue shares. For the league's median team, the estimated elasticity of revenue increased over the period as a whole.

In general, the comparison between competitive balance at the equilibria associated with profit maximisation (PM) on the one hand, and win percent maximisation subject to a financial constraint (WM) on the other, is indeterminate. Depending on the precise nature of the revenue functions and cost assumptions, competition may be more balanced, equally balanced or less balanced under WM than under PM. However, a finding that the empirical revenue function is more elastic (with respect to league position) for teams near the top of the league than for teams near the bottom reduces the range of empirically relevant comparisons. If the sum of fixed costs and the profit constraint is zero for both teams, competition is more balanced under WM than under PM. If the sum of fixed costs and the profit constraint is non-zero for one or both teams, either competition is either more balanced under WM than under PM or the comparison remains indeterminate.

The statistical analysis of FA Cup match results indicates that there has indeed been an increase in competitive imbalance between teams operating at different levels of the league's hierarchy, as the theoretical model predicts. Competitive imbalance appears to have increased in the late-1920s and 1930s. It has been suggested that this may be partly due to the emergence of a more professional ethos in football during this period, as well as demand-side shifts. A further significant increase in competitive imbalance has been underway since the late-1970s and especially during the 1990s. This was preceded by changes in the composition of demand whose initial impact on competitive balance may have been dampened by a lack of mobility in the players' transfer market. Contractual changes implemented in 1963, 1978 and 1995 have eased restrictions on player mobility. Consequently the most talented players have gravitated increasingly towards the highest-paying teams, and inter-divisional competitive imbalance has risen accordingly.

Footnotes

1. Although the 92-strong membership of the Premier League and Football League currently includes three Welsh teams, for convenience this paper refers to English football from this point onward.
2. League competition in English professional football is currently organised into four divisions: the Premier League (PL) comprising 20 teams; and Football League (FL) comprising three divisions (FLD1-FLD3) of 24 teams each. Three or four teams per season are promoted and relegated between adjacent FL divisions, and between FLD1 and PL. A four-division structure, with total membership close to the current complement of 92 teams, has operated since the 1921-2 season. Before the 1992-3 season, all teams were members of the FL and the divisions were numbered 1 to 4.
3. L_i is discrete, while talent is normally assumed to be continuous. When n is large, however, the distinction becomes negligible.
4. According to data published in *Rothmans Football Yearbook*, in 2001 29.1% of players employed by PL teams were born outside the UK or Ireland. For the FL the corresponding figure was 13.4%. In 1986 the equivalent figures were 5.0% (for the old division 1) and 2.0% (divisions 2 to 4).
5. $R_i(L_i)$ is slightly more restrictive than the revenue function used by Fort and Quirk (2002), because any differences between teams derive from the individual effects only, while the function $\rho(L_i)$ is the same for all teams. Fort and Quirk impose no such restrictions on their counterpart of $R_i(L_i)$. As well as league position, the empirical revenue functions reported in section III of this paper include a term allowing for the closeness of intra-divisional competition, in an attempt to incorporate one version of the uncertainty of outcome hypothesis. In a theoretical model of a two-

team league there is no internal divisional structure, but it is possible to think of uncertainty of outcome as one of the factors incorporated in the individual effects A_i .

6. At the PM equilibrium, $MR_1(L_1^*) = MR_2(L_2^*)$ implies $\varepsilon(L_1^*)AR_1(L_1^*) = \varepsilon(L_2^*)AR_2(L_2^*)$. If $\varepsilon' > 0$ and $\varepsilon(L_1^*) > \varepsilon(L_2^*)$, $AR_1(L_1^*) < AR_2(L_2^*)$. This implies $L_1^+ < L_1^*$ (and $L_2^+ > L_2^*$) is required for $AR_1(L_1^+) = AR_2(L_2^+)$. Similarly, if $\varepsilon' = 0$ and $\varepsilon(L_1^*) = \varepsilon(L_2^*)$, $AR_1(L_1^*) = AR_2(L_2^*)$ and $L_1^+ = L_1^*$ is required. If $\varepsilon' < 0$ and $\varepsilon(L_1^*) < \varepsilon(L_2^*)$, $AR_1(L_1^*) > AR_2(L_2^*)$ and $L_1^+ > L_1^*$ is required.
7. In the case $F_1 = F_2 = F$, if $F > 0$ and $\varepsilon' \leq 0$, $AR_1(L_1^*) - F/L_1^* > AR_2(L_2^*) - F/L_2^*$, because $AR_1(L_1^*) \geq AR_2(L_2^*)$ and $L_1^* > L_2^*$. Therefore $L_1^+ > L_1^*$ is required to satisfy the WM equilibrium condition. If $F < 0$ and $\varepsilon' > 0$, $AR_1(L_1^*) - F/L_1^* < AR_2(L_2^*) - F/L_2^*$, because $AR_1(L_1^*) < AR_2(L_2^*)$ and $L_1^* > L_2^*$. Therefore $L_1^+ < L_1^*$ is required. In the case $F_1 \neq F_2$, if $F_1 < F_2$, $F_2 > 0$ and $\varepsilon' \leq 0$, $AR_1(L_1^*) - F_1/L_1^* > AR_2(L_2^*) - F_2/L_2^*$. Therefore $L_1^+ > L_1^*$ is required. If $F_1 > F_2$, $F_1 > 0$ and $\varepsilon' > 0$, $AR_1(L_1^*) - F_1/L_1^* < AR_2(L_2^*) - F_2/L_2^*$. Therefore $L_1^+ < L_1^*$ is required.
8. While total revenue (from all sources) would be preferable in many respects to gate revenue, the former is only obtainable from company accounts, and many teams have not filed accounts regularly. Advantages of the gate revenue data set include comprehensiveness and consistency: there are no missing observations, and all data are compiled on an identical basis in accordance with league regulations.
9. The classification criteria and the composition of the groups are detailed in Dobson and Goddard (1998). Populations are from the 1961 census, the closest to the mid-point of the observation period. The group classifications are based on exogenous

characteristics of the teams, and not on their performance or revenue over the period under scrutiny.

10. The polynomial functional forms are:

$$\alpha_{i,t} = a_{i,0} + \sum_{m=1}^{M_1} a_{i,m} t^m ; \quad \beta_t = b_0 + \sum_{m=1}^{M_2} b_m t^m ; \quad \delta_t = d_0 + \sum_{m=1}^{M_3} d_m t^m ; \quad \phi_t = f_0 + \sum_{m=1}^{M_3} f_m t^m$$

$\alpha_{i,t}$ are time-varying home team individual effects, allowing for variation between teams and over time in base levels of spectator demand. β_t , δ_t and ϕ_t are also subject to polynomial trends, which are assumed not to vary between teams. F-tests indicated that $M_1=3$, $M_2=9$ and $M_3=2$ provide an adequate representation of the polynomial trends; higher-order terms beyond these values tested insignificant. t varies from 1 (1925-6 season) to 67 (1998-9 season); there is no break in t for the seven-year period when football was suspended during the Second World War. Teams with fewer than ten time series observations are excluded from the estimations.

11. The FA Cup is English football's principal knock-out cup competition, open to all PL and FL teams as well as non-league teams. The latter take part in a preliminary qualifying tournament. FLD2 and FLD3 teams enter in Round 1. Survivors are joined by PL and FLD1 teams in Round 3. Further rounds reduce the 64 Round 3 contestants to two finalists in Round 8. From Round 1 onwards, a random draw determines who plays whom and who has home advantage; there are no seedings.

12. The polynomial functional form is: $\gamma_{k,t} = g_{k,0} + \sum_{m=1}^{M_4} g_{k,m} t^m$. In this expression $g_{0,0}$ is redundant and is set to zero. Ordered probit regression is used to obtain estimates of the parameters μ_1 , μ_2 , $g_{k,m}$, and therefore $\gamma_{k,t}$. Chi-square tests for the joint significance of the additional coefficients introduced by increasing M_4 , based on the omitted variables version of Weiss's (1997) Lagrange Multiplier (LM) test, indicate that $M_4=3$ provides an adequate representation of the trend in $\gamma_{k,t}$.

13. If the first match of an FA Cup tie produces a winner after 90 minutes' play, this result settles the tie. If the first match is level after 90 minutes, a replay is staged at the home of the team initially drawn away. If the replay produces a winner after 90 minutes, this settles the tie. If the replay is level after 90 minutes, 30 minutes' extra time is played. Until 1993-4, if the replay was still level after 120 minutes, further replays were staged until a winner emerged. Since 1993-4, penalty shoot-outs have settled ties level after 120 minutes of the (first) replay (210 minutes in total). The introduction of penalty shoot-outs in the 1993-4 season should not affect the parameters, since this change only affects what happens *after* 210 minutes' play.
14. There is some ambiguity in the results for $\hat{\gamma}_{1,t}$ in the replays estimation, which is based on fewer observations than the estimation for first matches. In this case there is a form of selection bias against teams from the lower reaches of the FL, relatively few of which survive to contest a replay having been drawn away in the first match.
15. Eckard (2001) argues along similar lines that a lack of player mobility prevented the NA major league baseball players' labour market from functioning in accordance with the standard resource allocation model prior to the 1976 introduction of free agency.

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Table 1 Estimation results: revenue function

Season end-year = t:								
	1926	1936	1949	1959	1969	1979	1989	1999
(a) League performance score (%) by group:								
G1	26.9	25.5	25.1	25.7	26.3	25.0	24.1	25.9
G2	19.0	19.6	17.7	16.0	16.4	16.4	17.8	17.3
G3	18.4	22.4	24.1	27.0	30.7	35.1	36.2	30.0
G4	21.3	21.4	20.7	18.6	15.9	13.0	12.3	17.2
G5	14.4	11.1	12.4	12.8	10.7	10.5	9.6	9.7
(b) % share of gate revenue by group:								
G1	32.8	34.9	29.0	31.7	40.2	39.3	39.9	43.5
G2	18.6	17.9	21.3	17.6	19.2	16.5	18.3	20.8
G3	21.6	23.8	24.2	25.9	24.8	27.6	27.4	19.6
G4	16.9	15.9	16.3	15.3	9.4	10.2	8.7	12.5
G5	10.1	7.4	9.1	9.5	6.4	6.5	5.7	3.5
(c) Group mean values of $\exp(\hat{\alpha}_{i,t})$:								
G1 (g=1)	.0189	.0209	.0233	.0285	.0347	.0399	.0406	.0349
G2 (g=2)	.0125	.0157	.0178	.0206	.0219	.0231	.0221	.0208
G3 (g=3)	.0119	.0124	.0135	.0153	.0170	.0166	.0142	.0098
G4 (g=4)	.0094	.0117	.0128	.0139	.0142	.0137	.0125	.0126
G5 (g=5)	.0059	.0067	.0073	.0088	.0099	.0106	.0083	.0047
(d) Cross-sectional standard deviation of $\exp(\hat{\alpha}_{i,t})$:								
$s[\exp(\hat{\alpha}_{i,t})]$	.0051	.0059	.0067	.0079	.0095	.0114	.0126	.0130
(e) Other estimated parameters:								
$\hat{\beta}_t$	.6075	.5831	.5340	.6386	.8821	1.0801	.9178	.8373
$\hat{\delta}_t$	.0778	.0864	.0808	.0975	.1294	.1560	.1456	.1362
$\hat{\phi}_t$	-.2109 ^a	-.0756 ^a	-.0115	.0668	.1094 ^a	.1164 ^a	.0877 ^a	.0233
(f) Elasticity of revenue w.r.t. league position for the median team ($L_{i,t}=0.5$):								
$\hat{\epsilon}_t(0.5)$	.4996	.4633	.4220	.5034	.7026	.8638	.7160	.6485

Note: League performance scores (panel (a)) are calculated by expressing the sum of $L_{i,t}$ over all teams in Group g as a percentage of the sum of $L_{i,t}$ over all teams.

In panel (e), all reported $\hat{\beta}_t$ and $\hat{\delta}_t$ are significantly different from zero at the 1% level.

For $\hat{\phi}_t$, ^a denotes significantly different from zero at the 1% level.

Table 2 Estimation results: competitive balance

Season end-year = t:								
	1926	1936	1949	1959	1969	1979	1989	1999
(a) Proportion of home wins, draws and away wins, cup matches, 10 seasons up to and including t:								
Home wins	n/a	0.530	0.531	0.464	0.485	0.500	0.487	0.453
Draws	n/a	0.218	0.199	0.244	0.245	0.268	0.250	0.259
Away wins	n/a	0.252	0.270	0.293	0.271	0.232	0.263	0.288
(b) Ordered probit estimation results, first matches: $\hat{\mu}_1 = -0.881$; $\hat{\mu}_2 = -0.089$; obs. = 5438								
$\hat{\gamma}_{0,t}$	-0.013	-0.112	-0.146	-0.172	-0.167	-0.145	-0.119	-0.101
$\hat{\gamma}_{1,t}$	1.160	1.314	1.335	1.301	1.246	1.242	1.363	1.682
$\hat{\gamma}_{2,t}$	-1.141	-1.417	-1.458	-1.407	-1.314	-1.302	-1.498	-2.024
(c) Ordered probit estimation results, replays: $\hat{\mu}_1 = -0.916$; $\hat{\mu}_2 = -0.545$; obs. = 1498								
$\hat{\gamma}_{0,t}$	-0.021	-0.183	-0.242	-0.289	-0.290	-0.265	-0.234	-0.217
$\hat{\gamma}_{1,t}$	1.303	1.042	1.022	1.136	1.338	1.515	1.554	1.342
$\hat{\gamma}_{2,t}$	-1.352	-1.230	-1.210	-1.255	-1.380	-1.567	-1.798	-2.055
(d) Selected win probabilities conditional on (re-scaled) league position:								
$w_t(0.75,0.25)$	0.747	0.781	0.787	0.784	0.779	0.783	0.809	0.862
$w_t(0.9,0.1)$	0.853	0.892	0.897	0.895	0.888	0.891	0.915	0.957
(e) Cross-sectional standard deviation of win probabilities against median team:								
$s(w_t)$	0.1504	0.1712	0.1733	0.1719	0.1686	0.1715	0.1883	0.2261

Figure 1

Standard deviation of time-varying individual team effects, $s[\exp(\hat{\alpha}_{i,t})]$

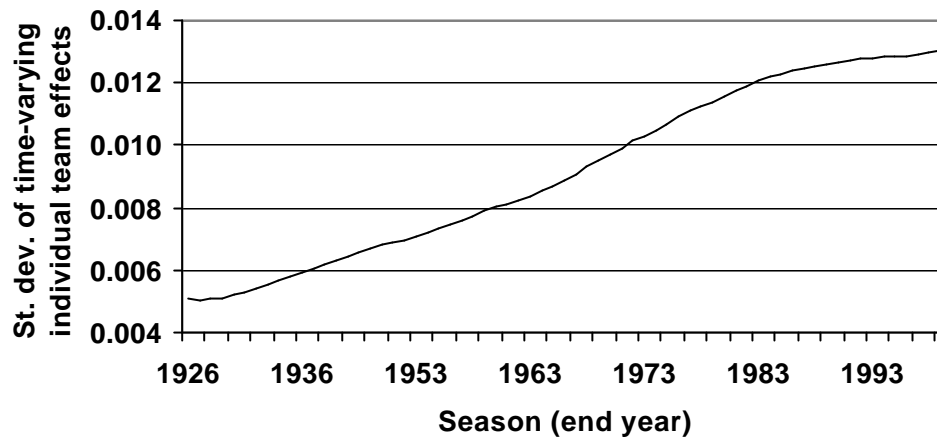


Figure 2

Elasticity of revenue with respect to league position for the median team, $\hat{\epsilon}_t(0.5)$

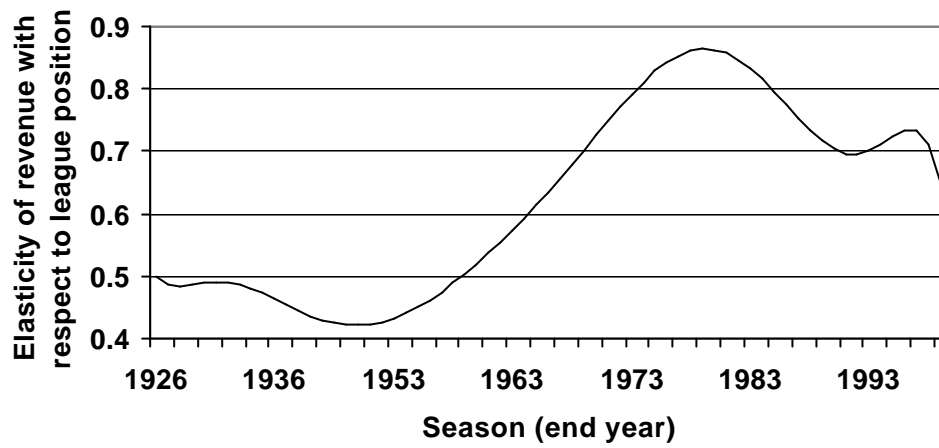


Figure 3

Standard deviation of win probabilities against the median team, $s(w_t)$

