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How to account for changes in the size of Sports Leagues? The Iso Competitive Balance Curves.

Jean-pascal Gayant
GAINS-TEPP, University of Le Mans, France

Nicolas Le Pape
CREM, University of Caen, France

Abstract

In this note, we focus on the measure of Competitive Balance in a sport league when the size of the league varies. We construct a Competitive Balance index defined as the ratio of the actual standard deviation to the maximal standard deviation, the value of the denominator depending on the size of the league. On the basis of this ratio we then construct Iso Competitive Balance curves.

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Contact: Jean-pascal Gayant - jpgayant@univ-lemans.fr, Nicolas Le Pape - nicolas.lepape@unicaen.fr.
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1. INTRODUCTION

The issue of Competitive Balance (CB) is a central issue in the literature on the economics of professional sports. The basic idea is that the managers of professional sports leagues must maintain a certain level of competitive balance in their league if they want it to remain attractive (Rottenberg (1956), El Hodiri and Quirk (1971), Fort and Quirk (1995), Vrooman (1995), Kesenne (2000).) An important part of the literature is also devoted to the mechanisms which restore a satisfactory level of competitive balance: salary caps, luxury taxes, draft rules, gate revenue sharing. Nevertheless some authors challenge the idea that a decrease in competitive balance necessarily leads to a weakening of fan interest. Szymanski (2001) develops a theoretical model and shows that if fan support is unequally distributed between teams, then unbalanced competitions may also be socially optimal. However there is a consensus on the need to adequately measure the balance. As mentioned by Zymbalist (2002), the most commonly used index is the standard deviation of win percentages. But other indexes can be used as the ratio of the actual to the idealized standard deviation of win percentages, the Gini coefficient of win percentages, the Hirshman-Herfindahl index of competitive balance, the Concentration Ratio, the ratio of the top to bottom win percentages, the index of dissimilarity (for a comparison, see for instance Mizak et al. (2005)).

Analysis of the within-season competitive balance requires consideration of possible changes in the size of the league (that sometimes occur from one year to another). The change in the size of the league is not a secondary issue in many professional sports, for instance in soccer either in Europe or in North America (see Table 1).

Table 1: Changes in the size of soccer leagues in Europe and North America

European Promotion/Relegation leagues (since 1960)	
French Premier League	1960 to 1963: 20 teams, 1964 and 1965: 18 teams, from 1966 to 1968: 20 teams, 1969 and 1970: 18 teams, from 1971 to 1997: 20 teams, from 1998 to 2002: 18 teams, from 2003 to 2012: 20 teams
Spanish Premier League	1960 to 1971: 16 teams, from 1972 to 1987: 18 teams, from 1988 to 1995: 20 teams, 1996 and 1997: 22 teams, from 1998 to 2012: 20 teams
English Premier League	1960 to 1987: 22 teams, 1988: 21 teams, from 1989 to 1991: 20 teams, from 1992 to 1995: 22 teams, from 1996 to 2012: 20 teams
Italian Premier league	1960 to 1967: 18 teams, from 1968 to 1988: 16 teams, from 1989 to 2004: 18 teams, from 2005 to 2012: 20 teams

German Premier League	1964 and 1965: 16 teams, from 1966 to 1991: 18 teams, 1992: 20 teams, from 1993 to 2012: 18 teams
North American closed league	
Major League Soccer	1996 to 1997: 10 teams, from 1998 to 2000: 12 teams, from 2001 to 2004: 10 teams, 2005 and 2006: 12 teams, 2007: 13 teams, 2008: 14 teams, 2009: 15 teams, 2010: 16 teams, 2011: 18 teams, 2102: 19 teams

Indeed, indicators of competitive balance are sensitive to the number of teams comprising the league in the same way as indices measuring the degree of concentration in an industry are sensitive to the number of rival firms (Kamerschen and Lam (1975), Davies (1979)). As part of the analysis of competitive balance in professional sports, Depken (1999) and Pawlowski et al. (2010), have proposed a modified Hirshman-Herfindahl index to correct the measure of competitive balance depending on the size of the league.

Examining this question, Adjemian et al. (2012) have shown that the type of correction suggested by Depken (1999) and Pawlowski et al. (2010) is inadequate or incomplete in the sense that if it neutralizes the variability of the lower bound of the CB index on the size of the league, it doesn't take into account the variability of the upper bound.

Our purpose in this note is not to answer the question: "Is CB desirable?"; our claim is only to design a more suitable measure of CB, and, by analogy with the work of Davies (1979) on the issue of industrial concentration, to construct Iso Competitive Balance curves. The note is organized as follows : in Section 2, we discuss the importance of the point award system for a satisfying measure of Competitive Balance ; in Section 3, we express a ratio of Competitive Balance derived from the standard deviation of the percentage of points ; in Section 4, we construct Iso Competitive Balance curves and, as an illustration, we give an example based on data from the Spanish soccer league. Finally, we discuss policy implications in Section 5.

2. MEASURE OF COMPETITIVE BALANCE AND POINT AWARD SYSTEM

Our objective is to build a robust and general measure of Competitive Balance. Since in some sports matches the result can be a draw, we will focus on the calculation of the dispersion of the distribution of percentage of points rather than of winning percentages. Let us consider the case of a m-k-0 ($m, k \in \mathbb{N}$) point award system (m points for a win, k points for a draw, 0 point for a loss, with $m > k$). Depending on the value of k relative to m, the total points awarded to all teams at the end of the season may not be constant but depend on the number of draws that occurred. More precisely, in a "once home-once away" league with N teams ($N \geq 2$), if T ($0 \leq T \leq N(N-1)$) denotes the aggregate number of ties, the total number of points distributed during a season equals $P_{m,k}(N) = (2k-m)T + mN(N-1)$. If, from one season to another, with the same number of teams in the league, $P_{m,k}(N)$ is not constant, the same percentage of points earned by a team can cover different degrees of Competitive Balance[1]. So, in order to construct a reliable index of competitive balance, we must assume that the total points distributed during the season are constant. In other words, $P_{m,k}(N)$ must be independent of T. This condition is fulfilled if and only if m = 2k points. If the actual allocation of points in the league does not respect this condition, one cannot calculate an index of competitive balance on this basis despite the fact that we know that this point award system has an influence on the outcome of games and therefore on the actual level of competitive balance! This means that we can only measure the *ex post* degree of competitive balance of a championship in which the results are conditioned by a point award system that may *ex ante* have "altered" the degree of competitive balance.

3. CHANGES IN SIZE OF THE LEAGUE AND THE MAXIMUM VALUE OF THE STANDARD DEVIATION

Let us denote by p_i the number of points obtained by the i^{th} team ($i \in \{1, \ldots, N\}$) in a m-k-0 point award system. The percentage of points obtained by a team is $s_i = \frac{p_i}{\sum_{i=1}^{N} p_i} = \frac{p_i}{P_{m,k}(N)}$. The standard deviation of the percentage of points is $\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(s_i - \bar{s})^2$ with $\bar{s} = \frac{1}{N}$. When the size of the league is constant, this standard deviation is a good index to measure competitive balance annually. However, when the number N of teams comprising the league changes, it is essential to put into perspective the measured level of standard deviation with what would have been its minimum and its maximum levels. Obviously, the minimum value of σ^2 is insensitive to changes in the size of the league since it is equal to 0. On the other hand, the maximum level of deviation is dependent on N. We therefore propose to measure the competitive balance using the CBR index = $\frac{\sigma^2 - \sigma^2_{min}}{\sigma^2_{max} - \sigma^2_{min}} = \frac{\sigma^2}{\sigma^2_{max}}$ (CBR for Competitive

[1] Such is the case in the actual European soccer leagues where m = 3 and k = 1.

Balance Ratio). This index of CB is such that its lower and upper bounds are i) invariant when the size of the league varies, and ii) respectively equal to 0 and 1.

It is then necessary to determine the value of σ^2_{max} depending on the size of the league. For this purpose, Adjemian et al. (2012) have shown that the configuration of so-called "Perfect Hierarchy" is the one that maximizes the level of the standard deviation of percentages of points in any league of N teams in the case where m = 2k. The configuration of Perfect Hierarchy can be described as follows (in a "once home-once away" championship) :

The 1st team wins its [2 × (N-1)] games, the 2nd team loses 2 games (the 2 games against the previous team) and wins [2 × (N-2)] games, the 3rd team loses 4 games (the 4 games against the 2 previous teams) and wins [2 × (N-3)] games, the Nth team loses its [2 × (N-1)] games (No draw occurs in the championship).

Under Perfect Hierarchy, the number of points obtained by the ith team is $p_i = 2m(N-i)$ and its share of points is $s_i = \frac{2m(N-i)}{mN(N-1)} = \frac{2(N-i)}{N(N-1)}$ $(i \in \{1, \ldots, N\})$. The configuration of Perfect Hierarchy maximizes σ^2 because no marginal change of result in the championship is likely to increase the dispersion of the percentage of points. For example, any draw between two following teams (which is the smallest move away from this configuration) will decrease the dispersion of percentage of points (for a formal proof, see Adjemian et al. (2012)). The value of the standard deviation under Perfect Hierarchy is obtained by replacing s_i by its value above in $\sigma^2 = \frac{1}{N}\sum_{i=1}^{N} s_i^2 - \frac{1}{N^2}$. It gives $\sigma^2_{Perfect\ Hierarchy} = \frac{1}{N^3(N-1)^2}\sum_{i=1}^{N} 4(N-i)^2 - \frac{1}{N^2}$, and since $\sum_{i=1}^{N} i = \frac{N(N+1)}{2}$ and $\sum_{i=1}^{N} i^2 = \frac{N(N+1)(2N+1)}{6}$, then $\sigma^2_{Perfect\ Hierarchy} = \sigma^2_{max} = \frac{N+1}{3N^2(N-1)}$.

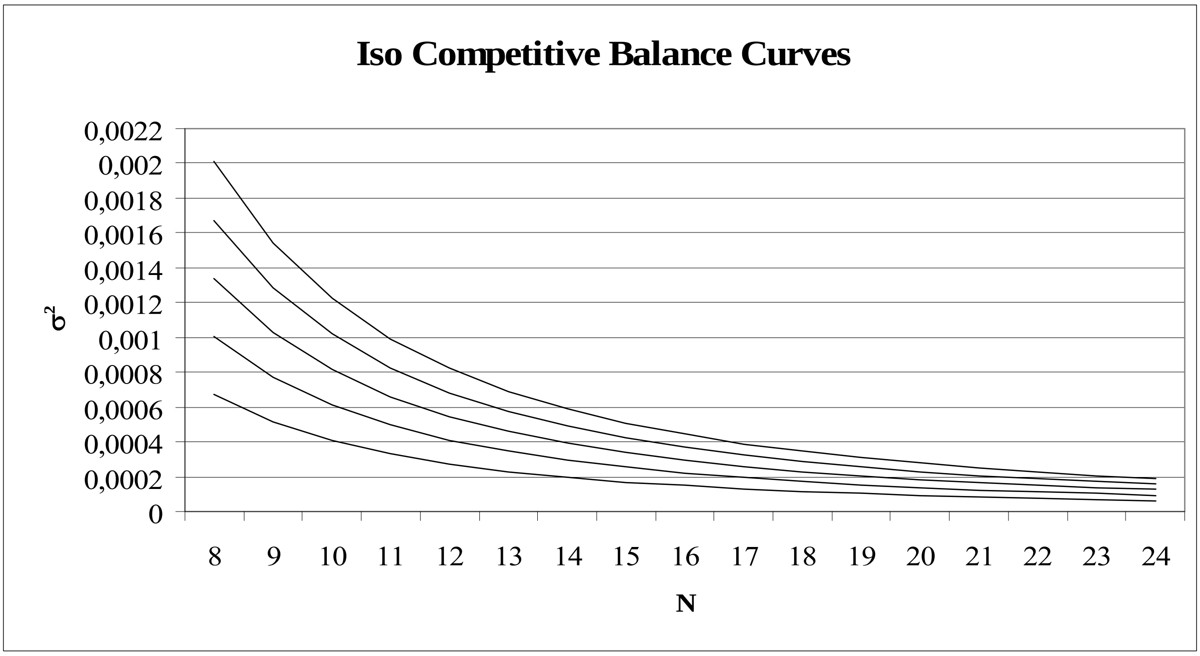
Finally, we can express CBR = $\frac{\sigma^2}{\sigma^2_{max}} = \frac{3N^2(N-1)\sigma^2}{N+1}$.

4. ISO COMPETITIVE BALANCE CURVES

In the empirical literature on the measurement of market concentration (based on the calculation of the CR_n -concentration ratio of the top n firms- or of the HHI -the Hirshman Herfindahl Index- for instance) there is a historical concern: the ability to dissociate, on the one hand, the effect of the intrinsic inequality of market shares of firms, and, on the other hand, the effect of the number of firms in this industry. Davies (1979) proposes a comparison of many existing measures and constructs iso-concentration curves. Our work on the theme of the influence of the number of "firms" on the measured level of Competitive Balance has some similarities with the analysis carried out by Davies. By extending our approach, we are brought to propose Iso Competitive Balance curves that indicate, for any value of N, the level of the standard deviation leading to a given level of Competitive Balance.

The equation of any Iso Competitive Balance curve is CBR = K, K being a constant term varying between zero and one[2], we can represent a beam of Iso Competitive Balance curves, expressing that $\sigma^2 = \frac{(N+1)K}{3N^2(N-1)}$. The Iso Competitive Balance curves slope downward in the $\sigma^2 N$ plane. Indeed, since $\sigma^2 = K.\sigma^2_{max}$, the relationship between σ^2 and σ^2_{max} is positive for all $K \in [0,1]$. Moreover, σ^2_{max} is a decreasing function of N; then it follows that σ^2 decreases with N for a given value of K. Intuitively, it means that, for a given "level" K of Competitive Balance, the measured value of σ^2 is even lower when N is large. The Iso Competitive Balance curves for a CBR between 0.1 and 0.3 are drawn in Figure 2.

Figure 2 : "Iso Competitive Balance Curves"

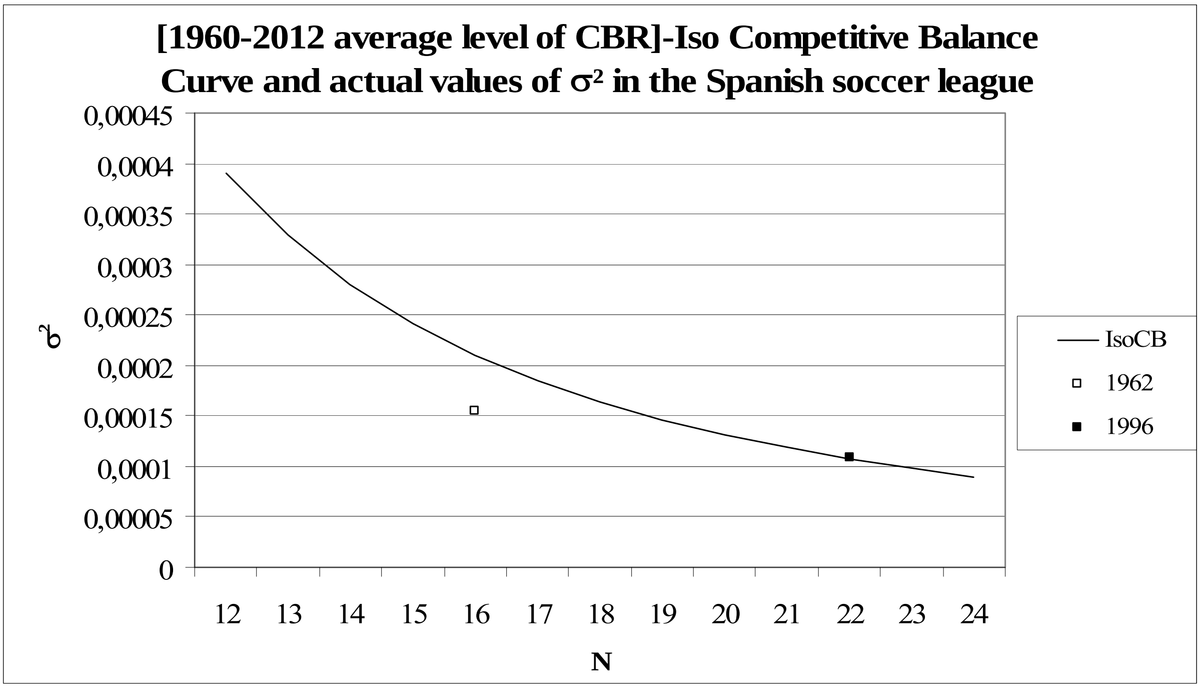


Let us illustrate how the Iso Competitive Balance curves are useful when comparing the level of CB related to different seasons characterized by different league sizes. As mentioned in the

[2] Obviously, the lower bound refers to the configuration where all teams obtain the same number of points and the upper bound corresponds to the configuration of Perfect Hierarchy

introduction, the Spanish soccer league has consisted of 4 different sizes since 1960. Let us focus on the 1962 (a 16-team league) and 1996 (a 22-team league) seasons. When referring to the standard deviation of the distribution of the final share of points[3] at the end of the season, the 1996 season is apparently more balanced than that of 1962, since $\sigma^2_{1962} = 0.0001546$ and $\sigma^2_{1996} = 0.0001090$. Actually, when placing these two values in the same diagram as the Iso Competitive Balance Curve corresponding to the average level of CBR during the 1950-2012 period[4] (see Figure 3), it appears that the 1962 season should be regarded as more balanced than that of 1996. Indeed, the Competitive Balance Ratio was lower in 1962 than it was in 1996 ($CBR_{1962} = 0.1048$ and $CBR_{1996} = 0.1446$).

Figure 3 : "[1960-2012 average level of CBR]-Iso Competitive Balance Curve and actual values of σ² in the Spanish soccer league"



5. POLICY IMPLICATIONS

The CBR tool is not more relevant than other measures of CB to deal with the question: is Competitive Imbalance harmful? Nevertheless, under the hypothesis that keeping a given level of CB is necessary for the sustainability of a league, it is necessary to discuss the question of the desirable size of the league with an appropriate index. As an illustration, if we

[3] using a 2-1-0 point award system
[4] 0.1429

calculate the average level of CBR in the 5 major European soccer leagues for the 1960-2012 period, we notice that the bigger the size of the league, the greater the level of CB (see Table 4).

Table 4 : Average level of CBR in the 5 major European soccer leagues depending on the size of the league (1960-2012)

League Size	CBR	Number of observations
16	0.158	35
18	0.154	95
20	0.150	96
22	0.129	34

This finding suggests that a more sophisticated econometric study could be conducted to estimate the impact of increasing the number of teams on the level of CB in European soccer leagues.

Another possible use of the CBR could be to adjust the continental ranking that determines the number of teams from each national league that will participate in the continental leagues. Indeed, in Europe, the present ranking is only determined by the results of the clubs of the national leagues in *UEFA Champions League* and *UEFA Europa League* games over the past five seasons. This calculation promotes countries in which a small number of teams dominate the national league. Correcting this ranking method with the actual level of CB would better reflect the average level of each national championship. Since these countries exhibit different league sizes, the suitable measure would obviously be the CBR.

6. CONCLUSION

Since the publication of the article by Depken (1999), it has been understood that it is necessary to correct the indexes of competitive balance to reflect any changes in the size of the league. In this note, we propose Iso competitive balance curves to visualize the amount of correction to be made to ensure comparability between the observed levels of competitive balance in a league before and after changes in the number of teams. More generally, we raise the question of a possible optimal size of a league that would ensure a maximum level of CB.

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