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The Multi-Dimensionality of Competitive Balance: Evidence from European Football

Abstract

Purpose: This paper addresses the problem of designing league regulatory mechanisms given the multi-dimensionality of competitive balance and the proliferation of empirical measures.

Design/methodology/approach: A three-stage approach is adopted. First, a taxonomy of empirical measures of competitive balance is proposed, identifying two fundamental dimensions - win dispersion and performance persistence. Second, a simple two-team model of league competitive balance is used to explore the dispersion-persistence relationship. Third, correlation and regression analysis of seven empirical measures of competitive balance for the 18 best-attended top-tier domestic football leagues in Europe over the ten seasons, 2008 – 2017, are used to: (i) validate the proposed categorisation of empirical measures into two dimensions; and (ii) investigate the nature of the dispersion-persistence relationship across leagues.

Findings: The simple model of league competitive balance implies a strong positive dispersion-persistence relationship when persistence effects increase for big-market teams relative to those for the small-market teams. However, the empirical evidence indicates that while leagues such as the Spanish La Liga exhibit a strong positive dispersion-persistence relationship, other leagues show little or no relationship, and some leagues, particularly the English Premier League and top-tier divisions in Belgium and Netherlands, have a strong negative dispersion-persistence relationship. The key policy implication for leagues is the importance of understanding the direction and impact of dispersion and persistence effects on the demand for league products.

Originality: The variability in the strength and direction of the dispersion-persistence relationship across leagues is an important result that undermines the "one-size-fits-all" approach to designing league regulatory mechanisms.

Keywords: professional team sports leagues; competitive balance; uncertainty of outcome; win dispersion; performance persistence; league regulatory mechanisms

1. Introduction

Competitive balance is one of the most fundamental concepts in sports economics, its importance deriving from the uncertainty of outcome hypothesis (Rottenberg, 1956) that fan interest in sporting contests depends crucially on the closeness of the competition. Sporting contests are unscripted drama, and drama is heightened, the greater the equality of win probabilities across the competitors. Given the fundamental importance of competitive balance, it is no surprise that there is a large and continually growing research literature on the subject. As Fort and Maxcy (2003) have recognised, the research literature has broadly split into two main tracks, the Analysis of Competitive Balance (ACB) and the Uncertainty of Outcome Hypothesis (UOH). ACB research has focused on the measurement of competitive balance in professional team sports leagues (descriptive), the explanation of both changes in competitive balance within leagues over time and differences in competitive balance between leagues (analytical), and the investigation of how regulatory mechanisms could be used to improve competitive balance (prescriptive). ACB research has involved both substantive theoretical development and empirical analysis. Empirical ACB research has tended to focus on empirical measures of competitive balance based on end-of-season league outcomes. By contrast, UOH research has mostly comprised the empirical analysis of match-level panel data for individual teams in a league to assess the statistical significance of uncertainty of outcome for gate attendances and/or TV viewing.

This present study is concerned with an important disconnect between the theoretical and empirical research within the ACB literature which has implications for the prescriptive advice on the regulatory mechanisms that should be employed by professional team sports leagues. While it is widely recognised that competitive balance is a multi-dimensional concept (Daly and Moore, 1981; Zimbalist, 2003; Kringstad and Gerrard, 2007) and that this multi-dimensionality has in part contributed to the proliferation of empirical measures of competitive balance, within the theoretical literature there appears to be an implicit assumption that the different empirical measures of competitive balance are highly correlated so that proposed changes in league regulatory regimes are expected to affect all of the dimensions of competitive balance in the same direction.

The research objectives of this paper are twofold. The first objective is to simplify the proliferation of empirical measures of competitive balance by proposing a two-level taxonomy that identifies different dimensions of competitive balance within which there are sub-groupings of empirical measures based on the type of measurement method. The second objective is to investigate whether the dimensions of competitive balance are closely associated and provide similar indications of trends in competitive balance within a league. A three-stage methodology is adopted. First, a theoretical taxonomy of empirical measures of competitive balance is proposed to identify the different dimensions of competitive balance. Second, a simple model of league competitive balance is used to explore the relationship between the different dimensions of competitive balance. Third, correlation and regression analysis are used to: (i) validate the proposed categorisation of empirical measures; and (ii) investigate the nature of the relationship between the different dimensions of competitive balance across leagues.

The structure of the paper is as follows. Section 2 reviews the existing literature on the empirical measurement of competitive balance using end-of-season league outcomes and proposes a taxonomy with two fundamental dimensions of competitive balance: win dispersion and performance persistence. Section 3 develops a simple two-team theoretical model of competitive balance in order to analyse the relationship between win dispersion and performance persistence (hereafter referred to as the dispersion-persistence relationship). Section 4 outlines the data and methods used to validate the usefulness of the two-dimensional taxonomy and investigate the dispersion-persistence relationship in 18 European football leagues (EFLs) over the ten seasons, 2008 - 2017. Section 5 reports the empirical results. Section 6 discusses the implications of the empirical results, with a particular focus on the three biggest EFLs - the English Premier League, the German Bundesliga and the Spanish La Liga – as exemplars of the variability in the dispersion-persistence relationship across leagues. Section 7 provides a short summary and conclusions. The usual disclaimer applies.

2. Competitive Balance as a Multi-Dimensional Concept

It has long been recognised in sports economics that competitive balance is a multi-dimensional concept and that inevitably this will lead to a proliferation of empirical measures. For example, Daly and Moore (1981) stated that ‘It is difficult to define and measure “equality of league competition” because the concept has a number of dimensions’ (p. 87). Zimbalist (2002; 2003) has echoed this perception, commenting that ‘There are almost as many ways to measure competitive balance as there are to quantify the money supply’ (2002, p. 112).

The multi-dimensionality of competitive balance as a concept coupled with the proliferation of empirical measures has led to several attempts to produce a taxonomy to categorise measures of competitive balance relative to the dimension (or combination of dimensions) that they are interpreted as representing. Two such taxonomies based on end-of-season league outcomes have been developed by Kringstad and Gerrard (2007) and Evans (2014). Kringstad and Gerrard (2007) identify three dimensions of competitive balance: (i) win dispersion (i.e. the distribution of wins across teams in a single season); (ii) performance persistence (i.e. the relationship of the win-loss records of teams across seasons); and (iii) prize concentration (e.g. the distribution of league titles between teams across seasons).

Importantly, Kringstad and Gerrard define these three dimensions of competitive balance in the context of a simple league characterised by a closed structure (i.e. no promotion and relegation), a balanced round-robin schedule of home-and-away matches with no play-offs, win-loss match outcomes with no tied matches, and a championship winner determined by the best win-loss record with all matches equally weighted. Kringstad and Gerrard argue that the simple league is a theoretical ideal which provides both a useful context for defining the basic formulations of the various competitive balance measures, and a starting point for developing variants of the basic formulations in order to take account of the complexities of real-world league structures including tied games, points systems, unbalanced schedules, promotion and relegation in merit hierarchy league structures, and play-offs to determine championship titles, promotion and relegation, and qualification to transnational tournaments.

Evans (2014) also proposes a three-way categorisation of competitive measures: (i) concentration measures defined as measures of the 'extent of the closeness between teams in a league in a season' (p. 3); (ii) dominance measures defined as measures of the 'extent to which the same teams persist in winning over a number of seasons' (p. 3); and (iii) measures combining concentration and dominance. Essentially both proposed taxonomies are similar with both recognising the same two fundamental dimensions of competitive balance, namely, win dispersion (which Evans terms "concentration") and performance persistence (which Evans terms "dominance"). Kringstad and Gerrard's third category of prize concentration is categorised by Evans as specific form of dominance (i.e. performance persistence) since effectively prize concentration is the persistence of performance at the extremes of the win distribution across several seasons. Also, both Kringstad and Gerrard (2007) and Evans (2014) recognise that there are composite measures of competitive balance that combine both win dispersion and performance persistence particularly Eckard's ANOVA-based approach (Eckard, 1998; 2001a; 2001b; 2003) and the related CBR measure proposed by Humphreys

(2002). Hence, both of these taxonomies effectively reduce to the same two-dimensional grouping of empirical measures of competitive balance. Buzzacchi *et al.* (2003) adopt a similar two-dimensional approach to measures of competitive balance, designating win dispersion as static (within-season) competitive balance, and performance persistence as dynamic (across-seasons) competitive balance. The principal conclusion from this review of the previous proposed taxonomies of competitive balance measures is summarised as Proposition 1.

Proposition 1: There are two fundamental dimensions of competitive balance in the context of end-of-season league outcomes – win dispersion and performance persistence.

The terminology used by Kringstad and Gerrard (2007) has been preferred for two reasons. First, it avoids the possible confusion created by the term "concentration" given that concentration ratios are a type of metric used to measure both win dispersion and performance persistence. Second, the term "persistence" better emphasises the dynamic, multi-season nature of this dimension of competitive balance and indeed Evans (2014) explicitly uses the word "persist" in defining "dominance".

Focusing on the win-dispersion dimension of competitive balance, a useful three-way sub-categorisation based on the types of measurement methods is possible as summarised in Proposition 2.

Proposition 2: There are three broad types of measures of the win-dispersion dimension of competitive balance – variance measures, inequality measures, and non-normality and tail outcome measures.

Variance measures treat win dispersion as the degree of dispersion of team win-loss records relative to the mean win percentage of 0.500. The most widely used variance measure of competitive balance is the ratio of standard deviations (RSD) (also referred to as relative standard deviation with the same acronym) which, as Fort (2007) and Jang *et al.* (2019) point out, although first formalised by Quirk and Fort (1992) and subsequently popularised in their *Journal of Economic Literature* survey article (Fort and Quirk, 1995), the RSD measure originated in the work of Noll (1988) and Scully (1989). As is widely recognised in statistics, variance measures are unit-dependent and so are of limited value when comparing the dispersion of variables with different units of measurement. Hence comparisons of dispersion across variables require variance measures that have been standardised such as the coefficient of variation which standardises the standard deviation by the mean to remove the unit-of-measurement effect. The RSD is a standardisation procedure specific to competitive balance in which the actual standard deviation (ASD) of team win percentages is standardised using the ideal standard deviation (ISD) defined as the standard deviation of the binomial distribution based on the number of matches played by each team and with every team having an equal win probability of 0.5 in every match.

$$(1) \ldots \qquad \mathrm{RSD} = \mathrm{ASD}/\mathrm{ISD} = \mathrm{ASD}/(0.5/\sqrt{\mathrm{G}})$$

where G is the number of matches played by each team.

RSD effectively standardises for the size of the league as measured by the length of the match schedule using the minimum standard deviation of win percentages to be expected when there is perfect ex ante competitive balance with sporting contests modelled as Bernoulli trials. Hence RSD as formulated excludes consideration of its upper bound and is usually interpreted as providing a benchmark lower bound of unity representing perfect competitive balance when ASD = ISD. However, in actuality the lower bound of RSD is zero given that ISD represents a theoretical *ex ante* standard deviation derived from the relevant binomial distribution with equal *win probabilities* while it remains possible for the ASD to take values as low as zero when there is perfect *ex post* competitive balance with all teams having equal *win percentages*.

Owen (2010) and Owen and King (2015) propose an alternative measure, ASD*, which standardises the upper bound using ASD^{ub} which represents the standard deviation of the most unequal distribution of win percentages in which the top team wins all of its matches, the second-best team wins all of its matches except the matches against the top team, and so on with every team winning only its matches against teams finishing lower in the league and losing all of its matches against teams finishing higher. The bottom team loses all its matches. Utt and Fort (2002) had previously used this extreme distribution and attributed its origins to a study by Fort and Quirk (1997) on college sports. Ruiz and Avila-Cano (2018) designate the distribution as the "cascade distribution".

$$(2) \ldots \qquad ASD^* = ASD/ASD^{ub}$$

Standardisation to improve comparability across leagues and over time has been a common feature of competitive balance measures. The most general form of standardisation has been to convert the competitive balance measures into an unit interval bounded by zero and unity as follows:

$$(3) \ldots \qquad CB_{st} = \frac{CB - CB_{min}}{CB_{max} - CB_{min}}$$

where CB_{st} is the standardised measure of competitive balance, CB is the actual (unadjusted) measure of competitive balance, CB_{min} is the minimum possible value of CB representing perfect competitive balance, and CB_{max} is the maximum possible value of CB when there is perfect competitive dominance. ASD* is one example of this form of standardisation where $ASD_{min} = 0$ and $ASD_{max} = ASD^{ub}$ as was pointed out originally by Goossens (2006) who proposed a similar standardised version of ASD which she termed the national measure of seasonal imbalance (NAMSI). Ruiz and Avila-Cano (2019) go one step further and argue that competitive balance measures should be standardised to ensure full comparability (what they term "cardinality") by not only conforming to a unit interval but should also be capable of being represented by a distance function so that the values of competitive balance measures can be compared and interpreted as well as differences between the values and proportions.

Empirical studies of competitive balance typically tend to calculate win dispersion measures on a season-by-season basis and then report average values over several seasons. An alternative approach mostly associated with the work of Eckard (1998, 2001a, 2001b, 2003) has been to aggregate team win-loss records in a league over several years and then apply an ANOVA decomposition to the total variance (VAR) to determine the proportion of the variance due to changes in the win-loss records of teams across seasons (VAR_{time}) and the proportion due to differences in the cumulative win-loss records of teams (VAR_{cum}). Eckard (2001a) defines %Time as the percentage of the total variance due to VAR_{time}. Subsequently Eckard (2003) has shown that the Competitive Balance Ratio (CBR) proposed by Humphreys (2002) is effectively just the square root of %Time.

(4) …
$$VAR = VAR_{time} + VAR_{cum}$$
$$\%Time = VAR_{time}/VAR = CBR^2$$
$$CBR = \sqrt{\%Time}$$

Eckard interprets %Time as a measure of the degree of stratification in leagues with higher %Time representing more "churning" of team win-loss records. Eckard's measure of %Time and Humphreys' CBR measure tend to be interpreted as indicators of performance persistence (with more churning implying lower performance persistence). But as Eckard (2003) has shown, both measures derive from the ANOVA decomposition of cumulative win dispersion so that effectively %Time and CBR are measuring performance persistence relative to win dispersion. Eckard in his own empirical work has been careful to avoid giving primacy to %Time as an indicator of competitive balance, always using %Time in conjunction with a range of other measures of win dispersion and performance persistence.

A second approach to measuring win dispersion has drawn more on empirical measures of inequality developed originally to measure the degree of monopolisation of market structures in industrial economics, or the degree of inequality in the distribution of income. The principal inequality measures used for competitive balance have been the Gini coefficient (Schmidt, 2001; Schmidt and Berri, 2001; Utt and Fort, 2002; Buzzacchi *et al.*, 2003), concentration ratios (Koning, 2000; Michie and Oughton, 2004; Manasis *et al.*, 2011; 2013), the Herfindahl-Hirschmann index (HHI) (Depken, 1999; Owen *et al.*, 2007; Lenten, 2008; Pawlowski *et al.*, 2010), and the entropy index (Horowitz, 1997). The HHI is probably the most widely used inequality measure for competitive balance because, unlike concentration ratios, it uses the win-loss records of all teams and can be easily adjusted for leagues with tied matches and/or leagues using point systems. In addition, the HHI can be easily standardised into a unit interval with a minimum value of 1/N where N is the number of teams in the league and a maximum value determined using the cascade distribution. Indeed, the cardinal measure, Distance to Competitive Balance (DCB) proposed by Ruiz and Avila-Cano (2019) is just the square root of the standardised HHI applied to point share but using a truncated-cascade distribution to determine the theoretical maximum (see below).

A third approach to measuring win dispersion is to focus on the shape of the distribution of win percentages, either the whole distribution or the tails. Several of these measures use the normal Gaussian distribution as a benchmark. The first "non-normality" measure of competitive balance was excess tail frequency used by Quirk and Fort (1992) and Fort and Quirk (1995) to compare the actual and theoretical distributions of historical team win percentages in the North American Major Leagues (NAMLs). More recently, Jang *et al.* (2019) have applied measures of skewness and kurtosis to examine differences in win dispersion between NAMLs and EFLs, finding that NAMLs show some tendency towards negative skewness and deficient tail frequencies (i.e. platykurtic) whereas leading EFLs show some tendency towards positive skewness and excess tail frequencies (i.e. leptokurtic). Fort (2006) and Fort and Lee (2008) use the PU measure of play-off uncertainty in Major League Baseball initially defined as the average difference in the win percentage between the divisional winners and runners-up in the two constituent leagues, the AL and the NL, but subsequently revised to allow for wild-card qualification. Effectively PU is a measure of win dispersion in the upper tail.

As noted earlier, the proliferation of measures of competitive balance has been exacerbated by the complexities of real-world league structures. Standardisation of measures of win dispersion has tended to control primarily for league size in terms of the number of teams and/or the number of games. One of the main issues for comparability between NAMLs and leagues in other sports elsewhere especially the EFLs is the occurrence of tied games and the partly related issue of using points systems to determine league rankings rather than just the number of wins. The usual approach to dealing with tied matches and points systems has been to interpret tied matches as “half-wins” and convert all match outcomes into either win percentages (1,0.5,0) or points (2,1,0). In the case of RSD, Buzzacchi *et al.* (2003) and Cain and Haddock (2006) treat tied matches as half-wins in calculating ASD but ignore tied matches in calculating ISD. Cain and Haddock’s approach has been criticised by Fort (2007) while Owen (2012) shows that RSD is affected, albeit to a relatively minor degree, if calculated using the (3,1,0) points system used in football (soccer) and/or if a non-zero probability is attached to tied matches in the calculation of ISD. The main problem with the use of non-zero probabilities for tied matches is that it introduces an arbitrariness into the calculations. Ruiz and Avila-Cano (2018) criticise the procedure of converting (3,1,0) points systems to a (2,1,0) points system before calculating competitive balance measures such as the HHI. They argue that this procedure distorts league outcomes and suggest instead that the HHI should be calculated using the actual points with the formulation of the upper bound adjusted for the effects of tied games. In the case of EFLs using the (3,1,0) points system, Ruiz and Avila-Cano propose using a truncated-cascade distribution in which only the top teams are assumed to win all their matches against lower-ranked teams while lower-ranked teams are assumed to draw all their matches against each other. Further, Ruiz and Avila-Cano argue that the choice of the truncation point should be that which yields the highest theoretical value for HHI which they calculate in the context of EFLs to be the top seven teams for both 18-team and 20-team leagues.

The second dimension of competitive balance which has focused on performance persistence has led to the development of two broad types of measures as stated in Proposition 3.

Proposition 3: There are two broad types of measures of the performance-persistence dimension of competitive balance – league-outcome persistence and tail-outcome persistence.

League-outcome persistence refers to the degree to which the league outcomes of all teams in one season are replicated in the next season. By contrast, tail-outcome persistence focuses only on performance persistence at the extremes of the win distribution in a league over several seasons. The most widely used measure of league-outcome persistence is the Spearman Rank Correlation Coefficient (SRCC) to measure the correlation between league rankings of all teams in two consecutive seasons.

(5) …
$$SRCC = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)}$$

where d_i is the difference between the league ranking of team i in season t and season t-1, and n is the number of teams in the league. The SRCC measure was first used by Daly and Moore

(1981) and subsequently by, for example, Maxcy (2002), Maxcy and Mondello (2006), Kringstad and Gerrard (2007) and Andreff and Raballand (2011). Alternatively, Eckard (1998) uses the autocorrelation (AR) coefficient between team win percentages across consecutive seasons while Groot (2008) suggests using Kendall's tau. And, as previously discussed, %Time as a measure of churning proposed by Eckard (2001a) and the alternative formulation as CBR (Humphreys, 2002) can also be interpreted as measures of performance persistence over multiple seasons.

Measures of tail-outcome persistence have primarily focused on the degree of inequality in the share of championship titles and play-off qualifications over several seasons. Hence typically the same measures of inequality used in win dispersion have been applied to tail-outcome persistence, namely, the Gini coefficient (and its associated graphical representation, the Lorenz curve), concentration ratios and the HHI. So, for example, Quirk and Fort (1992) report the Lorenz curves for league championships in all the NAMLs. Gerrard (2004) uses concentration ratios and the HHI index to measure the concentration of championship titles in 16 leading EFLs. Kringstad and Gerrard (2007) use the HHI index to calculate both the concentration of championship titles in the NAMLs and the "Big 5" EFLs as well as the concentration of play-off qualification in the NAMLs.

A key dimension of tail-outcome persistence in merit hierarchy league structures such as the EFLs is the extent to which newly promoted clubs can retain their higher divisional status and avoid relegation. Kringstad and Gerrard (2007) report promotion survival rates for the Big 5 EFLs defined as 'the average number of newly promoted teams to the top division that are relegated within two seasons as a ratio of the theoretical ideal if newly promoted teams had an equal probability of relegation as incumbent teams' (p. 168).

Table 1 provides a summary of the taxonomy of competitive balance measures.

Insert Table 1

3. The Relationship between Win Dispersion and Performance Persistence in a Simple Two-Team League Model

A simple model of a utility-maximising team

Consider a professional sports team whose owners seek to maximise their utility (Sloane, 1971) with ownership utility depending on both financial performance (i.e. profit) and sporting performance (i.e. win percentage). The ownership utility function, U(.), can be stated formally as

(6) … $$U = U(P, W)$$

where P = profit; and W = win percentage in the current season. This more general formulation of ownership objectives allows for the sportsman-owner effect (Quirk and El-Hodiri, 1974) where owners are prepared to accept poorer financial performance in pursuit of sporting success. Profit maximisation is the special case in which only profit has a direct effect on ownership utility with sporting performance having only an indirect effect through its impact on profit. Profit is defined as the difference between revenue (R) and costs (C).

(7) … $$P = R - C$$

We shall assume that revenue depends on the win percentage in both the current and previous season. The rationale for including both current and lagged effects reflects that several key revenue streams are partially determined by decisions made prior to the start of the current season based on expectations of the team's sporting performance influenced by its sporting performance in the previous season. For example, season ticket sales usually commence during the latter stages of the previous season, TV match schedules for the initial stages of the season are determined in advance, and many commercial sponsorship arrangements involve multi-year contracts. But, most importantly, in leagues organised as merit hierarchies, the win percentage in the previous season determines the sporting and financial level at which the team will compete in the current season. This is of critical importance in EFLs with promotion and relegation in the domestic leagues as well as qualification for the lucrative pan-European UEFA tournaments especially the UEFA Champions League. The revenue function is stated formally as:

(8) … $R = R(W, H)$

where H = historical (i.e. previous season) win percentage. The impact of the historical win percentage on current revenue is one of the mechanisms that creates performance persistence linking win dispersion across seasons.

A simple cost function is assumed, reflecting that the cost of playing talent (Q) is the dominant cost in a professional sports team.

(9) … $C = C(Q)$

The sporting production function represents the relationship between the sporting performance output (i.e. the win percentage in the current season) and the principal sporting production input, namely, playing talent. Just as in the revenue function, the sporting production function is assumed to be temporally dependent with sporting efficiency (i.e. sporting performance per unit of playing talent) positively related to the team's win percentage in the previous season. One rationale for this lagged effect is the accumulation of team-specific human capital as players and coaches acquire knowledge of how to work together more effectively coupled with the tendency for greater stability in team composition in successful teams (Gerrard and Lockett, 2018). This provides a second mechanism for performance persistence across seasons. The sporting production function can be formally stated as

(10) … $W = W(Q, H)$

Since the purpose of the model is to investigate the relationship between current and historic win percentages, it will be useful to restate the sporting production function in its inverse form

(10a) … $Q = Q(W, H)$

Substituting equations (7) – (9) and (10a) into equation (6) yields the extended ownership utility function

(11) … $U = U((R(W, H) – C(Q(W, H)), W)$

The 1st-order condition for maximising ownership utility is as follows

(12) … $U_R(R_W + R_H) – U_C C_Q(Q_W + Q_H) + U_W = 0$

where U_R represents the 1st-order derivative of ownership utility (U) with respect to revenue (R), R_W represents the 1st–order derivative of revenue (R) with respect to the current win percentage (W), and so on. If utility is measured in financial units such that $U_R = U_C = 1$, then equation (12) can be simplified and rearranged to yield

(13) … $R_W + R_H – C_Q Q_H + U_W = C_Q Q_W$

or

(13a) … $R_W + U_W + U_H = C_Q Q_W$

where $U_H = R_H – C_Q Q_H$. Equation (13a) is the usual optimisation condition that marginal utility equals marginal cost. Marginal utility consists of three components: (i) the profit effect i.e. the marginal revenue derived from winning in the current season (R_W); (ii) the “glory” effect i.e. the marginal utility derived directly from winning in the current season (U_W); and (iii) the persistence effect i.e. the marginal impact on current revenue and costs of sporting performance in the previous season (U_H). Marginal cost depends on: (i) the marginal cost of playing talent (C_Q); and (ii) the marginal (inverted) win contribution of playing talent (Q_W). Equation (13a) implies that the degree to which utility-maximising teams differ in their behaviour from static profit-maximising teams depends on the strength of the glory effect and the persistence effect. This result is summarised in Proposition 4.

Proposition 4: Utility-maximising team ownerships are more likely to deviate from static profit-maximising behaviour the greater the non-financial value of sporting performance (i.e. the glory effect) and the greater the persistence effects of past sporting performance.

A simple model of a two-team league

Suppose that there is a two-team league in which the teams differ significantly in their market size. Let team B be the big-market team and team S be the small-market team. The league equilibrium outcome can be stated as

$$(14) \ldots \qquad R_W^B + U_W^B + U_H^B = R_W^S + U_W^S + U_H^S = C_Q Q_W$$

Equation (14) states that the two-team league is in equilibrium when the marginal utility of both teams equal the league marginal cost.

The initial league equilibrium outcome is shown in Figure 1 using a simple linear graphical representation of the two-team league outcome similar to that of employed by Quirk and Fort (1992), Kesenne (1996), Downward and Dawson (2000) and others, but with marginal revenue replaced by marginal utility to allow for the more generalised ownership objective function encompassing profit maximisation as a special case. The intersection of the marginal utility lines of both teams determines the league equilibrium outcome (E). The big-market team wins the league with the higher win percentage ($W_B > W_S$). The league equilibrium also determines the marginal cost ($C_Q Q_W$).

Insert Figure 1

The simple linear model of a two-team league can be summarised algebraically by three equations:

(i) the marginal utility of the big-market team

(15) … $$MU_B = a_B + b_B W_B$$

(ii) the marginal utility of the small-market team

(16) … $$MU_S = a_S + b_S W_S$$

and (iii) the league outcome

(17) … $$W_B + W_S = 1$$

The intercept term in the marginal utility equations captures the persistence effect while the slope term represents the profit and glory effects. Combining equations (15) – (17) and rearranging yields

(18) … $$W_B = \frac{(a_B - a_S) - b_S}{-(b_B + b_S)}$$

Equation (18) implies that the big-market team's win percentage (W_B) is positively related to the size of the differential between the persistence effects of the two teams ($a_B - a_S$). This is shown in Figure 2 where an upward shift in the big-market team's marginal utility line caused by an increase in its own persistence effect (e.g. due to an increased TV rights deal for the UEFA Champions League) leads to a higher win percentage (W_B^*). In this particular case where the increased persistence impacts on the big-market team, there is a positive dispersion-persistence relationship. The general result is summarised in Proposition 5.

Proposition 5: An increase in the size of the persistence effects for bigger-market teams relative to those for smaller-market teams leads to a positive dispersion-persistence relationship in the league.

Note also that the new league equilibrium (E^*) is associated with higher league marginal cost ($C_Q Q_W^* > C_Q Q_W$).

Insert Figure 2

4. Data and Methods

The dataset comprises the top-tier divisions of the 18 best attended domestic football leagues in Europe, with league size determined by average attendance in the 2016/17 (2017) season (www.european-football-statistics.co.uk). These 18 EFLs are divided into three groups based on average gate attendance: the Big Five (average gate attendance above 20,000) – England, France, Germany, Italy, Spain; Medium-Sized EFLs (average gate attendance between 10,000 and 20,000) – Belgium, Netherlands, Portugal, Russia, Scotland, Turkey; and Smaller EFLs (average gate attendance between 5,000 and 10,000) – Austria, Denmark, Israel, Norway, Poland, Sweden, Switzerland. The dataset covers the ten seasons ending between 2008 and 2017 (source: www.rsssf.com).

Seven measures of competitive balance are reported: two variance measures of win dispersion (RSD, ASD*), one inequality measure of win dispersion (DCB), one league-outcome persistence measure (SRCC), two cross-season measures of churning (i.e. performance persistence) (%Time, CBR), and one measure of tail-outcome persistence (Championship HHI). The win dispersion variance measures are all calculated based on regular-season match outcomes only with tied matches treated as half-wins and match outcomes measured as win percentages (1,0.5,0). For the two most common league structures in the EFLs, 20 teams with 38 rounds and 18 teams with 34 rounds, the ISD (= 0.5/√Rounds) is 0.0811 and 0.0857, respectively, while the ASD^{ub} (using the full cascade distribution) is 0.3114 and 0.3140, respectively. The two cross-season measures of churning (%Time, CBR) and the league-outcome persistence measure (SRCC) have been adapted to take account of the merit hierarchy league structure in EFLs with promotion and relegation. In the case of %Time and CBR, for those teams that have not had continued membership of the league over the whole sample period due to promotion and relegation, their win percentage is only included for the seasons in which they participated in the league and their mean win percentage is only calculated for these seasons. In the case of SRCC, the teams competing in the league in current season are ranked by league position and the correlation calculated with their rankings in the previous season. Promoted teams are positioned at the bottom of the league (i.e. replacing the relegated teams) and ordered by their finishing position in the lower league. So, for example, in the case of the 20-team English Premier League with three teams promoted and relegated, in season 2016/17, the three newly promoted teams were Burnley, Hull City and Middlesbrough (who replaced Aston Villa, Newcastle United and Norwich City). For the previous season, 2015/16, Burnley are ranked 18th (since they finished top of the Football League Championship), Middlesbrough are ranked 19th (since they finished second in the Football League Championship) and Hull City are ranked 20th (since they finished fourth in the Football League Championship and won promotion via the end-of-season playoffs).

Correlation analysis using Pearson product-moment correlation is applied to the full sample (i.e. 10 years x 18 EFLs) as well as the 10-year league summative measures for all 18 EFLs. Only the four competitive balance measures calculated on a season-to-season basis (i.e. RSD, ASD*, DCB, SRCC) can be included in the full-sample correlation matrix.

The dispersion-persistence relationship for the 18 EFLs is explored using ASD* as the representative measure of win dispersion and SRCC as the representative measure of performance persistence. Correlation coefficients are calculated for each of the 18 EFLs. Three full-sample regression models of the dispersion-persistence relationship are estimated. Model 1 assumes a homogeneous relationship across all 18 EFLs; Model 2 allows for league-specific fixed effects; Model 3 allows for league-specific persistence effects on win dispersion.

5. Results

Table 2 reports the 10-year league summative measures for the seven competitive balance measures for the 18 EFLs. The medium EFLs are the least competitively balanced group of leagues with the highest average for both win dispersion (as measured by RSD, ASD* and DCB) and performance persistence (as measured by SRCC). The medium EFLs also have the lowest churning of team performance over the 10 seasons using the two ANOVA-based measures (%Time, CBR). The Big Five EFLs have the highest average concentration of championship titles. Within the Big Five EFLs, England and Spain are the least competitively balanced in regard of win dispersion, performance persistence and churning. Although the German Bundesliga has the lowest performance persistence, it has the highest championship concentration reflecting the dominance of Bayern Munich who won seven league titles during the sample period.

Insert Table 2

Table 3 reports the correlation matrix for both the full sample and the 10-year league summative measures for all seven competitive balance measures across all 18 EFLs. As expected, there is a high correlation between the two measures of RSD and ASD* since both are standardised measures of the standard deviation of win percentages. The RSD and ASD* are also highly correlated with the DCB measure and the two ANOVA-based measures of churning but more so RSD than ASD*, reflecting the effects of using the polar opposites of perfect competitive balance (i.e. equal win probabilities) and perfect competitive dominance (i.e. the full cascade distribution) for standardisation of win percentage standard deviations. The two ANOVA-based measures of churning are almost perfectly correlated given their definitional equivalence. Performance persistence (SRCC) is highly correlated with both win dispersion and churning, although slightly less so with the latter. Championship concentration has low to medium correlations with the other measures of competitive balance.

Insert Table 3

Table 4 reports the correlation between win dispersion (measured by RSD, ASD* and DCB) and performance persistence (measured by SRCC) for all 18 EFLs. There is on average a small positive correlation between win dispersion and performance persistence across all the EFLs. It should be noted that RSD and ASD* measures of win dispersion produce identical results for 11 out of 18 EFLs. The key result is the variability in the direction and size of the dispersion-persistence relationships. The correlation analysis indicates that most EFLs are characterised by a weak-to-medium positive dispersion-persistence relationship ($0.1 < r < 0.5$) with the Spanish La Liga and Poland having a strong positive dispersion-persistence relationship ($r > 0.5$). However three EFLs, the English Premier League, Belgium and Netherlands consistently exhibit a strong-to-medium negative dispersion-persistence relationship ($r < -0.4$).

Insert Table 4

Table 5 provides the results of the regression analysis for the full-sample dispersion-persistence relationship across all 18 EFLs using ASD* and SRCC as the representative measures. Model 1 (full homogeneity) yields a significant positive relationship. Model 2 (league-specific fixed effects) also yields a significant positive relationship but the size of the SRCC effect is nearly halved with reduced significance. Model 3 (league-specific fixed and persistence effects) provides similar results to the correlation analysis in Table 4 with most EFLs exhibiting positive persistence effects on dispersion. Again England, Belgium and Netherlands show a negative persistence effect with the English Premier League having by far the largest persistence effect in absolute terms (although the high degree of variability means that the estimated coefficient is only significant at the 10% level).

Insert Table 5

6. Discussion

The objective of this paper is to consider the difficulties created for designing league regulatory mechanisms given the proliferation of empirical measures of competitive balance. The link from theory to practice seems to rely on the tacit assumption that the empirical measures of competitive are closely associated and tend to move together in the same direction. The empirical analysis shows that this is not the case for the 18 leading EFLs over the 10-year period, 2008 – 2017. Rather it has been found that these empirical measures can be usefully classified in terms of the two fundamental dimensions of competitive balance - win dispersion and performance persistence. Win dispersion measures tend to be highly correlated with each other as do persistence performance measures. A simple theoretical model of league outcomes suggests a strong positive relationship between these two dimensions whenever the persistent effects for the bigger-market teams are larger than those for the smaller-market teams. If this is the case empirically, then this would justify the tacit assumption that policies designed to reduce win dispersion would also reduce performance persistence, and vice versa. However, crucially, the empirical analysis contradicts the tacit assumption and shows that the dispersion-persistence relationship is highly variable in size and direction across the 18 EFLs. This is exemplified by the three commercially largest EFLs with the Spanish La Liga having a strong positive dispersion-persistence relationship, the German Bundesliga having little or no relationship, and the English Premier League having a strong negative dispersion-persistence relationship. This is particularly anomalous since the biggest clubs in these three leagues are regular contenders in the group and knock-out stages of the UEFA Champions League which represents a very large significant persistence effect. Understanding the possible reasons for the differences in the dispersion-persistence relationship between these three leagues can help direct future research both in the other EFLs as well as professional sports leagues in general.

Spanish La Liga

The Spanish La Liga is one of the least competitively balanced EFLs and has a strong positive dispersion-persistence relationship. Neither of these features is surprising given the domination of Barcelona and Real Madrid, two of the biggest football clubs in world football, who together won the Spanish title nine times during the sample period. They have also regularly reached the final stages of the UEFA Champions League, with each club winning the trophy three times between 2008 and 2017. In the final season in the sample period, 2016/17, Barcelona and Real Madrid jointly accounted for close to half of the total revenues in the Spanish La Liga. Deloitte (2018a, 2018b) report that the Spanish La Liga as a whole grossed revenues of €2,854m in 2016/17 with Real Madrid having revenues of €674.6m and Barcelona slightly lower at €648.3m which together represents 46.6% of league revenues that year. The financial domination of Barcelona and Real Madrid is reinforced by La Liga's hybrid TV rights distribution mechanism over most of the sample period in which the largest teams sell their rights individually while the smaller teams have a collective deal (Solberg, 2017; Stenheim *et al*., 2020). As a consequence, UEFA ranks Spain as having one of the least equal TV distribution mechanisms (UEFA, 2018).

German Bundesliga

Historically the German Bundesliga has been one of the most competitively balanced EFLs (see, for example, Kringstad and Gerrard, 2007). Despite the dominance of Bayern Munich in the sample period, the German Bundesliga has had the second lowest average for win dispersion in the Big Five (with only the French Ligue 1 being lower), the lowest average performance persistence and the second highest level of churning (again bettered only by the French Ligue 1). One possible factor in maintaining competitive balance in the German

Bundesliga has been the financial regulatory regime dating back to the 1960s with a requirement for clubs to submit their financial budgets for approval by the league authorities to be granted a club license to compete in the Bundesliga (Frick and Prinz, 2006; Szymanski and Weimar, 2019). In addition, ownership of German football clubs by commercial investors has been limited by the so-called "50+1" rule which requires that the fans retain the majority ownership. To the extent that the financial regulatory regime and the ownership restrictions may have limited the size of both the glory effect and the persistence effect in the Bundesliga, then the simple league model would predict more (static) profit-maximising behaviour (Proposition 4) and a weak dispersion-persistence relationship (Proposition 5). However, Budzinski and Kunz-Kaltenhäuser (2020) find that the "50+1" rule may have a negative effect on competitive balance. As regards TV revenues, there is collective selling with distribution based on equal shares and league performance in the current and the previous three seasons (Solberg, 2017).

English Premier League

The English Premier League has, along with the Spanish La Liga, been one of the least competitively balanced EFLs with high win dispersion, high performance persistence and low churning. However, unlike the Spanish La Liga, the English Premier League has had a strong negative dispersion-persistence relationship between 2008 and 2017. The simple league model would suggest that the differential between the persistence effects of big-market and small-market teams has not only closed but has actually been reversed with persistence effects now stronger for the small-market teams. This reversal can be explained by a combination of the financial size of the English Premier League, driven by the growth in value of its media rights, and the distribution mechanism for these media revenues. The English Premier League is in financial terms the largest domestic football league in the world with total league revenues of €5,297m in 2016/17 which was 85.6% greater than the Spanish La Liga, the next largest domestic football league financially (Deloitte, 2018a). The principal reason for the financial success of the English Premier League is the value of its media revenues which comprised 60.8% of league revenues in 2016/17 (Deloitte, 2018a).

The distribution mechanism for centrally-sold media rights for English Premier League games is heavily weighted towards equal shares with 50% of the domestic media rights and all the overseas media rights allocated on an equal-shares basis. This has ensured a more equal revenue distribution overall in the English Premier League compared to other EFLs (UEFA, 2018). As a consequence of the size of the league overall and the more equal distribution mechanism, there were 10 English Premier League clubs ranked in the top 20 clubs globally in revenue terms in 2016/17 compared to only three Spanish clubs (Deloitte, 2018b). In addition, the largest five English Premier League clubs accounted for 48.0% of league revenues in 2016/17 whereas Real Madrid and Barcelona alone accounted for 46.4% of La Liga revenues that season (Deloitte, 2018a; 2018b).

For the smaller English Premier League clubs, the continued growth in league revenues relative to those for the second-tier Football League Championship combined with the equal-shares distribution mechanism for league media revenues has created a massive persistence effect for those teams by increasing their financial advantage over the newly-promoted teams and thereby increasing the likelihood of avoiding relegation and retain their Premier League status. The gap between the revenues of the middle-range clubs in the English Premier League (defined as those clubs avoiding relegation but not qualifying for the UEFA Champions League in 2007/08 and not qualifying for UEFA tournaments in 2016/17) and Championship clubs (excluding those newly relegated and receiving parachute payments) has risen from a ratio of 6.45 in 2007/08 to 9.15 in 2016/17 (own calculations based on club revenues as reported by Deloitte, 2010; 2018a).

So, although the English Premier League continues to be the least competitively balanced of the Big Five in terms of win dispersion and performance persistence, there has been a clear tendency for win dispersion and performance persistence to move in opposite directions with any adverse movement in one dimension of competitive balance being offset partially by a more favourable change in the other dimension. More research is required to determine whether this strong negative dispersion-persistence relationship in English Premier League may partly explain the paradox of why a league with low competitive balance as measured by win dispersion and performance persistence is so commercially successful and retains global interest in seeming defiance of the uncertainty-of-outcome hypothesis.

7. Summary and Conclusions

The focus of this study has been to attempt to resolve some of the problems in designing league regulatory mechanisms that arise from the multi-dimensionality of competitive balance and the proliferation of empirical measures. The approach adopted has been to suggest that ultimately the different measures of competitive balance can be simplified using a two-dimensional categorisation of win-dispersion measures and performance-persistence measures (Proposition 1) with further sub-groupings based on the types of measurement methods used (Propositions 2, 3). The results of the correlation analysis for the 18 EFLs for the period 2008 – 2017 validate this two-dimensional categorisation with very high correlations between the three season-based measures of win dispersion (RSD, ASD*, DCB) but much lower correlations between these win dispersion measures and the performance persistence measure (SRCC).

Having empirically validated the usefulness of the two-dimensional approach, the next step was to investigate the dispersion-persistence relationship. The simple theoretical model suggested a positive dispersion-persistence relationship with the strength of the positive relationship depending on the size of the persistence effects for bigger-market teams relative to those for the smaller-market teams (Proposition 5). The key new finding to emerge from the empirical analysis is the existence of marked differences in the dispersion-persistence relationship across the EFLs exemplified by the three largest EFLs with the Spanish La Liga showing a strong positive relationship, the English Premier League showing a strong negative relationship, and the German Bundesliga exhibiting no relationship at all.

The key policy implication for leagues is the importance of understanding the direction and impact of dispersion and persistence effects on the demand for league products. Professional sports leagues need to be clear on the type of competitive balance that they are seeking to promote. The variability in the strength and direction of the dispersion-persistence relationship across leagues means that leagues cannot rely on the "one-size-fits-all" approach in designing league regulatory mechanisms. Win dispersion and performance persistence are not necessarily strongly related and may not always move in the same direction. Hence although revenue distribution mechanisms that increase persistence effects are likely to impact adversely on win dispersion, in some leagues they may improve win dispersion particularly if the revenue distribution mechanisms are progressive in reducing the differential between the bigger-market and smaller-market teams. Future research should be directed at investigating the sources of persistence effects in the EFLs and other professional team sports leagues, particularly the role of TV revenue distribution mechanisms in influencing competitive balance, and understanding why these persistence effects vary in their impact on win dispersion.

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Win Dispersion			Performance Persistence	
Variance	**Inequality**	**Non-Normality & Tail Outcomes**	**League-Outcome Persistence**	**Tail-Outcome Persistence**
RSD (Quirk & Fort, 1992) **ASD*** (Owen, 2010) **ANOVA Decomposition** (Eckard, 1998)	**Gini Coefficient** (Schmidt, 2001) **Concentration Ratios** (Michie & Oughton, 2004) **HHI** (Depken, 1999) **DCB** (Ruiz & Avila-Cano, 2019) **Entropy Index** (Horowitz, 1997)	**Excess Tail Frequency** (Quirk & Fort, 1992) **Skewness & Kurtosis** (Jang et al, 2019) **PU** (Fort, 2006)	**SRCC** (Daly & Moore, 1981) **AR Coefficient** (Eckard, 1998) **Kendall's Tau** (Groot, 2008) **%Time** (Eckard, 2001a)	**Championship Title Concentration** (Quirk & Fort, 1992) **Playoff Qualification Concentration** (Kringstad & Gerrard, 2007) **Promotion Survival Rates** (Kringstad & Gerrard, 2007)

Note: due to space constraints, only one reference is included per measure; a fuller set of references for each measure is include in the main text.

Table 1: A Taxonomy of Competitive Balance Measures

692x182mm (57 x 57 DPI)

League	RSD	ASD*	%Time	CBR	DCB	SRCC	ChampHHI
England	1.871	0.487	24.75	0.497	0.459	0.749	0.300
France	1.576	0.411	41.46	0.644	0.386	0.555	0.220
Germany	1.632	0.446	39.07	0.625	0.422	0.471	0.540
Italy	1.749	0.456	33.59	0.580	0.432	0.659	0.460
Spain	1.845	0.480	21.78	0.467	0.459	0.680	0.460
Big Five Average	**1.735**	**0.456**	**32.13**	**0.563**	**0.431**	**0.623**	**0.396**
Belgium	1.641	0.468	35.13	0.593	0.440	0.658	0.320
Netherlands	1.866	0.510	27.35	0.523	0.476	0.747	0.280
Portugal	1.912	0.541	22.94	0.479	0.522	0.590	0.500
Russia	1.616	0.465	34.06	0.584	0.440	0.641	0.300
Scotland	1.869	0.496	29.22	0.541	0.490	0.576	0.580
Turkey	1.645	0.450	40.05	0.633	0.423	0.572	0.300
Medium EFLs Average	**1.758**	**0.488**	**31.46**	**0.559**	**0.465**	**0.631**	**0.380**
Austria	1.682	0.417	29.44	0.543	0.397	0.562	0.520
Denmark	1.569	0.422	42.32	0.651	0.413	0.537	0.420
Israel	1.541	0.450	56.36	0.751	0.457	0.516	0.200
Norway	1.422	0.411	50.99	0.714	0.384	0.457	0.360
Poland	1.272	0.366	45.05	0.671	0.350	0.407	0.300
Sweden	1.575	0.453	43.03	0.656	0.423	0.601	0.300
Switzerland	1.747	0.434	31.66	0.563	0.411	0.484	0.820
Smaller EFLs Average	**1.544**	**0.422**	**42.69**	**0.650**	**0.405**	**0.509**	**0.417**
EFL Average	**1.668**	**0.454**	**36.01**	**0.595**	**0.432**	**0.581**	**0.399**

Note: RSD, ASD*, DCB and SRCC calculated as annual averages; %Time, CBR and ChampHHI calculated for 10-year period.

Table 2: Competitive Balance in EFLs, 10-Year Summative Measures, 2008 - 2017

454x351mm (57 x 57 DPI)

(i) Full Sample (n = 180)

	RSD	ASD*	DCB	SRCC
RSD	1.000			
ASD*	0.941***	1.000		
DCB	0.879***	0.932***	1.000	
SRCC	0.344***	0.335***	0.277***	1.000

Two-tailed t test: * = significant at 10% level; ** = significant at 5% level; *** = significant at 1% level

(ii) League 10-Year Summative Measures (n = 18)

	RSD	ASD*	%Time	CBR	DCB	SRCC	Champ HHI
RSD	1.000						
ASD*	0.864***	1.000					
%Time	-0.847***	-0.652***	1.000				
CBR	-0.857***	-0.672***	0.997***	1.000			
DCB	0.825***	0.972***	-0.565**	-0.592***	1.000		
SRCC	0.707***	0.698***	-0.646***	-0.650***	0.601***	1.000	
ChampHHI	0.382	0.101	-0.430*	-0.417*	0.112	-0.233	1.000

Two-tailed t test: * = significant at 10% level; ** = significant at 5% level; *** = significant at 1% level

Table 3: Correlation between Competitive Balance Measures in EFLs, 2008 – 2017

442x310mm (57 x 57 DPI)

League	Within-League Correlation between Performance Persistence (SRCC) and Alternative Measures of Win Dispersion		
	RSD	**ASD***	**DCB**
England	-0.514	-0.514	-0.468
France	0.366	0.366	0.327
Germany	0.096	0.096	0.194
Italy	0.176	0.176	0.118
Spain	0.517	0.517	0.526
Big Five Average	**0.128**	**0.128**	**0.139**
Belgium	-0.602*	-0.726**	-0.721**
Netherlands	-0.420	-0.420	-0.400
Portugal	0.346	0.383	0.419
Russia	0.293	0.293	0.066
Scotland	0.147	0.147	0.157
Turkey	0.459	0.463	0.378
Medium EFLs Average	**0.037**	**0.023**	**-0.017**
Austria	0.266	0.266	0.243
Denmark	0.253	0.269	0.265
Israel	0.404	0.483	0.141
Norway	0.112	0.098	0.018
Poland	0.656**	0.656**	0.608*
Sweden	-0.021	-0.021	0.042
Switzerland	0.057	0.058	0.069
Smaller EFLs Average	**0.247**	**0.259**	**0.198**
EFL Average	**0.144**	**0.144**	**0.110**

Two-tailed t test: * = significant at 10% level; ** = significant at 5% level; *** = significant at 1% level

Table 4: Within-League Correlation between Win Dispersion and Performance Persistence in EFLs, 2008 - 2017

404x389mm (57 x 57 DPI)

Dependent Variable: ASD*	Model 1		Model 2		Model 3	
	Fixed Effect	SRCC Effect	Fixed Effect	SRCC Effect	Fixed Effect	SRCC Effect
All	0.382***	0.123***		0.064**		
Austria			0.381***		0.330***	0.154
Belgium			0.426***		0.580***	-0.170
Denmark			0.388***		0.366***	0.104
England			0.440***		0.871***	-0.512*
France			0.375***		0.318***	0.167
Germany			0.416***		0.438***	0.016
Israel			0.417***		0.330***	0.231*
Italy			0.414***		0.410***	0.069
Netherlands			0.462***		0.707***	-0.264
Norway			0.382***		0.399***	0.026
Poland			0.340***		0.252***	0.280***
Portugal			0.503***		0.482***	0.100
Russia			0.424***		0.427***	0.058
Scotland			0.460***		0.469***	0.048
Spain			0.437***		0.323***	0.232
Sweden			0.415***		0.457***	-0.007
Switzerland			0.403***		0.429***	0.010
Turkey			0.414***		0.341***	0.191
s	0.065		0.058		0.056	
R^2	0.112		0.367		0.457	
F	22.47***		5.187***		3.456***	
n	180		180		180	

s = standard error of regression; R^2 = coefficient of determination; F = one-tailed test of overall significance of regression; n = sample size; * = significant at 10% level; ** = significant at 5% level; *** = significant at 1% level

Table 5: Regression Analysis, Dispersion-Performance Relationship in EFLs, 2008 – 2017

389x378mm (57 x 57 DPI)

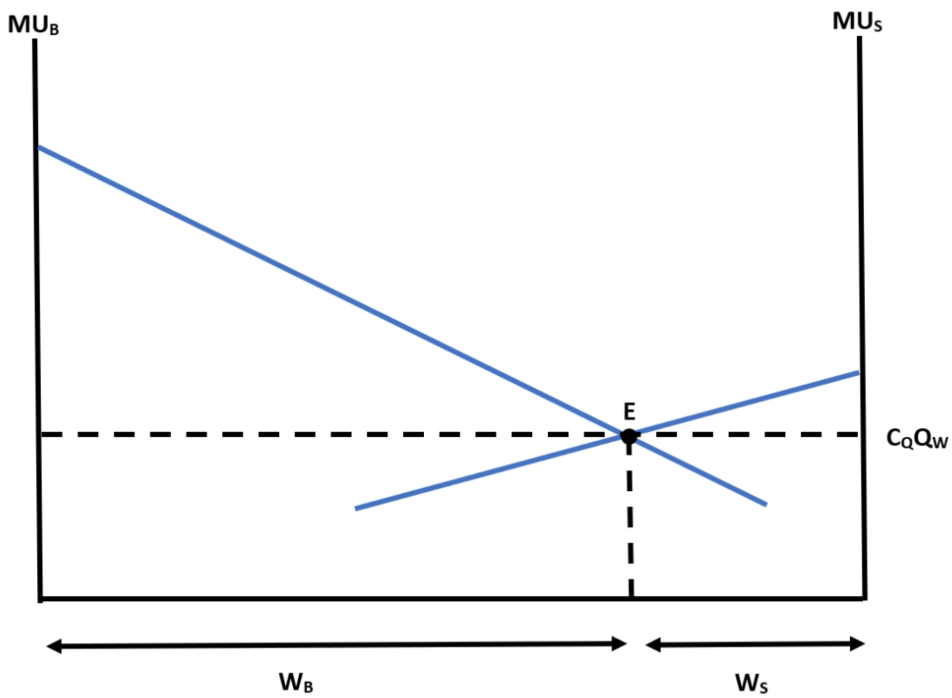

Figure 1: Equilibrium in a Two-Team League

307x225mm (96 x 96 DPI)

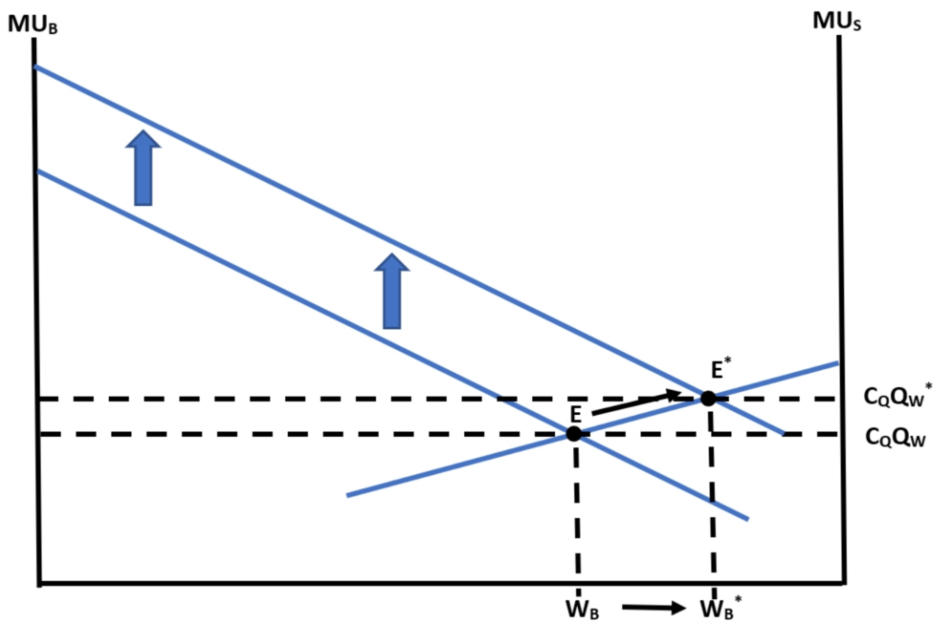

Figure 2: Impact on League Equilibrium of Increased Performance Persistence for Big-Market Team

314x218mm (96 x 96 DPI)

SBM-04-2021-0054 R1

The Multi-Dimensionality of Competitive Balance: Evidence from European Football

Responses to Reviewers

We are grateful to all three reviewers for their continued support and very helpful suggestions on how to further improve our paper. We have summarised our response to their comments below.

Responses to Reviewer 1

No.	Comment	Response
1	The authors have satisfactorily responded to the issues raised on the original text.	• Thank you for your appreciation of the revisions undertaken in response to the initial reviews
2	p. 27, lines 49-54. Season 2007/08 should be placed ahead of 2016/17.	• Done
3	P. 27, lines 56-57. The words "has increased" must be deleted.	• Done
4	P. 41, Table 5: The number of cases (N) as well as the 10% significant level should be included. Also, what "s" stand for?	• Number of cases included in Table 5 • 10% significance level added to Tables 3-5 • Definition of "s" added to Table 5

Responses to Reviewer 2

No.	Comment	Response
1	Well done. The revision has added more in terms of practical implications.	• Thank you for your appreciation of the revisions undertaken in response to the initial reviews. We are particularly pleased that you consider the revisions to have improved the practical implications of our paper.

Responses to Reviewer 3

No.	Comment	Response
1	Although the authors note the persistence-dispersion relationship implied by Proposition 5, it's still not clear what this really means for the	• We are disappointed that you still consider our paper to lack clarity although we are pleased that you

	reader. What does it mean for the persistence effect difference to increase in size? And how does this determine the relationship between persistence and dispersion? Most importantly: what does this mean to the lay reader?	recognise that it is “better than before” are regards the quality of communication. Much of the substantive revisions to our original paper were initiated by your concerns particularly as regards the exposition of our methodology (see pp. 19, 28, 29).
2	Further, the persistence intercept seems like it could simply be conflated with market size in general. The authors should spend a bit of time discussing how this is likely driven by market size (and relative market size) in a league. It is not clear that the intercept is any different than the standard league model that shifts out a demand (or utility) curve based on market size. How is this, specifically, persistence?	• We recognise that as in the standard league model which we have adapted, the intercept includes both current and lagged (i.e. persistence) size effects. Our focus is the dispersion-persistence relationship hence our emphasis on the persistence component of the intercept.
3	Again, the practical meaning of correlation between cross-season balance and within-season balance is not well communicated.	• Again we are disappointed that you feel that we have not fully clarified the practical significance of the dispersion persistence relationship (see p. 29).
4	The short 10-year period over which this study is done provides little insight into real long-term persistence and the relationship between the two. The fact that correlation directions are mixed seems just as easily a spurious result due to the small number of years. If this portion of the analysis is contaminated by a single team that rises among the ranks over this short period, for whatever reason. Indeed, this was the case in EPL with Leicester City during the short sample used here. Not surprisingly, EPL turns up a negative correlation. With the data here, there is not strong evidence that this would necessarily be the case over the long-term (and almost certainly has not during the long-term running of EPL.	• 10-year sample periods are very common in the competitive balance research. We are conscious of the small sample size for each individual EFL which is why we stress that our results are indicative only. • Leicester City only feature in three seasons in the sample period and so constitute only 1.5% of the observations for the English Premier League. The variability of their performance in these three season (league winners sandwiched between two mid-table finishes) does reduce the degree of persistence in the last two seasons but the impact on dispersion goes in opposite directions in these seasons so that overall Leicester City has very little influence on the reported results.
5	I am not sure the fixed effects regression provides significant insight into the relationship. As it is, it’s mostly just another way to do correlation. The fixed effects help to some extent I guess, but it doesn’t solve the other issues noted above. It doesn’t hurt, but I’m not sure it provides much stronger support for the claims	• We introduced the fixed-effects regressions in response to the comment in your initial review to use structural testing rather than relying only on correlation analysis. The fixed-effects models ensure that the estimates of the

	here (that there is extreme heterogeneity in the relationship).	persistence effects on win dispersion are not influenced by other underlying differences in win dispersion across the 18 EFLs.