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The competitive balance of UEFA and CONMEBOL football leagues: On managing the number of teams in league design

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Abstract

This article augments the literature on the analysis of competitive balance, encompassing its measurement, comparisons across leagues and seasons, and ramifications for league management. Central to our examination is the notion of competitive balance, which is intimately tied to the concentration concept. This concept can be depicted as a dual metric—capturing both inequality and the number of competing teams. Historically, its magnitude has been gauged using standardised measures of inequality and concentration. Among these, the Herfindahl–Hirschman index and its subsequent refinements stand out. We employ the distance-to-competitive-balance index, which, contingent upon the metric space chosen, qualifies either as an inequality or concentration measure. Our analysis spans the 2009/2010 to 2018/2019 seasons for both the Union of European Football Associations (UEFA) and South American Football Confederation (CONMEBOL) championships in the pre-COVID-19 era. We discern a tangible and significant correlation between the competitive equilibrium of leagues and the performance metrics of national teams. Both the disparities in strengths of teams and the number of participating teams emerged as paramount variables shaping this competitive balance. Further, we delineate the elasticities of competitive balance relative to these determinants. Our insights bear implications for designing football championship structures and delineating sports policies; thus, they are valuable for relevant sports governing bodies and federations. The strategic decision to enlarge team count vis-à-vis curtailing discrepancies in team competencies is nuanced, varying across federations and confederations. The Big Five European leagues display heightened sensitivity to inequality factors (with interventions such as financial fair play, salary caps or revenue distribution yielding pronounced effects), whereas for CONMEBOL, elasticity in relation to team count holds greater significance.

1 | INTRODUCTION

Rottenberg (1956), which is considered the starting point of the economic analysis of sports (García, 2019), includes the concept of competitive balance linked to the '*balance of playing strength among teams*' (p. 247). Conceptually, it is assumed that major differences in the strengths of participants in a competition lead to a low level of competitive balance (Zimbalist, 2002). In turn, having many participants in a competition will reduce the possibility of concentrating on strengths and enhance competitive balance.

Indeed, these strengths can be seen from the perspective of the teams' potential and can be associated with their characteristics or with what supporters and bettors expect from them. The strengths can also be associated with the results achieved by the teams, that is, not only with their potential or capabilities, but also with their actual performance in competitions. In this case, the most common approach is to take the final ranking of a competition as a reference and assess how the performances of the individual teams have been distributed in their matches against each other. For this purpose, a wide range of measures and indices have been used which, in short, quantitatively identify 'how the reward has been distributed' to each team based on the success of its performance in bilateral confrontations with other participating teams, that is, based on the teams' results. Accordingly, a substantial body of literature has been devoted to 'measuring' the competitive balance of different sports in different competitions and over various periods of time.

In the current paper, we expand upon the concept of competitive balance. This concept stands as a cornerstone in the sports economics literature and is well defined (e.g., Andreff & Scelles, 2015; Carreras & Garcia, 2018; Fort & Maxcy, 2003; Kringstad & Gerrard, 2004; Owen, 2014; Weber et al., 2016). In a successful sports league, each team must strike a balance between rivalry for the outcome and the practical economic association it maintains with every competitor (Groot, 2008; Scelles et al., 2018). In this regard, a heavily unbalanced competition might negatively impact fans' interest and, consequently, the demand (Késenne, 2006; Zimbalist, 2003). As the degree of competition among rivals is pivotal for the design of sports competitions (Szymanski, 2003), competitive balance carries significant management implications in the domains of sports organisation and administration. Indeed, the nexus between sports and business has tightened, with this field swiftly evolving in recent years, tethered to globalisation, technology, and advancements in marketing (Plumley et al., 2023).

Fluctuations in the level of competitive balance of a competition can arise not only from strictly sports-related factors but also from economic and financial environments (Gasparetto et al., 2023). From a sports economics perspective, a decline in competitive balance might detrimentally affect the competition as a product, confronting it with challenges due to a decrease in its appeal to broadcasting entities and commercial partners, which could incentivise the potential emergence of alternative competitions (Ramchandani et al., 2023). However, an inherently positive relationship between competitive balance and demand, driven by the uncertainty of competition outcomes, is not universally accepted (Chung et al., 2016; Coates et al., 2014). For instance, in major European football leagues or in the Union of European Football Associations (UEFA) Champions League, deterioration in competitive balance has been noted over recent years (Avila-Cano & Triguero-Ruiz, 2023; Csató, 2023; Plumley et al., 2022; Triguero-Ruiz & Avila-Cano, 2023). Yet, the demand from followers and the business volume surrounding sponsorships, broadcasting, and player salaries and transfers have substantially increased. Certain models, under specific conditions, predict that uncertainty about outcomes might have positive effects on demand (Coates et al., 2014; Humphreys & Miceli, 2020). The meta-analysis conducted by Collins and Humphreys (2022) does not conclusively support the uncertainty of outcome hypothesis.

In this context, the analytical approach of Fort and Maxcy (2003) remains relevant. In the literature, this perspective distinguishes the analysis of competitive balance from that of the uncertainty of outcome hypothesis. If we focus on the former, we attend to the competitive balance of leagues, their evolution over time, and the impact of changes in league organisation. Such changes might include the number of participating teams (Triguero-Ruiz et al., 2023), the introduction of "financial fair play" (Dermit-Richard et al., 2019; Peeters & Szymanski, 2014), the reorganisation of the group draw system (Triguero-Ruiz & Avila-Cano, 2023) or alterations in the number of teams being relegated or promoted. In this latter case, the distinction between 'open' and 'closed' leagues becomes particularly pertinent.

There are significant differences between major North American and European sports leagues (Dietl & Duschl, 2012). Among the former, most clubs are privately owned, with their primary objective being profit maximisation. Expansion typically occurs through team acquisitions, not necessarily saturating the market, and they often experience team relocations and commonly impose salary caps. In contrast, European clubs are generally member-owned associations that aim for victory maximisation. They tend to cover the market, with rare relocations, and typically lack salary caps. Arguably, one of the primary distinctions is that North American leagues are 'closed' in terms of their organisation and ownership, while European leagues are 'open', with promotions and demotions each season. This openness also extends to ownership rights, as members can actively participate in club affairs.

The initial analyses of competitive balance were conducted on American team sports, organised around closed leagues. Subsequently, numerous studies have focused on the European model of professional team sports organised around open leagues. Comparative studies have also been undertaken (e.g., Plumley et al., 2023). Buzzacchi et al. (2003), after analysing both types of leagues, conclude that open leagues typically exhibit lower balanced compared to closed leagues. In this regard, the distribution of revenue, draft systems or salary caps render some leagues more competitive than others (Ramchandani et al., 2023). The implementation of promotion and relegation stimulates competition among clubs and leagues, while concurrently elevating financial risk for the participating clubs. In open leagues, clubs invest in talent (and wages) to maintain performance, and it is usually the larger, more established clubs that attain superior on-field results (Clarkson et al., 2023). Dietl et al. (2008) demonstrate that clubs tend to allocate higher investments when engaged in an open league as opposed to a closed one.

If, on the other hand, we concentrate on the uncertainty of outcome hypothesis, we aim to understand the effect of competitive balance on fans, particularly on their demand (Ramchandani et al., 2019). In this sense, competitive balance would aim to ensure uncertainty of outcome, yet it does not represent the same concept (Plumley et al., 2023; Scelles et al., 2022). In this context, the present paper concentrates on the approach of analysing competitive balance.

Specifically, we calculate and analyse the competitive balance levels of men's football leagues for the 2009/2010 to 2018/2019 seasons of the UEFA and the South American Football Confederation (CONMEBOL). Although the Big Five (English Premier League, Spanish La Liga, German Bundesliga, Italian Serie A and French Ligue 1) have been extensively studied, as have some of the major South American leagues (Argentinean Liga Profesional de Fútbol or Brazilian Brasileirão Serie A), neither other European leagues nor the other South American leagues, in comparison with to the former, have been studied to a similar extent. As far as we are aware, there are no important studies in this regard that would allow for a homogeneous comparison of the competitive balance of CONMEBOL national leagues in relation to that of UEFA national leagues over many seasons.

Are there significant differences between both geographical areas and within each confederation? Are the more powerful leagues, in terms of financial resources, supporters, prominent teams and more skilled players, more competitive? To this end, in the present paper, we calculate the corresponding values of the distance to competitive balance (*DCB*) index (Triguero-Ruiz & Avila-Cano, 2019) from the Herfindahl–Hirschman (*HHI*) index (Herfindahl, 1950; Hirschman, 1945) and number of teams in each league in each season. For detailed data on the measurements taken, see Appendix A.

Furthermore, the primary objective of this article is to identify the concept of competitive balance and link it with that of concentration, distinguishing it from the concept of inequality. Measurements of inequality have frequently been erroneously utilised to represent and measure competitive balance (Humphreys, 2019). To this end, we return to the concept of concentration linked to industrial economics, which is directly related to inequality and inversely related to the number of agents (Hirschman, 1945). Precisely on this point, our contribution is that the consideration or not of the dimension of the metric space in which we are measuring (in short, of the number of reference agents) will allow us to use the *DCB* index as a measure, respectively, of concentration or inequality. Finally, with the data obtained, we can see the effects of both variables (inequality of distribution and number of teams) on the competitive balance of European and South American leagues over the past decade.

These considerations may bear relevance to the design of championship, especially when sports authorities aim to ensure achievable levels of competitive balance. Might it be more effective to modify the number of teams playing in the championship, or would it be more effective to limit the differences between teams' potential?

The remainder of the current article proceeds as follows: First, we review the theoretical framework on the measurement of concentration and inequality in a league, and we present the methodology for estimating the effect on the concentration of inequality of the distribution and the number of agents. Section 3 provides the results of competitive balance measurements in the UEFA and CONMEBOL national leagues, here looking at a time span of a decade. Additionally, we present the *DCB* as an index of concentration and inequality applied to the above data. Specifically, in this section, an estimation is given to provide an explanatory model for the concentration levels (competitive balance) depending on both the levels of inequality and number of teams featured in UEFA and CONMEBOL championships during the 2009/2010 to 2018/2019 seasons. In addition, using the corresponding panel data models, this relationship is estimated separately, as well as for the five major leagues in each confederation, the latter showing clearly differentiated findings. Finally, the conclusions are presented.

2 | BACKGROUND, RELATED LITERATURE AND METHODOLOGY

In this section, we discuss the problem of using inequality measures as indices of competitive balance. Furthermore, we show that *DCB* index can be used as a measure of inequality and concentration, here depending on the dimension of the metric space in which we undertake the measurement.

Competitive balance is a multidimensional concept, and its measurement, typically carried out using a set of measures and not just a single metric, is subject to various approaches. One such approach (Ramchandani et al., 2018) distinguishes between (i) measurement within a league, even when carried out across repeated seasons, which is tied to concentration indices, and (ii) measurement over time, termed *dominance* (with contributions from Ramchandani, Plumley, Mondal and Wilson) or *persistence* (Gerrard & Kringstad, 2023). In the first case, within-season, a monopoly configuration is not feasible, as the bilateral nature of matchups ensures that no single team can monopolise all the points. In the second case, between-season, a team can indeed maintain its leadership over time. Therefore, while the identity of a team might not be crucial for concentration measures, it is vital for dominance measures (e.g., the number of different teams to win the league title; the maximum number of league titles won by a single team; the number of different teams to finish in the top three positions in the league). Evans (2014) offers various examples of relevant indices. Gerrard and Kringstad (2023) emphasise the importance of understanding the relationship between these two facets of analysis. In this paper, we undertake a within-season analysis across multiple seasons; hence, we will use measures related to result concentration.

2.1 | Measuring concentration and inequality in a league

Competitive balance has traditionally been measured using statistical measures of dispersion on the understanding that the existence of greater differences between the values of the variables studied (number of wins, scores achieved, etc.) would indicate a greater overall imbalance in the distribution. Thus, the first measures of competitive balance have shown the dispersion of winning percentages in a league if ties were not allowed or of weighted wins and ties if ties were allowed (Humphreys, 2019). Measures based on standard deviation indicating the degree of inequality between the sizes of the variable under consideration have been very frequent, though their use was soon found to be undesirable for a comparison between leagues with different numbers of teams (Owen, 2010). This led to the standardisation of deviation by relativising it to an 'idealised' deviation (Noll, 1991; Scully, 1989). The identification of the idealisation that all teams have a half chance of winning each match, meaning that match outcomes are distributed according to a binomial distribution, was also used by Van Scyoc and McGee (2016). Moreover, Gayant and Le Pape (2012) developed a standardised variance, which had already been defined as standardised dispersion by Kelly (1981). Humphreys (2002) defined the competitive balance ratio as a dynamic measure that, in any case, is also based on the concept of standard deviation. Authors such as Schmidt (2001), Schmidt and Berri (2001), Utt and Fort (2002) or Gayant and Le Pape (2015) have used the well-known Gini index or versions of it. Borooah and Mangan (2012) used entropy, whose minimum and maximum values were obtained by Horowitz (1997).

The above measures are inequality indices that provide information on the dispersion of the observations and differences regarding the mean value of the sizes of the distribution elements. These measures are not strictly measures of concentration, which would provide information on the degree to which a block of elements in the distribution accumulates in relative terms. Moreover, it should be noted that the indices used to estimate the competitive balance must consider the characteristics of sporting competitions, such as the absence of a monopoly as a possible configuration because of the bilateral nature of the matches or the effect of the number of elements given that leagues and championships have a different number of participating teams (Doria & Nalebuff, 2021; Lee et al., 2019; Owen & King, 2015; Owen & Owen, 2022).

Measures based on the Herfindahl–Hirschman Index (*HHI*) are indeed concentration indices. The difference with measures of inequality is no less significant for being apparently subtle. In fact, it is easy to see that, in the applied literature, we can find some confusion between the concepts of *concentration* and *inequality*, not only when using them in the analysis of certain phenomena (economic, social, political and, particularly, in sports economics), but also when studying these phenomena by means of statistical measures or indices. Although both concepts have a close theoretical relationship and, at the applied level, have positive correlations, they are nonetheless different.

The following example may be useful: Let us assume that there is a symmetric duopoly, that is, two firms having an equal share of a market. In this case, they will generate high concentration but no inequality (as both are equal). If a third firm appears with a 1% share that subtracts equally from the previous two, the concentration will still be very high, but now, inequality will also be very high (because there are two very large firms compared with one very small one). The mere fact that there are only a few firms in a market indicates high concentration; comparing the sizes of these firms would be another matter. Therefore, this is an important factor when measuring *competitive balance* because leagues often have different numbers of teams. If, in the above example, we consider that the markets are, in fact, league championships, we would expect the first one to have a lower competitive balance than the second because it would be as if two teams have accumulated all the points against a third team that has lost all its matches; in the second championship, however, the smaller team has at least obtained some points.

In this regard, we should recall that, since Hirschman (1945), it has been accepted to conceptualise concentration as a dependent function of two variables that characterise the size distribution of firms in a market: (i) inequality and (ii) the number of firms. The former directly affects, and the latter inversely affects, the level of concentration in the market. Therefore, given a certain level of inequality, more firms result in less concentration, and given several firms, more inequality means more concentration. The *isoconcentration curves* (Davies, 1979) allow us to distinguish the effects of both variables on the concentration index, that is, the levels of inequality that, given the number of firms, lead to the same level of concentration. Each index can be characterised in terms of the elasticity of substitution between the inequality measure and number of firms.

This characterisation of concentration measures as functions whose parameters include inequality and the number of elements of the distribution is also among the axioms proposed (or their implications) by Hall and Tideman (1967) and Encaoua and Jacquemin (1980). Ávila Cano (2019) highlighted it among the set of four formal properties that a concentration index must fulfil. Therefore, this positive dependence on a measure of inequality and negative dependence on the number of firms must be considered when considering a measure of concentration. This is key in distinguishing them from the usual measures of inequality (standard deviation, variance, coefficient of variation, variance of logarithms, entropy and Gini, among others) because the relationship between the two concepts sometimes results in them being used indiscriminately.

In this respect, an important issue is to consider the space in which the index is defined. It should be noted that if it is defined in a simplex, the edges and vertices of the simplex will show size distributions in which there are firms (teams) with zero shares because it applies to share vectors of non-negative sizes that sum to unity. This means that if two markets (leagues) with different numbers of firms (teams) are compared, the market (league) with fewer firms (teams) will be represented by a vector with as many zeros as the difference between the number of firms (teams) in both markets (leagues) (Hennessy & Lapan, 2007; Szpiro, 1987). In practice, the number of firms is set to the larger of the two distributions and the difference in the inequality is measured. If this aspect is not taken into account—that is, if the effect of the number of firms is not considered—the implementation of the inequality measure will result in a measure of *inequality* between the sizes of each distribution but would not enable a comparison between distributions with different numbers of firms for the purpose of comparing *concentration*.

In the case of competitive balance, confusion also occurs. As we see it, competitive balance is a concept related to concentration rather than inequality. Therefore, a league in which there is a small group of leaders who 'concentrate' the points awarded for their sporting results against the bulk of teams who accumulate defeats and, if applicable, draws, will suggest a highly unequal and concentrated distribution of results. However, if the number of teams increases, inequality levels may remain high, but concentration may also be reduced.

Moreover, in sports economics, the correction for the number of elements, which, in the case of the *HHI*, affects its minimum value, has been calculated by subtracting from the *HHI* the inverse of the number of teams (Depken, 1999), multiplying by it (Michie & Oughton, 2004) or dividing by it (e.g., Lenten, 2008; Pawlowski et al., 2010; Plumley et al., 2018; Ramchandani et al., 2018, 2023). In practice, Mitchie and Oughton's Herfindahl Index of Competitive Balance (*HICB*) is used to measure within-season competitive balance. It is defined as $HICB = \left(\frac{HHI}{1/n}\right)100$, which essentially standardises the lower bound to allow for comparisons between leagues with different numbers of teams. However, this transformation of the *HHI* does not account for the fact that the upper bound is also affected. Furthermore, for certain sports, it is important to note that the lower bound of the *HHI* is not necessarily the inverse of the number of teams (Triguero-Ruiz et al., 2023).

Owen et al. (2007) proposed the normalisation of the HHI so that it was correctly relativized to the maximum and minimum values it could take and was defined over a unitary interval. Plumley et al. (2023) define a standardised version of the HICB that incorporates an estimate of the upper bound: $SHICB = \left(\frac{HICB}{Max\ HICB(N)}\right)100$. Additionally, Ramchandani et al. (2019) and Plumley et al. (2022) standardise the HICB with respect to leagues with a certain number α of teams using the equation $NHICB = HICB\left(\frac{Max\ HICB(\alpha)}{Max\ HICB(N)}\right)$. The identification of the maximum is also contingent on the number of teams in the league. For this, they use the Complete Cascade Distribution as the most imbalanced distribution of points (Avila-Cano et al., 2021). In reality, this perfectly unequal distribution depends not only on the number of teams but also on the scoring system.

The correction required for not reaching the monopoly solution, identified by Gayant and Le Pape (2015), which consists of identifying the maximum value that the HHI can reach (here lower than the unit the monopoly configuration implies), had not been undertaken until the works of Avila-Cano et al. (2021). This correction is required in sports where the scoring systems do not meet the stability condition stating that the total number of points in a competition is fixed: for example, systems that award three points to the winner and zero to the loser and one point to each team in case of a tie result in the most imbalanced distribution, namely the Truncated Cascade Distribution, or those that add bonuses based on team performance (Avila-Cano et al., 2023), where the 'Truncated Double Cascade' distribution is the most imbalanced. In these systems, it is impossible to know how many points there will be before the end of the competition. This affects the maximum values that the HHI can reach for the purposes of normalisation.

In this context, Triguero-Ruiz and Avila-Cano (2019) established the *DCB* index as a measure. This index satisfies the cardinality property, which gives meaning to the comparison between competitions. We are interested in exploring these aspects in more detail. For this purpose, we will use the *DCB* index, which can be interpreted as an index of inequality and concentration, depending on the dimensional space in which it is applied.

Formally, a league configuration is a vector of the shares of the teams' size $\mathbf{s} = (s_1,...,s_n)$. Let S^{n-1} be the set of admissible configurations, here given *n*. Note that a distribution with fewer elements may be thought of as having additional elements with zero shares. A concentration index, $C(\mathbf{s})$, where $\mathbf{s} \in S^{n-1}$, would be associated with an inequality index $D(\mathbf{s})$ satisfying that $C(\mathbf{s}) = f(n, D(\mathbf{s}))$, where $\frac{\partial C(\mathbf{s})}{\partial D(\mathbf{s})} > 0$ and $\frac{\partial C(\mathbf{s})}{\partial n} < 0$. Therefore, given *n*, there must be an ordinal equivalence relation between $C(\mathbf{s})$ and $D(\mathbf{s})$: $C(\mathbf{s}) \geq C(\mathbf{z})$ if and only if $D(\mathbf{s}) \geq D(\mathbf{z})$, where **s** and **z** are the vectors of the same simplex S^{n-1}. It should be noted that the measurement is performed on a given simplex, where the vertices and edges are theoretical configurations of the market. Note also that a vertex will represent a monopoly configuration that will incorporate null sizes in the vector of quotas representing the league configuration (although we know that this configuration cannot occur because, in a bilateral competition, it is not possible for a team to gain all the points, given that it cannot take part in all the matches). Under these conditions, to compare the measurement of concentration in league configurations with different numbers of teams, given that the measurements have to be made on the same simplex, the reference simplex will be the one with the largest size, that is, the one with the highest number of teams; and, as we have already mentioned, in those competitions where there is a smaller number of teams, the difference will be completed with null sizes.

Therefore, the *DCB* index can be interpreted as a measure of concentration or inequality depending on whether we take into account the number of agents (firms, teams in a competition, etc.), the distribution (market, sports championship, etc.) with a strictly positive share (which entails filling the vector with zeros) or if the influence of the number of firms is not considered; we will refer to the *DCB* index as DCB_d when measuring inequality.

The following example will help illustrate this point. Let the league configurations be $\mathbf{s} = (0.5, 0.3, 0.2)$ and $\mathbf{z} = (0.5, 0.25, 0.2, 0.05)$. They have been designed in such a way that there is no doubt about the outcome in terms of concentration and inequality: concentration is higher in **s** because fewer teams share the total points, and the two largest teams outnumber the two largest teams in **z** in terms of the share of points. In the **z** market, however, there is a more unequal share: the second largest team in the **s** league has lost ground to the fourth team, which, in any case, plays a relatively small role.

Different concentration and inequality indices will be used to compare the forecasts. Specifically, to measure concentration, we will use the following indices: Herfindahl–Hirschman (Herfindahl, 1950; Hirschman, 1945), Hannah and Kay (1977), weighted at 0.5 and 1.5; Rosenbluth (1955), which is analogous to Hall and Tideman (1967); and Horvath (1970). To measure inequality, Shannon's (1948) entropy and the widely known standard deviation; variance of logarithms; coefficient of variation; and Gini will all be used. In both cases, we measure the result provided by *DCB*, here depending on whether concentration or inequality is to be measured. The results provided by these different measures of both concepts are shown in Table 1. We can see that we obtain signs of the difference when applied to each

TABLE 1 Measures of concentration and inequality.

Measures of concentration				Measures of inequality			
	s	z	Sign C(z)-C(s)		s	z	Sign D(z)-D(s)
Herfindahl–Hirschman	0.380	0.355	(−)	Entropy	7.929	8.294	(+)
Hannah–Kay (0.5)	0.345	0.284	(−)	Variance of logarithms	0.141	0.699	(+)
Hannah–Kay (1.5)	0.369	0.335	(−)	Gini	0.200	0.350	(+)
Rosenbluth-Hall & Tideman	0.417	0.385	(−)	Standard deviation (shares)	0.125	0.162	(+)
Horvath	0.725	0.686	(−)	Coefficient of variation	0.374	0.648	(+)
DCB	0.416	0.374	(−)	DCB_d	0.265	0.374	(+)

league that coincides with the forecast, highlighting the versatility of the *DCB* index to capture both phenomena by maintaining or not the simplex, here depending on the number of teams.

The comparisons with other concentration measures presented in Table 1 suggest that the different measures are not substantially different to order; they are clearly different 'numerically', but they all seem to collect the same information about the sign of the differences. For us, it is relevant that inequality measures and concentration measures vary with different signs. Why, then, do we have an interest in the *DCB* index? The *DCB* index is a mathematical distance that allows for proportions to be maintained, measurements to be interpreted as percentages, and differences between measurements to be interpreted as percentage points. In addition, it can be calculated as the square root of the correctly normalised *HHI*. The *DCB* index has relevant properties to compare between measures that the other indices do not have.

2.2 | DCB as an index of concentration and inequality

Hirschman (1945) has shown that $HHI = \lambda^2 + 1$, with $\lambda = \sigma/\mu$ is the coefficient of variation, σ is the standard deviation, and μ is the mean. On the other hand, it has been well known since Adelman (1969) that the sum of the squares of the shares of a distribution can be expressed as a function of the variance, σ^2, and the number of elements of the distribution, n: $HHI = n\sigma^2 + 1/n$. Note that the coefficient of variation, standard deviation or variance are measures of inequality. Then, *HHI* has a property traditionally required for any concentration index; that is, it should depend positively on a measure of inequality and negatively on the number of elements.

The *DCB* index can also be obtained as $DCB = \lambda/\sqrt{n-1}$ (Avila-Cano & Triguero-Ruiz, 2021). Furthermore, the *DCB* index can be understood as a measurement of concentration or inequality, depending on whether this is maintained in the space being measured (referenced to the championship that features the largest number of teams). Therefore, an estimation can be made to explain the levels of competitive balance by the levels of inequality and number of teams. This relationship can be estimated based on a Cobb–Douglas function, in which the relationship between the variables is of a multiplicative nature and these are raised to a power. Thus,

$$DCB_{i,t} = A \cdot DCB_{d_{i,t}}^{\alpha} \cdot N_{i,t}^{\beta} \cdot u_{i,t} \tag{1}$$

here with the hypothesis: $\alpha > 0$ y $\beta < 0$. It is noteworthy that both parameters would indicate the percentage increase in concentration for a 1% increase in inequality (α) or the number of companies (β). Specifically, $\alpha = \frac{\partial DCB}{\partial DCB_d} \cdot \frac{DCB_d}{DCB}$ and $\beta = \frac{\partial DCB}{\partial N} \cdot \frac{N}{DCB}$. In other words, they are the elasticities of concentration in relation to inequality and the number of companies. Therefore, in a league featuring 20 teams, a parameter $\beta = 0.4$ may suggest that an increase in the championship of up to 21 participants (i.e., an extra team, [$\Delta N = 5\%$]) would entail an increase in competitive balance of 2%.

3 | RESULTS

What does the comparative evolution of the competitive balance of the national leagues associated with UEFA and CONMEBOL look like? Are there differences between the two geographical areas and within each confederation? Are the most powerful leagues more competitive? These are some of the questions we aim to answer below, here based on the calculation of the *DCB* indices of the 64 federations analysed over a decade. It should be noted that the usefulness of the *DCB* index when comparing competitions comes from its characterisation as a mathematical distance.

DCB has a property required for any concentration index: it positively depends on a measure of inequality and negatively on the number of elements. Therefore, an estimation can be made to explain the levels of competitive balance by the levels of inequality and number of teams. This relationship can be estimated from a Cobb–Douglas relation, and we can estimate the elasticities between competitive balance and the inequality of the distribution and between the competitive balance and number of teams in the league.

3.1 | Evolution of the competitive balance in UEFA and CONMEBOL

The data correspond to the 2009/2010 to 2018/2019 seasons of the two main football confederations on a global level: the UEFA and CONMEBOL. In all cases, the scoring system for each championship was (3, 1, 1, 0), where three points were awarded to the winner of each match, zero points to the loser and one point to each team in the event of a tie.

The data for each association and each season refer to the points obtained by each of the participating teams at the end of each national league competition played during these years. It should be noted that the UEFA is composed of 55 national federations, while we have data for 54 federations, that is, all except Liechtenstein, which has no league. Data for each league in each season, here corresponding to the participating teams, the results of the final rankings and the points scored all come from the public domain (https://www.transfermarkt.com/ or https://www.besoccer.com/). Therefore, 540 data points corresponding to UEFA leagues are available (54 national federations and 10 seasons). These data synthesise the information obtained from 97,132 matches played in the 10 seasons under consideration (Triguero-Ruiz & Avila-Cano, 2022).

CONMEBOL is made up of 10 national federations. It should be noted that, in this confederation, various associations design and run two league competitions throughout the year, called the 'Opening' and 'Closing' competitions. In the federations of Argentina (since 2014) and Chile (since 2017), both championships have been unified, while in Bolivia, Colombia, Paraguay, Peru and Uruguay they have remained separate. Brazil, Ecuador and Venezuela have only had a single league championship per year during the period under review. In total, 166 data corresponding to the different CONMEBOL tournaments were available. These data include information obtained from 44,092 matches played in the 10 seasons under consideration. Therefore, if we add the 540 data from UEFA, a total of 706 observations are available for 64 football federations over 10 seasons, which synthesises the information on the 141,224 matches played.

Over the period analysed, the average competitive balance of the UEFA and CONMEBOL teams was around a $DCB^{Total} = 46\%$. On 355 occasions, it was lower, and on 351 occasions, it was higher. Moreover, the range achieved by the indices was very wide. Specifically, the lowest value occurred in the Argentinian league in 2016/2017, with 30 teams and a $DCB^{Arg} = 10\%$, while the highest occurred in the 2011/2012 season of the Gibraltar league, with a $DCB^{Gib} = 91\%$; this may be related to the fact that only six teams participated, one of which won almost all its matches, while the last one only managed a draw. In CONMEBOL, the average value was $DCB^{CONMEBOL} = 38\%$, while in UEFA, it was 10 points higher: $DCB^{UEFA} = 48\%$. Details of the calculated values can be found in Appendix A.

Appendix B shows the average annual values for each country. The Argentinian league had the highest competitive balance (lowest *DCB*), followed by Brazil. The European Big Five were among the 10 leagues with the best competitive balance. Appendix B also shows the variation in average concentration levels between the second and first five-year periods, where a positive variation represents the percentage points by which concentration has increased. On average, the level of competitive balance would have stayed the same, with a slight increase in concentration (around one point) between the second 5-year period (2019/2014) and first period (2014/2009). Again, the top leagues (Argentina, Brazil, England, France, Spain, Germany and Italy) were in a similar situation, with variations in concentration below average, as were Colombia, Chile and Uruguay.

Figure 1 relates the average level of concentration of results for each league to the average evolution achieved. Interestingly, the Big Five and apparently strongest South American leagues are located in the southwest quadrant. Note that the leagues in the southwest quadrant would present a more favourable characterisation in the sense of having an above-average competitive balance and better-than-average evolution of competitive balance. In contrast, the leagues in the northeast region would present the opposite situation: worse competitive balance and worse evolution of their competitive balance. It is worth noting that, in general, the latter correspond to minor leagues in terms of their economic and sporting importance. In a favourable situation, alongside the main leagues mentioned above, there were other leagues with a certain economic and sporting prominence, such as those of Belgium, Portugal, Belarus, Norway, Netherlands, Poland, Czech Republic, Russia, Serbia, Turkey, Colombia, Peru or Venezuela.

3.2 | Estimation of elasticities

The model

$$DCB_{i,t} = A \cdot DCB_{d_{i,t}}^{\alpha} \cdot N_{i,t}^{\beta} \cdot u_{i,t} \tag{2}$$

can be transformed using logarithms:

$$C_{i,t} = a + \alpha D_{i,t} + \beta n_{i,t} + v_{i,t} \tag{3}$$

whereby $C_{i,t} = logDCB_{i,t}$; $a = logA$; $D_{i,t} = logDCB_{d_{i,t}}^{\alpha}$; $n_{i,t} = logN_{i,t}$; y $v_{i,t} = \log u_{i,t}$ can be duly estimated by maximum likelihood. In particular, the application of the augmented Dickey–Fuller test ensures the stationarity of the concentration and inequality series. The results of the Chow, Hausman and Breusch–Pagan tests have suggested that the pooling estimation method must be used. The model has been estimated as panel data. To undertake the estimation of the parameters, the R package (R Core Team, 2020) with the *plm* library (Croissant & Millo, 2018) has been used. The results are shown in Appendix C.

Therefore, regarding the national leagues belonging to the CONMEBOL federation, it was necessary to average the competitive balance and inequality indices of certain national federations, given that, during the same season, several championships are held, as indicated in Section 2. The results are shown in Appendix A. Therefore, if we add the 540 data items from UEFA, a total of 640 observations are available for 64 football federations over 10 seasons.

Table 2 displays the main results. Here, the model was adapted by means of raised values for the determination coefficient, with the estimations of the parameters being significant. In turn, the parameters were stable when replicating estimations solely for the UEFA and CONMEBOL leagues. The only noteworthy aspect here is that, in the latter, a greater elasticity would be seen in the absolute value of

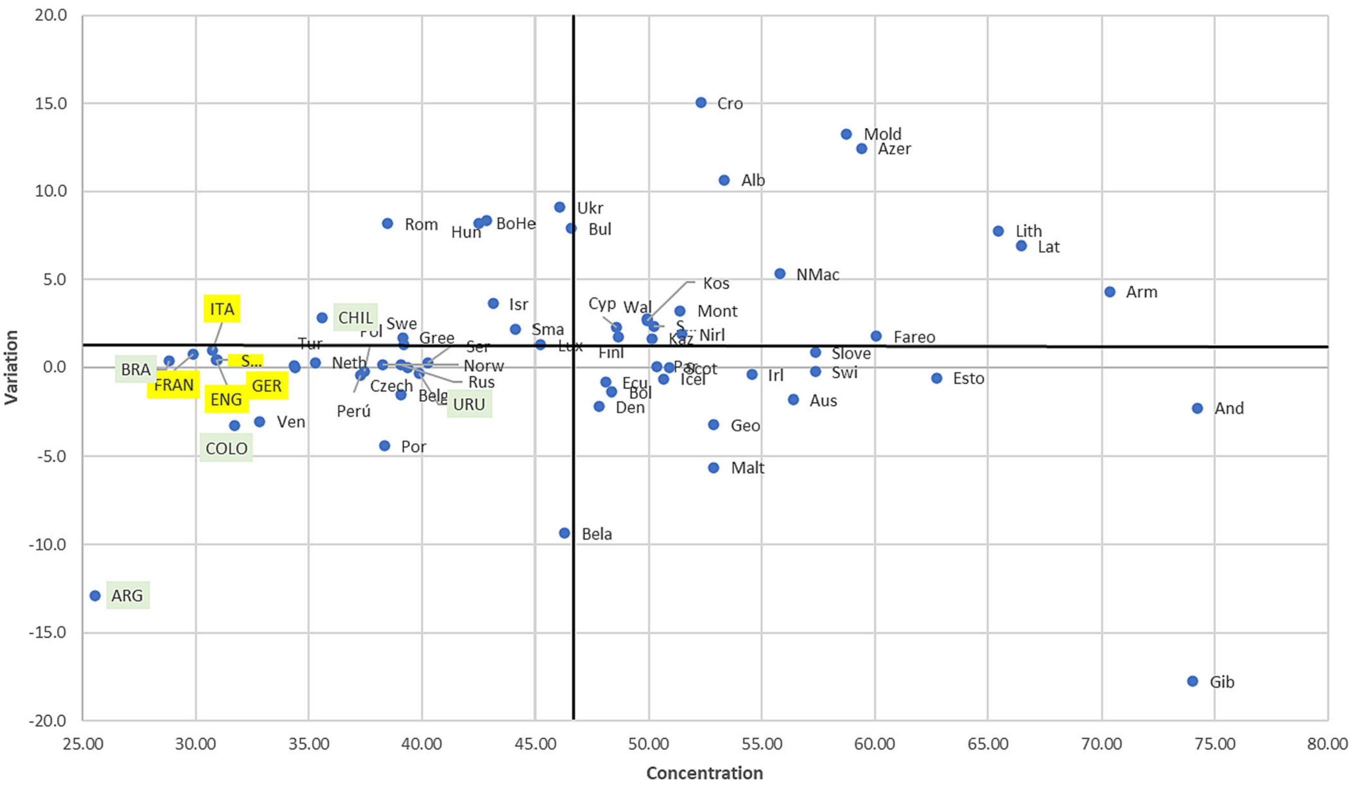

FIGURE 1 Average level of competitive balance (2009–2019) and variation of competitive balance (2014/2019 compared with 2009/2014). Percentages and percentage points of the *DCB* index.

TABLE 2 Elasticities of competitive balance on inequality (α) and the number of teams (β).

	α	β	R^2 adj.	N
Total	.164***	−.900***	0.961	640
UEFA	.167***	−.849***	0.990	540
CONMEBOL	.122***	−1.204***	0.903	100
UEFA-Big Five	.219***	−1.177***	0.996	50
CONMEBOL-Big Five	.042	−1.822***	0.938	50

Note: [ns] indicates no significance.
*Statistical significance at the 10% level.
**Statistical significance at the 5% level.
***Statistical significance at the 1% level.

the number of teams in the league and a slightly lower elasticity of the inequality between the results. As an example, for a league with 20 teams, the introduction of another team in the competition ($\Delta N = 5\%$) would entail a decrease in concentration in the general model of 4.5%, while in UEFA, it would be 4.2% and would be in CONMEBOL 6.0%.

Likewise, among the most relevant championships, the effect of the number of teams variable seems to be more relevant. Indeed, the inequality parameter corresponding to the five main CONMEBOL leagues was the only one that not significant. In these five leagues (Argentina, Brazil, Chile, Colombia and Uruguay), the insertion of a new team would imply a drop in concentration of more than 9.1%.

Under these conditions, it would appear worthwhile to further investigate the results by constructing the corresponding iso-concentration curves (Davies, 1979). For each inequality level (defined as being between $DCB_d = 10\%$ and $DCB_d = 90\%$ and shown on the *X*-axis), it is placed the number of teams (*N*, showed on the Y-axis), which creates the same concentration level (measured using *DCB*, also in percentage):

$$N = k \cdot d, \text{with } k = \left(\frac{DCB_{i,t}}{A}\right)^{1/\beta} \text{ and } d = DCB_{d_{i,t}}^{\alpha/\beta} \qquad (4)$$

An iso-concentration curve for each *DCB* level can then be obtained. Higher iso-concentration curves correspond to lower levels of concentration: for each inequality level, the number of compatible teams is greater. In this sense, Figures 2 and 3 show the estimated iso-concentration curves for the top five UEFA and CONMEBOL leagues, respectively. A simple look at this can reveal the differences and implications.

Indeed, in the UEFA-Big Five leagues, an increase in the number of teams compensated for greater inequality levels so that the concentration levels were maintained and, therefore, competitive balance was not affected. Concerning the CONMEBOL-Big Five leagues, the competitive balance was not substantially sensitive to changes in inequality, meaning that the number of teams determined their level. Thus, the iso-concentration curves were basically lines parallel to the *X*-axis, while in the UEFA-Big Five leagues, they were concave curves.

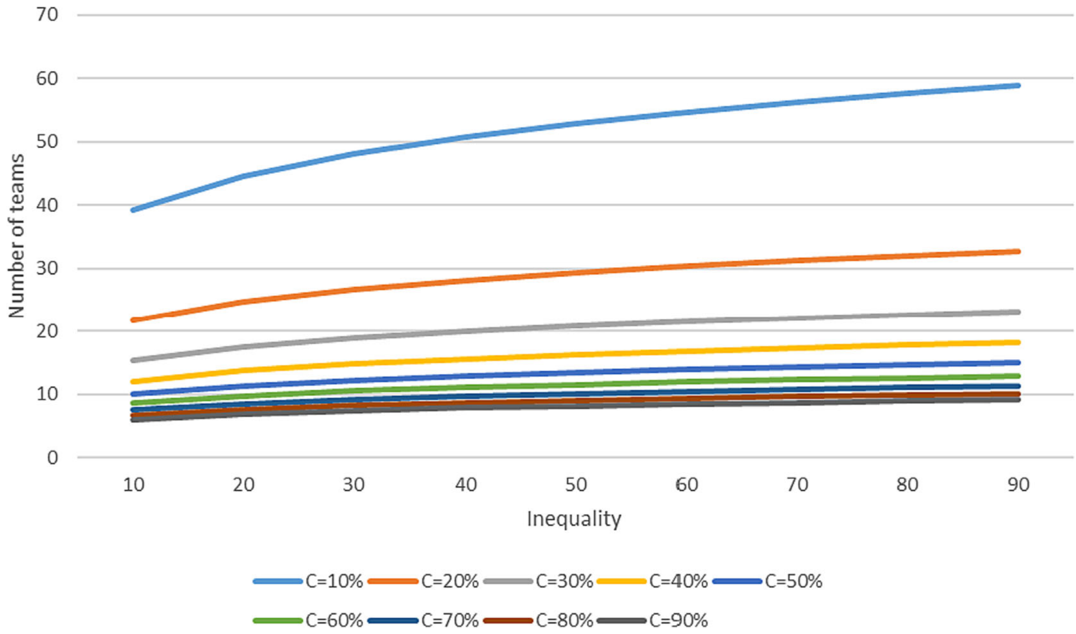

FIGURE 2 Iso-concentration curves for the Union of European Football Associations (UEFA)-Big Five.

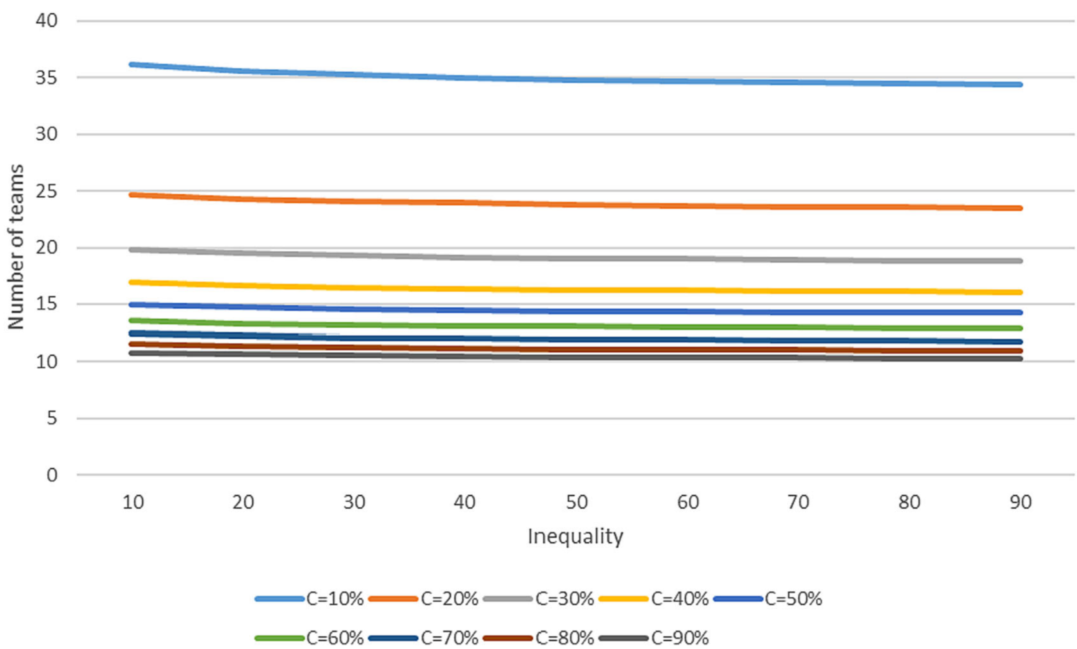

FIGURE 3 Iso-concentration curves for the South American Football Confederation (CONMEBOL)-Big Five.

4 | DISCUSSION AND CONCLUSIONS

This article has focused on measuring competitive balance as a variable dependent on the inequality of strengths among participating teams in competitions and the number of these teams. We have applied the analysis to the UEFA and CONMEBOL leagues over a decade, allowing us to offer suggestions in terms of organisation and management.

However, to the extent that the promotion of competitive balance relates to stimulating demand and business, does it make sense to conduct such an analysis at this juncture? Is it meaningful to measure, compare and explain the level of competitive balance in leagues when demand seems to concentrate on leagues and teams with an accentuated concentration of economic resources, allowing them to retain the most valued and highly paid players? Does this make sense in an environment where digital platforms, major broadcasters and even states and governments are investing in certain sports, in our case, football?

We affirmative respond. It echoes the societal response to the implementation and intensification of competition defence policies in settings marked by the presence of large companies in numerous sectors. These entities disrupt the normal course of the affected markets, imposing negative impacts on consumers and overall welfare. This is expected and reasonable. First comes understanding, and second taking action—and doing so judiciously, that is, through oversight and regulation (Avila-Cano & Triguero-Ruiz, 2023). The annihilation of effective competition, or its continued deterioration, portends scenarios that may ultimately exhaust the appeal of the sport. Therefore, reconciling sports and business becomes essential and achievable. We have a case in point with the UEFA Champions League: It is reasonable that, initially, at the entire group stage, each group exhibits a high level of concentration. The groups are structured with the strongest teams distributed among them, showcasing a high average concentration of results. However, this arrangement increases the likelihood that the competitive balance at the knockout stages will be higher, which typically aligns with heightened fan engagement.

Hence, this article unfolds based on the premise that the concept of competitive balance relates to the equilibrium in strengths exhibited by competitors in a sports championship (Kringstad & Gerrard, 2004). This makes this balance highly relevant in sports economics, particularly concerning sports organisation, management, and competition design (Szymanski, 2003). It also significant due to its potential influence on the generated demand. In this paper, we have concentrated on analysing it in open leagues (H. Dietl & Duschl, 2012), rather than delving into the uncertainty of outcomes produced in competitions and, therefore, any potential effects on demand (Fort & Maxcy, 2003).

The measurement of competitive balance is subject to various approaches and metrics (Evans, 2014; Ramchandani et al., 2018). In our case, we have focused on measuring it within different leagues (albeit across several seasons) rather than on dominance or persistence over time (Gerrard & Kringstad, 2023). Traditionally, inequality and concentration measurements have been used interchangeably to gauge competitive balance. In the current paper, the proposal is that the concept of competitive balance is more readily identifiable with concentration rather than inequality. Indeed, the number of participating teams in a championship is an essential variable that has a bearing on the measurement of competitive balance. Moreover, starting with the work of Hirschman (1945), it has been well known that concentration can be modelled depending on both inequality and the number of distribution elements forming the basis of the analysis. This aspect is considered vital for characterising competitive balance in relation to its measurement.

The most commonly used concentration index to measure competitive balance is the Herfindahl–Hirschman Index, which has undergone various refinements to adjust it to the unique characteristics of sports competitions. These include changes in the number of teams n, which affects its lower bound, which, in general, is $HHI_{min} = 1/n$ (Triguero-Ruiz et al., 2023), and changes in the point allocation system per match (which, along with the number of teams, affects the upper bound that the *HHI* can reach, given that the bilaterality of matchups prevents a monopoly configuration, so $HHI_{max} < 1$). In this regard, notable contributions include those of Owen et al. (2007), who proposed the standardisation of the *HHI*; standardizations addressing the lower bound by Depken (1999), Michie and Oughton (2004), Lenten (2008) and Pawlowski et al. (2010); and various works by Plumley, Mondal, Wilson and Ramchandani, cited in Section 2, which standardise the *HHI* by relativizing both the upper and lower bounds. Avila-Cano et al. (2021) and Avila-Cano et al. (2023) standardise the *HHI* by identifying the most imbalanced distribution, dependent on the scoring system and the number of teams and provide appropriate calculation spreadsheets in their papers. In this regard, the measurement of competitive balance proposed by Triguero-Ruiz and Avila-Cano (2019), known as the *DCB* index, has been used. This index measures both the concentration and inequality of competitions, depending on whether the number of teams is considered when making comparisons.

On the other hand, the analysis of competitive balance in the literature has largely focused on UEFA, while CONMEBOL championships have received scant attention. In the present paper, a joint measurement of the competitive balance levels attained in the leagues of both confederations has been undertaken—these confederations are, undoubtedly, the most economically and sportingly powerful in the current football landscape. Based on these measurements, a model has been devised for competitive balance grounded on the inequality of the point distributions achieved at the end of the championships and number of participating teams. The estimations of the panel data model have allowed us to reach different results, particularly when differentiating among the five top leagues in each confederation (UEFA-Big Five and CONMEBOL-Big Five). The empirical results presented herein may prove valuable for UEFA, CONMEBOL, and domestic league organisers in their efforts to enhance the competitive levels within European and South American football. In this vein, the primary findings are as follows.

Firstly, the average concentration of outcomes in European leagues (48%) is significantly higher than that of South American leagues (38%). Specifically, within European leagues, the concentration of results varies from 29% in France during the 2010/2011 season to a striking 91% in Gibraltar for the 2011/2012 season. In the CONMEBOL context, this range extends from a low of 10% in Argentina in the 2016/2017 season to 51% in Paraguay in that same timeframe. Regarding decade-long averages, the competitive balance fluctuates between 30% and 74% within UEFA (for France and Andorra, respectively) and ranges from 26% in Argentina to 50% in Paraguay within CONMEBOL. Considering that UEFA encompasses 54 national federations and CONMEBOL includes an additional 10, it is crucial to focus on particular leagues due to this broad diversity. Therefore, given that there are no general rules of behaviour (beyond distinctions between European and South American leagues, and major leagues versus others), decisions made by league organisers and national federation authorities should draw references but be specific to each case.

Secondly, the European and South American 'Big Five' leagues exhibited enhanced levels of competitive balance, accompanied by a steadily positive trend over the past decade. Moreover, this state of affairs remained relatively stable throughout the period in question. Indeed, Figure 1 reveals a pattern in which leagues that are commonly perceived as prominent due to their sporting and economic potential concurrently demonstrate a superior average competitive balance and a favourable evolution over the decade. This observation prompts a compelling question: Is there a relationship between the competitive balance of national leagues and the international standing of their corresponding national teams? This query can seemingly be answered as follows: As these leagues grow in prominence, a correlation appears to manifest itself between competitive balance and the global significance of the affiliated leagues and federations.

In this context, Figure 4 illustrates the relationship between a decade-long average of FIFA points (https://www.fifa.com/fifa-world-ranking/men?dateId=id14142) and the average values of the *DCB*. The graph depicts a pronounced negative correlation between FIFA points and average *DCB* values, implying that higher point averages (reflecting a superior evaluation of the national team's competitive prowess) align with lower average *DCB* values, signifying a heightened competitive balance within the associated leagues. Essentially, this interconnection between a national league's competitive balance and the FIFA ranking attributed to the performance of the linked national team might pinpoint a nexus between the talent and potential of players—who largely compete in the league—and that league's competitive equilibrium. It has been established that there is no universal correspondence; for instance, players from country A competing in country A's national league might also play in international leagues. The reverse, involving foreign players in country A's league, is equally valid. Nonetheless, the evidence suggests that such players introduce a distinctive competitive dynamic to the leagues they join.

In this regard, considering that national federations are typically responsible for national teams, while leagues have their own organisers who are legally and economically distinct from the former, an operational conflict may arise. League organisers might be keen on orchestrating championships where a strong core of teams succeed in continental tournaments, enhancing the prestige of the competition, which in turn significantly impacts demand and, subsequently, revenue (a trajectory seemingly adopted by the European Big Five in the past two decades). Conversely, the corresponding federations might be particularly inclined to bolster the competitive balance of the leagues in which their national clubs compete. Therefore, on the one hand, smaller leagues should use the actions of major leagues as a reference. On the other hand, the separation between federation authorities and league organisers makes sense as they respond to different interests, but both should deploy cooperative strategies.

Thirdly, the analysis carried out in this study confirms that inequality among teams and their numbers indeed influences the competitive balance of European and South American leagues, albeit in opposite directions (negatively and positively, respectively). Therefore, each specific case must be scrutinised to determine where each league stands concerning both variables. If necessary, measures should be taken, especially considering that these are open leagues. For example, focus might be directed towards the two aforementioned variables that impact competitive balance—inequality and the number of participating entities—which

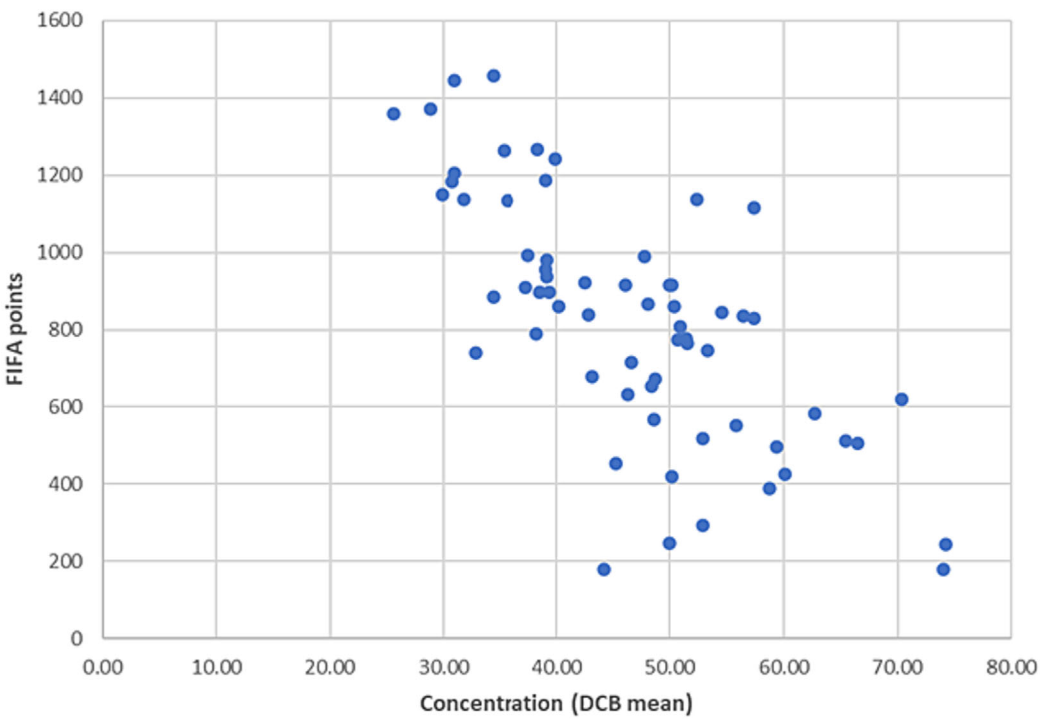

FIGURE 4 FIFA points—competitive balance relationship.

undeniably exhibit distinct behaviours. Furthermore, changes to these variables stem from different decisions. Indeed, expanding or reducing, for instance, the number of participants in a league by two teams is quite different from implementing measures aimed at curbing the growth of strength disparity (through financial fair play, wage caps, revenue distribution, etc.).

Fourthly, and in relation to the previous comment, the estimations carried out allow for a quantitative derivation of a percentage relationship between the variables 'inequality' and 'number of teams', with the explained variable being 'competitive balance'. Our results are relevant in terms of championship design insofar as organisers are eager to ensure attainable levels of competitive balance. Depending on the federations and confederations to which they belong, increasing the number of teams playing in the leagues may or may not be more effective than limiting the differences between the teams' potential.

CONMEBOL leagues exhibit a higher elasticity of competitive balance relative to the number of teams compared to UEFA leagues. In the major South American leagues, the 'inequality' variable does not show a significant effect. These leagues vary in team numbers, ranging from 12 (Paraguay and occasionally Bolivia and Ecuador) to 20 (Brazil and at times Argentina, Colombia, and Venezuela). Notably, between 2015 and 2018, Argentina had between 26 and 30 teams. In contrast, within UEFA, the range of teams in the leagues is between 8 (Latvia or Moldova) and 20 for four of the Big Five (Germany has 18 teams). Excluding the case of Argentina, over the past four seasons, European leagues would have a broader range of variation. However, the impact of introducing a new team would be significantly higher in South American leagues, particularly within the top five. Meanwhile, the inequality variable has a more profound impact on competitive balance within Europe's Big Five, suggesting that measures aimed at reducing disparities in team strengths would yield more significant effects. Therefore, in terms of decision-making, the five major European leagues should focus their attention on inequality factors, while the South American leagues should focus on the number of teams.

Consequently, the findings presented herein offer valuable insights for the structuring of football championships and the formulation of sports policies by pertinent sports bodies and federations. Whether the strategy should be to augment the number of teams or to curtail differences in teams' potential hinges upon the specific federations and confederations in question.

CONFLICT OF INTEREST STATEMENT

The authors report there are no competing interests to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in figshare at https://doi.org/10.6084/m9.figshare.21626312.v1

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APPENDIX A: *DCB* MEANS (2009/2019, 2008/2014 AND 2014/2019) AND VARIANCES (2009/2019)

		DCB 2009/2019		DCB		
	Federations	**Mean**	**Variance**	**2009/2014**	**2014/2019**	**Variation**
UEFA	Albania *(Alb)*	53.3	32.8	48.0	58.7	10.7
	Germany *(GER)*	34.4	0.4	34.4	34.4	0.0
	Andorra *(And)*	74.2	3.5	75.4	73.1	−2.3
	Armenia *(Arm)*	70.3	42.2	68.2	72.5	4.3
	Austria *(Aus)*	56.4	4.5	57.3	55.5	−1.8
	Azerbaijan *(Azer)*	59.4	49.3	53.2	65.6	12.4
	Belgium *(Belg)*	39.1	1.2	39.9	38.3	−1.6
	Belarus *(Bela)*	46.3	25.7	51.0	41.6	−9.4
	Bosnia & Herzegovina *(BoHe)*	42.5	32.7	38.4	46.6	8.2
	Bulgaria *(Bul)*	46.6	37.4	42.6	50.5	7.9
	Cyprus *(Cyp)*	48.6	5.6	47.4	49.7	2.3
	Croatia *(Cro)*	52.3	90.2	44.8	59.9	15.1
	Denmark *(Den)*	47.8	5.1	48.9	46.7	−2.2
	Scotland *(scot)*	50.9	1.2	50.9	50.9	0.0
	Slovakia *(Slova)*	50.2	2.1	49.0	51.4	2.4
	Slovenia *(Slove)*	57.4	1.1	56.9	57.8	0.9
	Spain *(SPA)*	30.9	0.6	30.7	31.1	0.4
	Estonia *(Esto)*	62.7	1.0	63.0	62.4	−0.6
	Finland *(Finl)*	48.7	5.2	47.8	49.5	1.8
	France *(FRAN)*	29.9	0.4	29.5	30.2	0.7
	Wales *(Wal)*	49.9	20.1	48.5	51.3	2.8
	Georgia *(Geo)*	52.9	56.9	54.5	51.3	−3.2
	Gibraltar *(Gib)*	74.0	109.9	82.9	65.1	−17.8
	Greece *(Gree)*	39.2	3.8	38.3	40.0	1.7
	Hungary *(Hun)*	42.9	24.0	38.7	47.0	8.3
	England *(ENG)*	30.9	0.8	30.7	31.1	0.4
	Rep. of Ireland *(Irl)*	54.6	15.3	54.8	54.4	−0.4
	Northern Ireland *(Nirl)*	51.5	2.3	50.5	52.4	1.9
	Iceland *(Icel)*	50.7	1.2	51.0	50.3	−0.7
	Faroe Islands *(Fareo)*	60.1	3.4	59.2	61.0	1.8
	Israel *(Isr)*	43.1	7.8	41.3	45.0	3.6
	Italy *(ITA)*	30.8	0.7	30.3	31.2	1.0
	Kazakhstan *(Kaz)*	50.2	4.1	49.3	51.0	1.6
	Kosovo *(Kos)*	49.9	3.7	48.6	51.3	2.7
	Latvia *(Lat)*	66.5	30.3	63.0	69.9	6.9
	Lithuania *(Lith)*	65.5	31.8	61.6	69.4	7.8
	Luxembourg *(Lux)*	45.2	1.1	44.6	45.9	1.3
	North Macedonia *(NMac)*	55.8	22.9	53.1	58.5	5.3
	Malta *(Mal)*	52.9	19.9	55.7	50.1	−5.6
	Moldova *(Mold)*	58.8	59.8	52.1	65.4	13.3
	Montenegro *(Mont)*	51.4	11.2	49.8	53.0	3.2
	Norway *(Norw)*	38.3	0.6	38.2	38.3	0.2
	Netherlands *(Neth)*	35.3	0.8	35.1	35.4	0.3

(Continues)

	Federations	DCB 2009/2019		DCB		
		Mean	Variance	2009/2014	2014/2019	Variation
	Poland *(Pol)*	37.5	8.7	37.6	37.4	−0.2
	Portugal *(Por)*	38.4	5.1	40.6	36.2	−4.4
	Czech Republic *(Czech)*	39.4	0.3	39.4	39.4	0.0
	Romania *(Rom)*	38.5	27.9	34.4	42.6	8.2
	Russia *(Rus)*	39.1	0.4	39.0	39.2	0.2
	San Marino *(Sma)*	44.1	3.8	43.1	45.2	2.2
	Serbia *(Ser)*	40.3	1.0	40.1	40.4	0.2
	Sweden *(Swe)*	39.2	0.9	38.5	39.9	1.3
	Switzerland *(Swi)*	57.4	1.0	57.5	57.2	−0.2
	Turkey *(Tur)*	34.3	0.9	34.3	34.4	0.1
	Ukraine *(Ukr)*	46.1	23.9	41.5	50.6	9.1
CONMEBOL	Argentina *(ARG)*	25.6	53.4	29.8	17.0	−12.9
	Bolivia *(Bol)*	48.4	3.7	49.2	47.8	−1.4
	Brasil *(BRA)*	28.8	0.4	28.7	29.0	0.4
	Chile *(CHIL)*	35.6	4.6	33.9	36.8	2.9
	Colombia *(COLO)*	31.7	3.8	33.5	30.3	−3.3
	Ecuador *(Ecu)*	48.1	7.8	48.6	47.7	−0.8
	Paraguay *(Par)*	50.4	1.0	50.3	50.4	0.1
	Perú *(Perú)*	37.3	2.2	37.6	37.2	−0.4
	Uruguay *(URU)*	39.9	1.6	40.1	39.8	−0.3
	Venezuela *(Ven)*	32.8	4.6	34.5	31.4	−3.1

APPENDIX B: TEST AND ESTIMATED MODELS

Test	Variable/effect	Value	Df	Conclusion
Dickey–Fuller	DCB	-6.8444^{**}	-	Stationary
Dickey–Fuller	DCB_d	-7.7782^{**}	-	Stationary
Hausman	Within/ Random	0.20512^{ns}	2	Not significant
Breusch–Pagan	Time	0.12538^{ns}	1	Not significant
Breusch–Pagan	Individual	541.9^{***}	1	Significant
Chow	Within/ No pooling	45.519^{***}	126	Individual
Chow	Pooling/ No pooling	61.867^{***}	189	Pooling

Note: ^{ns} Not significant,
** $p \leq .01$,
*** $p \leq .001$.

APPENDIX C: MAXIMUM LIKELIHOOD ESTIMATION OF THE COBB–DOUGLAS FUNCTION WITH COUNTRY FACTOR AND POOLED MODEL

Range		All	UEFA	CONMEBOL	UEFA/MjL	CONMEBOL/MjL
Estimate	(intercept)	5.50858***	5.38170***	6.50438***	6.11870***	8.93621***
	log (DCB_d)	0.16486***	0.16734***	0.12235*	0.21900***	−0.04180[ns]
	log(N)	−0.89615***	−0.84915***	−1.20400***	−1.17787***	−1.82248***
Std. error	(intercept)	0.05084	0.02376	0.22676	0.03730	0.33831
	log (DCB_d)	0.00942	0.00482	0.05084	0.00400	0.05821
	log(N)	0.01261	0.00410	0.04029	0.01202	0.06952
***R*-squared**	Value	0.898	0.990	0.905	0.996	0.941
	Adj. value	0.898	0.990	0.903	0.996	0.938
***F*-statistic of model**		5576.3 ***	25673.4 ***	460.7 ***	5784.4 ***	374.4 ***

Note: [ns] Not significant,
** $p \leq .05$,
*** $p \leq .001$.