

On competitive balance in the group stage of the UEFA Champions League^{*}

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Abstract

This article examines competitive balance in the group stage of the UEFA Champions League over the last two decades (1999/2000–2017/2018). Competitive balance is considered both before and after a competition. Have the groups been designed in such a way as to ensure similar levels of competitive balance ex ante? Have the demonstrated strengths (ex post competitive balance) of the different groups been similar over each season? What is the relationship between the competitive balance in the designed groups and that achieved in the same groups after the competition? Are the performance achieved in terms of ex post competitive balance similar to ex ante competitive balance levels? We found that, despite expectations, the groups' ex ante competitive balance was not homogeneous. Although ex ante competitive balance serves as a good predictor, on average, of ex post competitive balance, we observed significant differences at the levels of group and seasons. Therefore, it is possible to improve the design mechanism of the groups that make up the group stage of the champions so that they are composed homogeneously in terms of ex ante competitive balance.

KEYWORDS

competitive balance, distance to competitive balance, soccer, truncated cascade distribution, UEFA Champions League

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JEL CLASSIFICATION

L11, Z20, Z21

1 | INTRODUCTION

The promotion of competitive balance appears to be a priority on the agenda of the global governance of football. Thus, the UEFA president has identified one priority in the initial period of his presidency: "improving competitive balance in European football and reducing the gap between elite clubs and the rest" (UEFA, 2019b). But what is the competitive balance? "At its heart, it is the situation where, in any head-to-head matchup, each team has an equal likelihood of winning" (Van Scyoc & McGee, 2016). Then, if a league exhibited a competitive balance, every team would be a potential champion.

This article examines competitive balance in the group stage of the UEFA Champions League (UCL) over the last two decades (1999/2000–2017/2018). We are interested in the balance between the UCL groups and in the relationship between the competitive balance of the groups' pre- and post-competition. Have the groups been designed in such a way as to ensure similar levels of competitive balance? What is the relationship between the competitive balance in the designed groups and that achieved in the same groups after the competition? Thus, the concept of competitive balance (Andreff, 2015; Szymanski, 2003; Zimbalist, 2002) can be (i) linked to team characteristics before a competition, that is, strengths and talent, irrespective of behaviour and performance during the competition, (ii) based on effort and on performance, and (iii) a result of the competition, which is usually the case (Kringstad & Gerrard, 2004).

In the first case, *ex ante* competitive balance is related to expectations and the odds of who will win the competition. To measure *ex ante* competitive balance, we can consider those variables that reflect the strengths and talents of the teams. A suitably weighted average of the teams' recent past results could serve as a good indication of their actual strengths. Numerous previous studies have used betting odds to calculate *ex ante* competitive balance (Gomez-Gonzalez et al., 2019).

The uncertainty surrounding the results of a championship is one of the aspects in the literature on competitive balance that commands the most attention. The uncertainty of outcome hypothesis (UOH) proposes a positive relationship between fan interest and the competitiveness of games (Bradbury, 2019). Therefore, if uncertainty contributes to consumer demand for sports, we can expect a greater competitive balance to increase team revenue. However, it can be understood that there is little interest (Berri et al., 2007), indifference (Hogan et al., 2017) or even a reverse relationship between uncertainty and demand (Coates et al., 2014). In fact, interest in sporting events may be determined by *ex ante* expectations with respect to the quality of the game (Chung et al., 2016). In their study, Schokkaert and Swinnen (2016) focused on the UOH and UCL; they found qualification in lower rounds has become more predictable in the UCL and outcomes at later stages have become less predictable.

Ex post, that is, after the competition the results allow each team's competitive balance to be evaluated *a posteriori*. From the point of view of the fans' uncertainty about the betting shops, gamblers, or generally all those with a vested interest in the competition, these results are useful in terms of the next competition. This is because they reveal the first estimation of the competitive balance before the new competition starts.

Thus, the *ex post* competitive balance is linked to the distribution of results or winners of the competition, and so is more related to the current distribution of sporting quality than to the expectations at the beginning of the competition.

In this article, we propose examining both concepts from the point of view of football, and, more specifically, in the group stage of the UCL (UEFA, 2018). In this sense, the competitive balance of the UCL groups over the last two decades has been low and decreasing. The elevated levels of concentration of the results that the groups

show in the UCL are to be expected, given the way in which the groups are formed and have been decreasing, particularly at ex post level. Furthermore, we can reject the idea that the UCL groups were homogenous in terms of ex ante and ex post competitive balance. That is, in both ex ante and ex post, some groups are more balanced than others. The ex ante competitive balance is not a good predictor of the ex post competitive balance in terms of specific groups per season. However, the ex post competitive balance, on average, is significantly explained by the ex ante competitive balance.

The article is structured as follows. In Section 2, Material and methods are presented. Results are discussed in Section 3, in which the ex ante competitive balance is calculated, the possible differences between groups are identified, and their average progress over the seasons are analysed; similarly developed, but with the ex post competitive balance levels, and we compare these results: Are the ex ante and ex post competitive balances compatible? Lastly, the Discussion is presented.

2 | MATERIALS AND METHODS

From an ex ante point of view, we focus on the score or coefficient that the UEFA itself assigns to the participating teams, in accordance with their sporting track record in the competitions organised by this sporting body. UEFA coefficients (UEFA, 2019a) are based on historic performance in UEFA tournaments of clubs and their domestic leagues; hence, by design, they do not incorporate all available information pertinent to predicting current club performance. However, they are used by the UEFA to form groups. Therefore, it is logical to ask the following questions: are the groups designed in such a way as to ensure similar levels of competitive balance? In other words, are the teams homogeneously distributed over the groups to ensure that they are of similar levels of competitiveness? From UEFA's point of view, the UCL groups should clearly not be perfectly balanced. If they were perfectly balanced "within," they would be unbalanced "between" groups. This would mean a lot of top clubs would be eliminated in the group phase, destroying interest in the later part of the tournament.

From an ex post perspective, we take into account the points awarded to each team after playing all the games corresponding to their group. Irrespective of the way in which the groups were originally seeded, we can ask ourselves: have the demonstrated strengths of the different groups been similar over each season?

We compare the levels of competitive balance ex ante and ex post. How far are they compatible, and in what sense are they related to each other? It seems reasonable to think that in European football, there is a high concentration of strength and talent in certain clubs, which is equally obvious in their domestic national and UCL championships. What can we infer about the relationship between the competitive balance in the groups designed by the UEFA and the competitive balance reached in the same groups after a competition?

2.1 | Changes in the UCL regulation

Both before and after the competition, we calculated the competitive balance of each group in each of the seasons analysed, that is, from the season 1999/2000, in which the format of 32 teams was first introduced, up to 2017/2018. The group stage starts with the 32 teams, who have, at least in theory, demonstrated the greatest strength and competitiveness.

A relevant change in the regulation took place in the 2009/10 season. The group stage featured the 22 automatic qualifiers and 10 winners of the play-off round, five through the Champions Path and five through the Non-Champions Path (UEFA, 2009). As we will see later, this change in regulation is substantially significant in the evolution of the ex ante competitive balance.

The 32 participating teams in the UCL group stage are seeded into four groups or "pots," here with eight teams in each. The composition of the first group ("Pot 1") has changed over time. Until the 2015/2016 season, the

seeding of the teams was determined by the UEFA club coefficients. In the 2015/2016 season, this changed. Pot 1 contained the title holders and the champions of the top seven associations based on their UEFA country coefficients. If the title holder is one of the champions of the top seven associations, the champions of the association that are ranked eighth are also seeded into Pot 1. Pots 2, 3, and 4 contain the remaining teams, seeded based on their UEFA club coefficients.

Therefore, in the period covered by the current article, there has been a change in the composition of the first draw pot. The UEFA club coefficients have been changed to UEFA country coefficients. In practice, it is true that the UEFA coefficients are used by UEFA to form the groups: UEFA club coefficients (based on historic performance in UEFA tournaments of clubs in their domestic leagues) or UEFA country coefficients (historic performance of national teams). Nevertheless, a number of additional criteria have been used over time. For instance, teams belonging to the same domestic League cannot be grouped together and, in some seasons (from July 2014), it was ruled that teams belonging to different countries (particularly, Russia and Ukraine) could not be placed in the same group. In practice, the implications of this change have not been very significant overall.¹

After these four groups of eight have been ordered, a draw decides the formation of the eight competition groups, with four teams in each. The teams from the first group of eight head each one of the competition groups drawn; in succession, the next eight teams from the second group are also assigned by a draw to each of the eight competition groups. Likewise, the third and fourth groups. The one restriction is that teams from the same association cannot compete in the same group.

Finally, in each competition group, the four teams play a double round-robin league with a scoring system of points for a win (p_w), draw (p_t), and loss (p_l): $\{p_w, p_t, p_l\} = \{3, 1, 0\}$. The first two from each group qualify for the round of 16 according to the total score reached after this league. From then on, there are double elimination rounds apart from the final, which is a single elimination round. Our interest lies in the competition phase for groups.

2.2 | Measuring competitive balance

Owen and Owen (2020), Scelles et al. (2020), and Dubois (2022) highlighted the distance to competitive balance (DCB) index to measure the competitive balance. This metric is preferred for this analysis because it fulfils the cardinality property (Triguero Ruiz & Avila-Cano, 2019) which, taking the unit interval as the range, is represented by a mathematical distance, thereby ensuring that the ratios are maintained. Moreover, it is interpretable in terms of the percentage of concentration, which means that its differences are significant in terms of percentage points. The index is defined as follows:

$$DCB = \sqrt{\frac{HHI - HHI_{\min}}{HHI_{\max} - HHI_{\min}}}$$

¹The incorporation of the UEFA country coefficients mean the following:

- In the 2015/2016 season, PSV Eindhoven was in Pot 1, even though, based on the UEFA club coefficient, it had not participated in the UCL. In contrast, Borussia Dortmund did not play in the UCL, even though it would have played in the UCL because of the UEFA club coefficient. Real Madrid and Atlético de Madrid participated in Pot 2 and would have participated in Pot 1 instead of Juventus and Zenit Saint Petersburg.
- In the 2016/2017 season, Leicester City and CSKA Moscow would not have played in the UCL. Benfica was in Pot 1 and would have been in Pot 2. Atlético de Madrid, Sevilla CF and Borussia Dortmund were in Pot 2 and would have been in Pot 1.
- In the 2017/2018 season, Chelsea, Shakhtar Donetsk and Benfica would have been in Pot 2 instead of Pot 1, and Monaco in Pot 4 instead of Pot 1. Spartak Moscow would not have participated, even though they were in Pot 1. Meanwhile, Atlético de Madrid, Barcelona FC, Sevilla CF, PSG and Manchester City were in Pot 2 and would have been in Pot 1.

Therefore, the modification affected one (PSV Eindhoven), two (Leicester City and CSKA Moscow), and one team (Spartak Moscow) per season that participated in the UCL under the new criteria and would not have done so under the previous one. This change in regulations will also be considered later.

TABLE 1 Distance to competitive balance index in the UEFA Champions League group stage (1999/2000–2017/18). EX ANTE analysis

Group	A	B	C	D	E	F	G	H	Min.	Max.	Mean	Range	Standard error of the mean	Confidence interval $t_{95\%} = 2.3646$
1999/00	0.717	0.652	0.488	0.671	0.693	0.500	0.402	0.317	0.317	0.717	0.555	0.399	0.053	0.430 0.680
2000/01	0.585	0.680	0.576	0.398	0.523	0.635	0.506	0.509	0.398	0.680	0.551	0.282	0.031	0.478 0.625
2001/02	0.632	0.332	0.309	0.314	0.428	0.590	0.577	0.524	0.309	0.632	0.463	0.323	0.047	0.351 0.575
2002/03	0.500	0.694	0.696	0.360	0.347	0.686	0.336	0.607	0.336	0.696	0.528	0.360	0.058	0.392 0.664
2003/04	0.361	0.500	0.391	0.454	0.550	0.779	0.386	0.418	0.361	0.779	0.480	0.418	0.048	0.366 0.594
2004/05	0.459	0.533	0.605	0.643	0.375	0.581	0.558	0.429	0.375	0.643	0.523	0.267	0.033	0.445 0.601
2005/06	0.685	0.683	0.638	0.346	0.587	0.588	0.498	0.743	0.346	0.743	0.596	0.397	0.045	0.491 0.701
2006/07	0.485	0.556	0.593	0.446	0.460	0.572	0.486	0.731	0.446	0.731	0.541	0.285	0.033	0.463 0.619
2007/08	0.467	0.514	0.403	0.467	0.385	0.447	0.326	0.526	0.326	0.526	0.442	0.201	0.024	0.386 0.498
2008/09	0.783	0.635	0.411	0.528	0.654	0.411	0.426	0.626	0.411	0.783	0.559	0.372	0.048	0.445 0.674
2009/10	0.619	0.680	0.542	0.697	0.735	0.748	0.673	0.619	0.542	0.748	0.664	0.207	0.024	0.607 0.721
2010/11	0.361	0.388	0.822	0.736	0.722	0.775	0.567	0.622	0.361	0.822	0.624	0.460	0.062	0.479 0.770
2011/12	0.534	0.680	0.462	0.607	0.712	0.517	0.406	0.962	0.406	0.962	0.610	0.556	0.062	0.463 0.757
2012/13	0.511	0.629	0.431	0.456	0.707	0.652	0.723	0.660	0.431	0.723	0.596	0.292	0.040	0.501 0.691
2013/14	0.607	0.660	0.445	0.628	0.516	0.295	0.565	0.634	0.295	0.660	0.543	0.365	0.043	0.441 0.646
2014/15	0.689	0.841	0.476	0.457	0.627	0.649	0.695	0.493	0.457	0.841	0.616	0.385	0.047	0.505 0.727
2015/16	0.719	0.257	0.764	0.370	0.762	0.680	0.661	0.514	0.257	0.764	0.591	0.507	0.067	0.431 0.750
2016/17	0.505	0.386	0.612	0.777	0.348	0.836	0.610	0.619	0.348	0.836	0.587	0.487	0.060	0.444 0.729
2017/18	0.262	0.654	0.692	0.581	0.921	0.517	0.560	0.704	0.262	0.921	0.612	0.659	0.066	0.454 0.769

Note: DCB values for each of the eight groups per season. Mean, minimum, maximum, range, standard error, and confidence interval (95%) for the values. Those season-groups outside the confidence interval of the season are highlighted.

where HHI is the Herfindahl–Hirschman index, defined as the sum of the square of the points shares by the teams in the league; $HHI_{\min} = \frac{1}{N}$ is the minimum value in a league of N teams; and HHI_{\max} is the maximum value, which is less than the unit as it is unable to reach the monopoly configuration, and which must be calculated according to the number of teams and the scoring system of the championship (Avila-Cano et al., 2021).

3 | RESULTS

Our interest lies in (i) identifying whether the composition of the UCL groups of each season has been compatible with a balanced and homogeneous design from the perspective of *ex ante* competitive balance; (ii) calculating the *ex post* competitive balance of the groups and their progress; and (iii) analysing the relationship between both levels of competitive balance before and after the competition.

3.1 | Ex ante competitive balance analysis

In each season, as each UCL competition group is determined by the strengths and proven capabilities of the participating teams, based on the UEFA coefficients (association and clubs) and the role of chance in the final set-up, it is reasonable to think, *ex ante*, that the competitive balance of the groups is similar. The groups are formed according to the degree of strength that the teams have displayed over the previous season, historically, and in terms of their competitive environment—that is, their corresponding national leagues.

The groups have been designed in such a way that, at least nominally, there is a high concentration of results in each of them: the theoretically best, or strongest, teams are spread out, one in each group. Thus, in each group, for each season, at least one of the teams proved themselves to be substantially higher in UEFA coefficient over the rest, and, by the same token, at least one team tended to have a substantially lower coefficient. It is therefore not surprising that the competitive balance of each group is relatively low. However, even if it is low within the groups, it would be desirable for it to be homogenous or similar among the groups.

Therefore, the crux of the matter does not lie in the level of competitive balance but in the homogeneity of the competitive balances reached by the teams in each season. Can we find substantial differences between the groups' levels of competitive balance in each season? If so, and if they persist over seasons, then they indicate that the composition of the groups does not follow a sufficiently balanced pattern in terms of competitive balance, or in other words, there are “easier” groups than others, and, given this, the design of the groups is questionable from the point of view of their *ex ante* competitive balance.

However, we know that the major European football leagues have, overall, shown high and increasing growth in the concentration of results, that is, a decrease in competitive balance (García Villar & Guerrero Rodríguez, 2007; Michie & Oughton, 2004; Owen et al., 2007; Pawlowski et al., 2010; Triguero Ruiz & Avila-Cano, 2019). It would not be logical to analyse the progression of each group, whose composition is random, based on the rules. But, what if we question the evolution of competitive balance over the last few seasons on a global scale: Has it, too, shown an upward trend, and in such a way that the concentration of results is reflected not only in the top national leagues but also in the UCL?

We used the UEFA coefficients of the teams to measure the *ex ante* competitive balance of each group. The shares were calculated from the sum of the UEFA coefficients of the teams for each group. Using as the basis each club's coefficients from the 1999/2000 season to 2017/2018 (UEFA 2019b), the DCB index of each of the eight groups formed in each season by the UEFA was built. Table 1 shows the results, together with a first statistical analysis (minimum, maximum, mean, standard error, and confidence interval).

Based on the results, we answered the first question: Can we see substantial differences between the *ex ante* levels of the competitive balance of the groups in each season? The answer is affirmative. Note that 44% of the

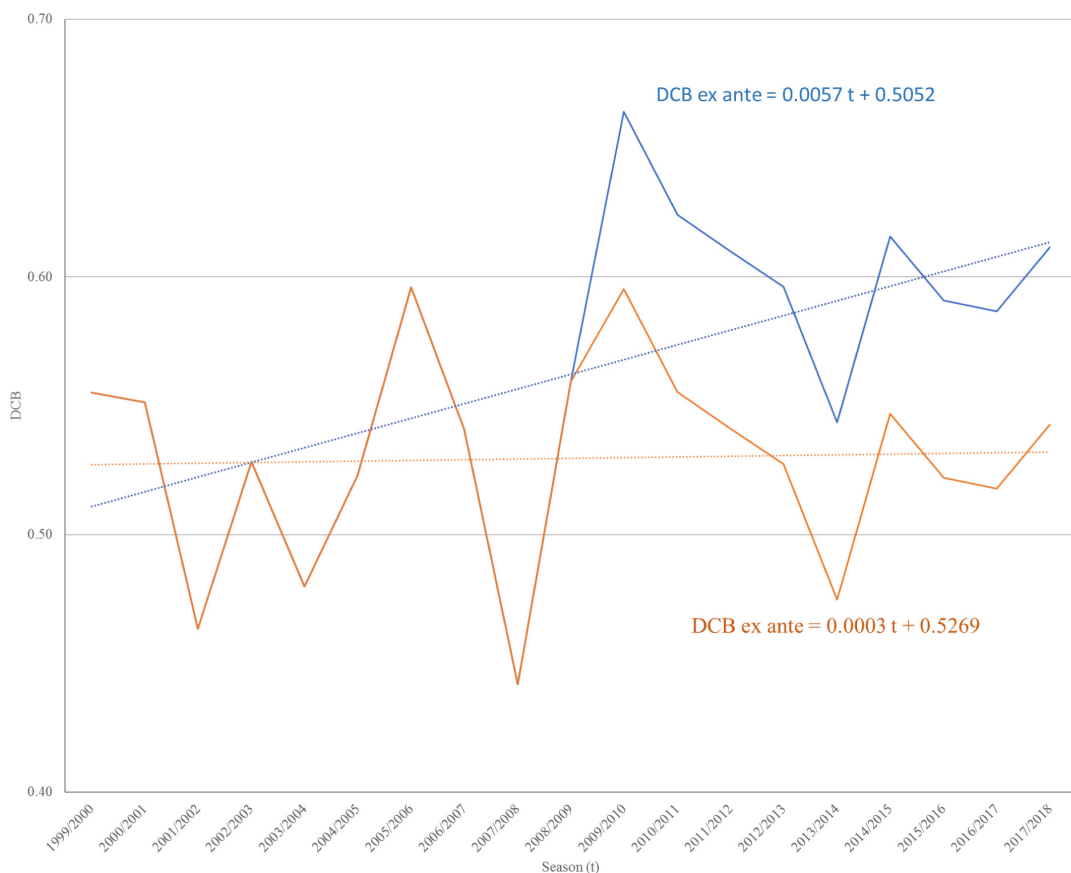


FIGURE 1 Evolution and trend of the average ex ante competitive balance per season in the group stage of the UEFA Champions League (1999/2000–2017/2018). The trend of the average ex ante competitive balance has been decreasing over time (blue line). However, the trend of the average ex ante competitive balance has not decreased over time if we consider the change in the UCL regulation (red line). Original data (blue line): Student's $t = 2.7476$ and $p = 0.0137$ (**), with the positive slope of the temporal regression: 0.0057 ($SE = 0.0020$). $R^2 = 0.307$. Transformed data with step effect from the change in the UCL regulation (red line): Student's $t = 0.1522$ and $p = 0.8808$, coefficient 0.0003 ($SE = 0.0018$). $R^2 = 0.01$.

observations (67 out of 152 cases) of competitive balance were outside the confidence interval for that season, defined as 95%. In all seasons, there were values outside the confidence interval (between two and six of the eight values). These observations are highlighted in Table 1.

Therefore, we can affirm that at the design level of the groups, there were indeed statistical differences in the competitive balance: there were significantly more balanced groups than others.

At the group level, the average competitive balance clearly showed a significant drop over time. More specifically, the mid-five years of the DCB index have grown from 51.5 (1999/2000 to 2003/2004) to 53.2, 60.7, and 60.1 (2014/15 to 2017/18), so the overall average has been 56.3. In the first decade, only two seasons had higher DCB values than the average ones, while in the second decade there were eight seasons with a higher concentration of results. Figure 1 clearly shows this trend, which was also confirmed by a seasonal regression.

In 2008/09, UEFA approved modifications to the preliminary qualifying phase. These changes were implemented in the following season. Figure 1 shows a possible jump in the evolution of the competitive balance thereafter. To identify the significance of this change, we have introduced a dummy variable from the 2009/10

TABLE 2 Distance to competitive balance index in the UEFA Champions League group stage (1999/2000–2017/18). EX POST analysis

Group season	A	B	C	D	E	F	G	H	Min.	Max.	Mean	Range	Standard error of the mean	Confidence interval $t_{95\%} = 2.3646$	
1999/00	0.5682	0.7171	0.3780	0.4660	0.5689	0.4509	0.6993	0.2893	0.2893	0.7171	0.5172	0.4278	0.0529	0.3921	0.6423
2000/01	0.6386	0.6193	0.4513	0.1634	0.2736	0.3576	0.4167	0.3943	0.1634	0.6386	0.4144	0.4752	0.0567	0.2803	0.5485
2001/02	0.5576	0.4374	0.2916	0.3001	0.3919	0.7715	0.3636	0.7336	0.2916	0.7715	0.4809	0.4799	0.0663	0.3241	0.6377
2002/03	0.2677	0.8508	0.3749	0.3971	0.4305	0.5689	0.5957	0.8137	0.2677	0.8508	0.5374	0.5831	0.0743	0.3617	0.7131
2003/04	0.1948	0.1634	0.5446	0.4902	0.6882	0.7171	0.4420	0.2218	0.1634	0.7171	0.4328	0.5537	0.0774	0.2497	0.6158
2004/05	0.5590	0.6307	0.7241	0.6630	0.5339	0.4660	0.8137	0.4420	0.4420	0.8137	0.6040	0.3716	0.0453	0.4970	0.7111
2005/06	0.8267	0.8375	0.6550	0.2736	0.4020	0.7241	0.5342	0.4969	0.2736	0.8375	0.5937	0.5639	0.0715	0.4246	0.7629
2006/07	0.7314	0.4767	0.4882	0.5889	0.7336	0.2893	0.4902	0.3636	0.2893	0.7336	0.5202	0.4442	0.0561	0.3875	0.6530
2007/08	0.3001	0.3943	0.4158	0.3791	0.5867	0.8518	0.7528	0.8330	0.3001	0.8518	0.5642	0.5518	0.0786	0.3783	0.7500
2008/09	0.4660	0.2361	0.6660	0.7221	0.3401	0.7655	0.5844	0.6282	0.2361	0.7655	0.5510	0.5294	0.0663	0.3942	0.7079
2009/10	0.8330	0.4882	0.4902	0.7809	0.8267	0.3807	0.6088	0.5682	0.3807	0.8330	0.6221	0.4522	0.0610	0.4779	0.7663
2010/11	0.3943	0.4660	0.7655	0.6916	0.5946	0.7715	0.6866	0.7715	0.3943	0.7715	0.6427	0.3772	0.0514	0.5212	0.7642
2011/12	0.7314	0.2361	0.7336	0.9291	0.4767	0.3919	0.2617	0.8110	0.2361	0.9291	0.5714	0.6930	0.0932	0.3510	0.7919
2012/13	0.8330	0.5648	0.3943	0.7171	0.6395	0.6193	0.5298	0.4834	0.3943	0.8330	0.5977	0.4387	0.0485	0.4829	0.7124
2013/14	0.7064	0.6903	0.6550	0.8248	0.5016	0.7143	0.7171	0.5342	0.5016	0.8248	0.6679	0.3232	0.0371	0.5803	0.7556
2014/15	0.5135	0.8137	0.3576	0.7600	0.6126	0.8330	0.6088	0.5940	0.3576	0.8330	0.6366	0.4753	0.0569	0.5021	0.7712
2015/16	0.8267	0.4305	0.5682	0.4427	0.5797	0.5832	0.7314	0.5946	0.4305	0.8267	0.5946	0.3962	0.0470	0.4835	0.7057
2016/17	0.8475	0.3456	0.7087	0.7598	0.4969	0.7221	0.7451	0.7819	0.3456	0.8475	0.6760	0.5019	0.0593	0.5357	0.8162
2017/18	0.7715	0.8248	0.5906	0.7299	0.5533	0.6521	0.6569	0.9507	0.5533	0.9507	0.7162	0.3974	0.0463	0.6068	0.8256

Note: DCB values for each of the eight groups per season. Mean, minimum, maximum, range, standard error, and confidence interval (95%) for the values. Those season-groups outside the confidence interval of the season are highlighted.

season onwards. This dummy is significant, so when discounting the jump effect, there is no statistically significant trend in the evolution of the average concentration of results when considering this change in UCL regulations.

3.2 | Ex post competitive balance analysis

Once the group stage of the competition is over, each of the four teams in each of the eight groups will have played six games. Therefore, given the score system, the maximum number of points that a team can reach is 18 and the minimum is 0. The perfectly balanced score share is reached if each team has points share equal to $\frac{1}{4}$. This distribution of results generates the minimum concentration in such a way that the corresponding value of HHI is: $HHI_{\min} = \frac{1}{N} = 1/4$, where N is the number of teams in the competition. The DCB index generates a null value: $DCB = 0$. In the case of ex ante competitive balance, it would be equivalent to all four teams having equal UEFA coefficient.

However, the least balanced point distribution, that is, that which generates the greatest concentration of results corresponds to a *Truncated cascade* distribution in the first team (Avila-Cano et al., 2021). Here, the first team will have won all their games (winning 18 points), whereas each of the other three teams will have lost the two games, and drawn with the other teams; thus, each of the three will have a total of 4 points. In total 30 points will have been shared out, and the share distribution will be (3/5, 2/15, 2/15, and 2/15). Note that this share distribution is the reference used for the ex ante analysis performed with the UEFA coefficients. This distribution generates the maximum concentration of results so that the corresponding value of the HHI index in this distribution is: $HHI_{\max} = 0.413$. The DCB index generates a unit value: $DCB = 1$.

The question remains: Is the ex post competitive balance similar across the eight groups? What has been the global evolution of the competitive balance reached over the last few seasons? Does the decrease in competitive balance exhibit a stylised fact in European football sporting competitions, whether on a national or European level?

To answer these questions, we calculated the DCB indices for each of the eight groups from the 1999/2000 seasons to 2017/18. We then counted on 152 observations of competitive balance corresponding to each of the eight groups for each of the 19 seasons.

Table 2 shows the results, together with an initial statistical analysis useful from the perspective of our interest. Once again, we observed substantial differences in competitive balance levels among the groups in each season, although now from an ex post perspective. In 47% of the observations (72 out of 152 cases), the competitive balance of at least one group was outside the confidence interval of 95%. In all seasons, there were values outside the confidence interval (between three and five of the eight values).

We can affirm that once the competition ended, statistically significant differences in competitive balance among the groups can be confirmed. There were groups that were significantly more balanced than others; that is, after the competition, the groups did not display a homogeneous performance in terms of competitive balance.

For its part, the mean competitive balance of the eight groups showed a statistically significant drop over time. More specifically, the 5-year averages of the DCB index have increased from 47.7 (1999/2000 to 2003/2004) to 56.7, 62.0, and 65.6 (2014/15 to 2017/18). Thus, if the overall average has been 57.6, then in the first decade only two seasons showed above-average DCB values, while in the second decade there were eight seasons with a higher concentration of results. Figure 2 illustrates this trend, which was also backed by a seasonal regression.

Therefore, we can affirm that the drop observed in competitive balance in the major European football leagues were also observed at a group level in the competition phase of UCL. As this competition has become established,

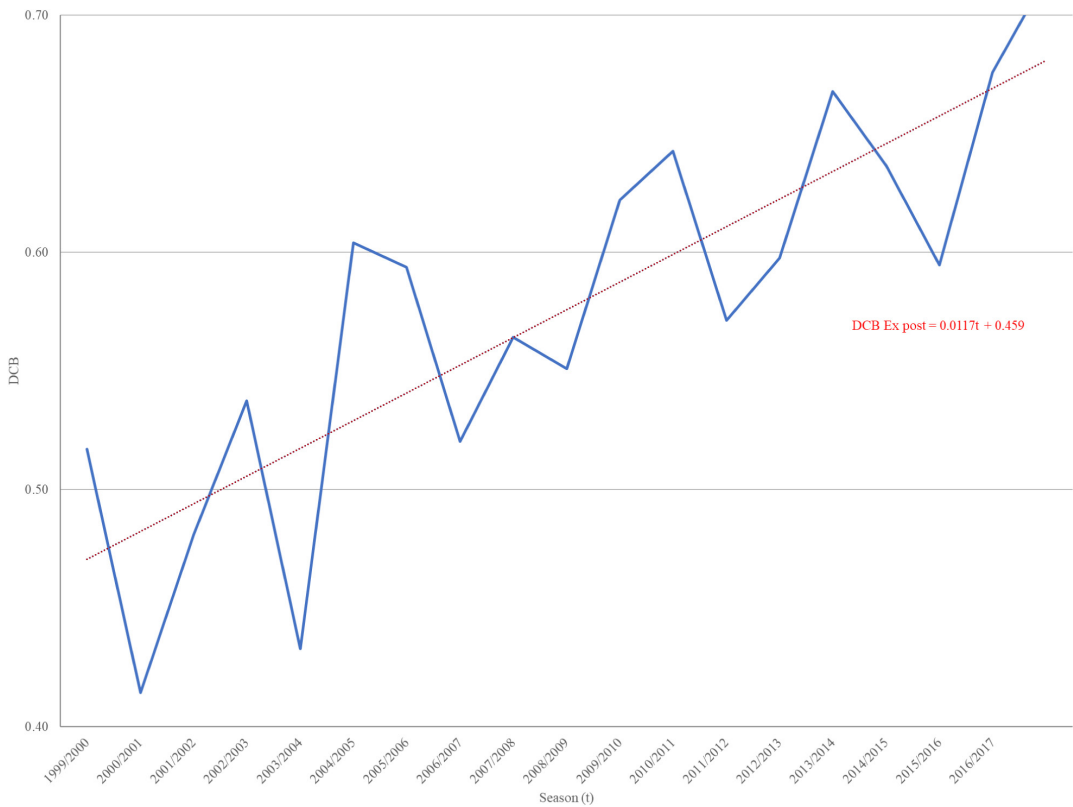


FIGURE 2 Evolution and trend of the average ex post competitive balance per season in the group stage of the UEFA Champions League. The trend of the average ex post competitive balance has been decreasing over time. Student's $t = 5.9854$ and $p = 0.0000$ (***) with the positive slope of the temporal regression: $0.0117(SE = 0.0019)$. $R^2 = 0.678$.

the concentration of results became significant, indicating the formation of a core of teams that were highly competitive, both in their respective national leagues and in Europe.

3.3 | Relationship between ex ante and ex post competitive balances

As shown in Tables 1 and 2, the levels of competitive balance reached ex ante and ex post differ from each other (which initially seems logical). The seasonal regressions shown in Figures 1 and 2 revealed that ex ante, the upward trend was less significant than ex post. This is due to including, for the purpose of forming the groups (ex ante), the coefficients of the clubs over 5 years, which adjusted or reduced the volatility in the rankings based on the latest results. However, ex post, the data were obtained from the last competition and were, in theory, subject to greater volatility. Indeed, the inclusion of the scores over 5 years “smoothed” the data as a moving average would (as well as contribute to ensuring the presence of the most structurally powerful teams).

In this section, we tackle the third research question: Are the ex ante and ex post competitive balances compatible? In other words, we wanted to ascertain the correlation between the groups' competitive balance before the competition, according to their strengths “summarised” by the UEFA coefficients, and after the competition, as demonstrated by the points achieved.

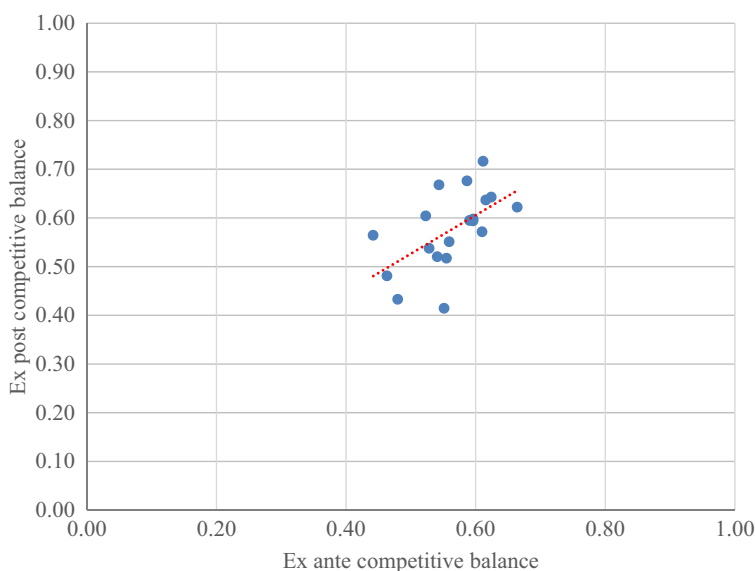


FIGURE 3 Regression DCB ex post versus DCB ex ante. Regression DCB ex post versus DCB ex ante ($N = 19$ seasons). The average ex ante competitive balance explains the ex post average competitive balance. Student's $t = 2.8800$ and $p = 0.0104$ (**) with the positive slope of the temporal regression: 0.7905 ($SE = 0.2745$). $R^2 = 0.328$.

3.3.1 | The ex post competitive balance according to the ex ante competitive balance

An initial approach could focus on the following question: Does the ex ante average level of the groups explain the ex post competitive balance average level of each season? A simple regression analysis shows us (Figure 3), with 95% significance, that the average ex ante competitive balance explains the ex post average competitive balance.

The above analysis involves regressing the seasonal average ex post competitive balance on the average ex ante competitive balance. Note that, as measured with the DCB index, we have chosen to represent the seasonal average competitive balance in Figure 3 in a two-dimensional 1×1 space. Thus, in addition to a strong association between the two averages, the overall levels of competitive balance are concentrated around 40%–70%.

However, the above approach does not consider the values of the competitive balance indices individually for each team and each season; rather, it considers the average per season. For this reason, another approach should be undertaken in terms of the existing correlation between the two matrixes, ex ante (**A**) and ex post (**P**), of the levels of competitive balance by groups and seasons shown in Tables 1 and 2. The correlation index $r(\mathbf{A}, \mathbf{P}) = 0.338$ reached a relatively low and barely significant value ($p = 0.1574$).

Likewise, a simple calculation of the correlation coefficients for each season (Table 3) between ex ante and ex post competitive balance levels for each group showed a high level of volatility: in five seasons, the correlation was negative, although weak, except for seasons 2006/2007 and 2008/2009. The correlation is in the main, positive, although there are six cases where it is low ($r < 0.5$) and nine above 50%. Only for the 2010/2011 season is the value $r > 0.8$.

Therefore, although the ex ante competitive balance, on average, explained the ex post competitive balance, the year-on-year correlation was highly variable.

To extend the analysis of the variability, we performed a two-way analysis of variance for both DCB ex ante and ex post, obtaining no evidence of significant differences between groups, but there are significant differences between seasons for DCB ex post. The results obtained can be seen in Table 4.

TABLE 3 Pearson's coefficient by season

Season	Pearson's coefficient	S_e	Empirical t	p-value
1999/00	0.4353	0.3675	1.1843	0.2811
2000/01	0.7459	0.2719	2.7428	0.0336
2001/02	0.6643	0.3052	2.1768	0.0724
2002/03	0.3787	0.3778	1.0022	0.3549
2003/04	0.6047	0.3252	1.8597	0.1123
2004/05	0.5383	0.3441	1.5644	0.1688
2005/06	0.6551	0.3085	2.1236	0.0779
2006/07	-0.7000	0.2915	2.4013	0.0532
2007/08	-0.1596	0.4030	0.3960	0.7058
2008/09	-0.6457	0.3117	2.0715	0.0837
2009/10	0.0779	0.4070	0.1915	0.8545
2010/11	0.8402	0.2214	3.7954	0.0090
2011/12	0.2876	0.3910	0.7355	0.4898
2012/13	-0.1309	0.4047	0.3233	0.7574
2013/14	0.0172	0.4082	0.0422	0.9677
2014/15	0.3982	0.3745	1.0633	0.3285
2015/16	0.6741	0.3015	2.2354	0.0668
2016/17	0.6388	0.3141	2.0338	0.0882
2017/18	-0.2613	0.3941	0.6631	0.5319

Note: Standard error (S_e), Student's t, and p-value. Highlighted $p < 0.1$.

TABLE 4 ANOVA two-factor without replication $DCB_{ex\ ante}$ and $DCB_{ex\ post}$

	Seasons		Group	
	F Empirical	p-value	F Empirical	p-value
DCB ex ante	1.3997	0.1428	0.9326	0.4839
DCB ex post	1.6339	0.0611	0.6263	0.7334

Note: Highlighted $p < 0.1$.

Next, we carried out an analysis based on the maximum likelihood estimation of a panel of bivariate data, season, and group. With this analysis, we want to obtain the ability of ex ante DCB to explain ex post DCB. To obtain evidence of the impact that the regulatory modifications, discussed above, here stacked in 2009–2010 and 2015–2016, have had on the evolution of the ex post competitive balance of the competition, we introduced two fixed factors starting in 2009/2010 and 2015/2016, respectively.

The model has been estimated as panel data. The results of the Chow, Hausman, and Breusch-Pagan tests suggest that the one-way (individual) effect within the model must be used. To undertake the estimation of the parameters, the R package (R Core Team, 2020) with the plm package (Croissant & Millo, 2008) has been used. Detailed results are shown in the [Tables A1](#) and [A2: Appendix A](#).

The variable reflecting the regulation applied as of the 2015–2016 season is not significant. The result obtained from applying panel data to explain DCB ex post with the variables DCB ex ante and the dummy variable that responds to the regulatory change, which is applied as of the 2009–2010 season, shows that the coefficients

TABLE 5 Differences in the competitive balance (DCB) in the UEFA Champions League group stage (1999/2000–2017/18) between ex ante and ex post analysis

Group	A	B	C	D	E	F	G	H	Mean	Standard error of the mean	Confidence interval $t_{95\%} = 2.3646$
1999/00	0.148	↓ -0.065	0.110	0.205	0.124	0.050	↓ -0.298	↓ 0.028	0.038	0.056	-0.095 0.170
2000/01	-0.054	0.061	↑ 0.125	↑ 0.234	↑ 0.250	↑ 0.277	0.089	↑ 0.115	0.137	0.039	0.044 0.230
2001/02	0.075	-0.105	0.017	0.014	0.036	-0.182	↑ 0.213	↓ -0.209	-0.018	0.050	-0.135 0.100
2002/03	↑ 0.233	↓ -0.157	↑ 0.321	-0.037	-0.084	0.117	↓ -0.259	↓ -0.207	-0.009	0.075	-0.186 0.168
2003/04	↑ 0.166	↑ 0.337	-0.154	-0.036	-0.138	↑ 0.062	-0.056	↑ 0.197	0.047	0.062	-0.099 0.193
2004/05	-0.100	-0.097	-0.119	-0.020	↓ -0.159	0.115	↓ -0.256	-0.013	-0.081	0.039	-0.174 0.011
2005/06	-0.141	-0.155	-0.017	0.072	0.185	-0.136	-0.036	↑ 0.246	0.002	0.054	-0.126 0.130
2006/07	-0.246	0.079	↑ 0.105	-0.143	-0.274	↑ 0.282	-0.004	↑ 0.367	0.021	0.083	-0.175 0.217
2007/08	0.167	0.119	-0.012	0.088	-0.202	↓ -0.404	↓ -0.427	↓ -0.307	-0.122	0.086	-0.325 0.080
2008/09	↑ 0.317	↑ 0.399	↓ -0.151	↓ -0.194	↑ 0.314	↓ -0.355	↓ -0.159	-0.002	0.021	0.101	-0.216 0.259
2009/10	↓ -0.213	↑ 0.192	0.051	-0.084	-0.091	↑ 0.368	↑ 0.064	0.051	0.042	0.064	-0.109 0.193
2010/11	-0.033	-0.078	0.056	0.045	0.127	0.004	-0.120	-0.149	-0.018	0.033	-0.097 0.060
2011/12	↓ -0.198	↑ 0.444	↓ -0.272	↓ -0.322	↑ 0.236	0.125	0.144	0.151	0.039	0.096	-0.189 0.266
2012/13	↓ -0.322	↑ 0.064	↑ 0.037	↓ -0.261	↑ 0.068	↑ 0.033	↑ 0.193	↑ 0.177	-0.001	0.067	-0.160 0.157
2013/14	-0.099	-0.031	↓ -0.210	↓ -0.197	0.014	↓ -0.419	-0.152	0.099	-0.124	0.057	-0.258 0.009
2014/15	↑ 0.175	0.028	↑ 0.118	↓ -0.303	0.014	↓ -0.184	0.087	-0.101	-0.021	0.058	-0.157 0.115
2015/16	-0.108	-0.174	↑ 0.196	-0.073	↑ 0.182	↑ 0.096	-0.070	-0.080	-0.004	0.050	-0.122 0.114
2016/17	↓ -0.343	0.041	-0.097	0.017	-0.148	↑ 0.114	-0.135	-0.163	-0.089	0.051	-0.210 0.031
2017/18	↓ -0.509	↓ -0.171	↑ 0.102	↓ -0.148	↑ 0.368	↓ -0.135	↓ -0.097	↓ -0.247	-0.105	0.090	-0.318 0.109

Note: ↑, Out of the confidence interval, upper tail; ↓, Out of the confidence interval, lower tail.

obtained are significant. Likewise, the empirical F of the model estimation is significant, and $R^2 = 0.1736$ of the variability of DCB ex post.²

3.3.2 | Qualitative coincidence

We continue with a more detailed analysis in which we attempted to answer the following question, with the intention of defining the relationship between the calculated ex ante and ex post competitive balances: Do the groups that, ex ante and ex post, performed around the average or markedly differently, coincide? To answer this, we examined the relationship between competitive balances from a qualitative point of view: a greater relationship will be linked to a season where both ex ante and ex post competitive balances are outside the confidence interval. For each group and season, Tables 1 and 2 show the DCB values corresponding to the ex ante and ex post competitive balances.

First, we observed that out of the 152 double observations, a third (46) were found within the corresponding confidence intervals, while the rest were outside these intervals only ex ante (34), only ex post (38) or almost equally, in both (34) (Table 5).

Second, around 53% of the observations qualitatively behaved in a similar way: either both competitive balances were around average or both were outside the confidence intervals. However, it is necessary to point out that 47% of the observations are qualitatively different: they stand out because the ex ante competitive balance was significantly different from the season average, without the ex post being so, and vice versa. The following subsection completes this analysis.

3.3.3 | Quantitative coincidence

Similarly, we asked whether the ex ante and ex post values reached were substantially different, that is, for the degree of their quantitative coincidence. We wanted to confirm whether these ex ante and ex post competitive balances are, although dissimilar, statistically different. Note that this is necessary because, while the possible result space of the ex ante analysis can be infinite, that of the ex post analysis is finite and limited. Therefore, the possible coincidences between values could be due to pure chance.

In fact, the number of possible league configurations (over which the ex ante competitive balance can be calculated) is infinite as far as they are not calculated according to results, but rather by indicators (from the points assigned by UEFA, as we have done throughout this article, the bets placed before games, or the composite indicators of the strengths and talent of the teams). Therefore, the domain of the measuring function of the ex ante competitive balance corresponds to the unit simplex with the $n-1$ dimension, where n is the number of teams. It is a continuous space. However, the number of possible league configurations that can be reached ex post is finite, given that the cardinality of the pattern of the results is finite: each team wins, loses, or draws each of their games, and can be calculated (Triguero Ruiz & Avila-Cano, 2019).

Thus, the degree to which the possible results space is discrete makes it necessary to ask whether, or not, the differences measured for each group and season between the ex ante and ex post competitive balances are statistically different from zero. For each possible ex post result, we identified the context of the possible results as statistically equal, ex ante.

Table 5 shows the differences between the levels of competitive balance for each group and season, highlighting those that are significantly different. We observed that out of the 152 data, 80 were not significantly different

²The fixed effects (individual) might be capturing differences between groups. The estimation indicates that there are groups in which ex post competitive balance shows upward or downward differences with respect to ex ante competitive balance. Table 5 shows that, over the course of the seasons, groups B, C and E finally turn out to be significantly more competitive than expected, compared with groups D and G.

from zero; that is, in over 53% of the cases, the levels of ex ante and ex post levels of competitive balance were similar. However, in the other 72 cases, they were different; specifically, in 38, the ex post competitive balance increased with respect to the ex ante level (the DCB index decreased), and in 34, it decreased (DCB grow), in such a way that the outcome of the competition dramatically alters the degree of competitive balance that was predicted at the start of the season.

Therefore, it is not wise to use a group's ex ante competitive balance to forecast the ex post competitive balance. The risk of error was approximately 50%, and there was no predetermined bias.

4 | DISCUSSION AND CONCLUSION

In this article, we examined the concept of competitive balance from a twofold perspective: before the competition, with which the strengths and talent of the participating teams are linked, and after the competition, which incorporates the performance of these strengths and talent. The competitive balance was measured in the scope of the UCL group stage from both points of view, and in turn, they were compared.

The reference variable of the ex ante competitive balance was the UEFA coefficient of the clubs, given that this summarises the strengths and talents of the teams. For the ex post competitive balance, the final score distribution after the competition was used. The analysis encompassed the seasons between 1999/2000 and 2017/2018. The use of the DCB index ensured the significance of the differences between the two measures of competitive balance, in addition to assuring us that the ratios were maintained.

By calculating the ex ante competitive balance from the clubs' UEFA coefficients, we were able to compare the levels of the groups' competitive balance for each season. Given the way in which the groups are formed by the UEFA, the competitive balance among them should be, at least in principle, low and homogenous. Calculating the ex post competitive balance based on the final scores also allowed us to analyse the global evolution of the groups' competitive balance. Given the downward evolution, confirmed in the literature, of competitive balance in the major European football leagues, it seems reasonable to assume that the concentration of results for the UCL groups has also grown.

What has been the result? The competitive balance of the UCL groups over the last two decades has been low and decreasing, the same as in the major European leagues. The DCB value, on average for the two decades, has been between 56.3% and 57.6% in terms of ex ante and ex post, when the average of the five major European football leagues has been around 40%–41% (Triguero Ruiz & Avila-Cano, 2019). Decreasing, both at ex ante and ex post levels, to such a degree that the slope values are significantly different from zero in the seasonal regressions of the DCB indices.

Our analysis included a comparison of both levels of competitive balance. On the one hand, the degree to which the ex ante summarises the recently demonstrated strengths of the clubs in their national associations, and in the competitions organised by the UEFA, could make it a relevant variable to explain the level of competitive balance ex post on an aggregate level or as an average. On the other hand, if we look at the specific indices of each group and season, we can suggest the existing level of correlation on a global level and by season, thereby confirming whether they are significant or not. The degree to which we can identify those groups that have a competitive balance outside the confidence interval allows us to complete a qualitative analysis to identify the degree to which these groups coincide ex ante and ex post. In quantitative terms, we analysed the statistical differences between the calculated DCB indices.

Based on our results, we can reject the idea that the UCL groups were homogenous in terms of ex ante and ex post competitive balance. Ex ante, in 44% of the cases, there were significant differences with respect to the average. In all seasons, at least two and up to six groups out of the eight had competitive balance values outside the confidence interval. Ex post, in 47% of the cases, there were significant differences with respect to the average,

and in all seasons, from three and up to five groups out of the eight, had competitive balance values outside of the confidence interval.

In the current article, we do not discuss whether a higher or lower level of competitive balance affects the uncertainty of the results and sporting demand. This is a broad and fertile field that has parallel development. However, certainly, few world football authorities would argue for competitions having a greater concentration of results around a few teams. Therefore, if European football decision-makers are interested in increasing the competitive balance of the UCL, they need to act more effectively.

In this sense, UCL's new format with more teams should, in principle, favour higher levels of competitive balance and break the trend shown in recent years. On the other hand, the scoring system establishes the rewards or incentives for winning. This is part of the mechanism that generates the results in a competition. Hence, the move to a scoring system that rewards 3 points to the winner, 0 to the loser, and 2 points in case of a draw have led to an increase in the competitive balance. The incorporation of such mechanisms into the scoring system (as happened in the 2017 Six Nations rugby tournament by introducing offensive and defensive bonuses) is another element of interest to increase the competitive balance and decrease the concentration of results.

It is true that the UCL must maintain a high competitive tension to ensure the attention of the fans. In this respect, the impossibility for two teams from the same federation to belong to the same group can be a useful factor. However, this can also sometimes be awkward if teams from the same country have large differences in UEFA points, which ends up altering the ex ante competitive balance of the two groups. Perhaps, in such cases, UEFA should set limits on this based on the difference in quality between the teams from the same country that qualify for the group stage.

On the other hand, the development of women's football in recent seasons is unquestionable. It would be interesting to build, from the beginning, competitions in which the achievement of high levels of competitive balance would be one of the main goals for the sports authorities, particularly in the UEFA Women's Champions League.

Thus, we can summarise our main conclusions: (i) As has occurred in the major European football leagues, the UCL group phase has suffered a notable drop in competitive balance over the last two decades. (ii) The elevated levels of concentration of the results that groups show in the UCL are to be expected, given the way in which groups are formed. This is because the teams are assigned in accordance with the UEFA coefficients, as well as other factors, such as the impossibility that two or more teams of the same league can compete in the same group. (iii) Although the design mechanism for the groups should enable the groups to be comprised homogeneously in terms of ex ante competitive balance, this is not the case. The ex post competitive balance itself proves this. (iv) The ex ante competitive balance is not a good predictor of ex post competitive balance in terms of specific groups per season. However, the ex post competitive balance, on average, is significantly explained by the ex ante competitive balance. (v) The ex ante and ex post competitive balances show weak correlations, overall, and per season, and neither qualitatively nor quantitatively do they coincide in more than half of the observations. (vi) These results may be useful to football authorities and managers in designing championships and tournaments.

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APPENDIX A

TABLE A1 Test and estimated models

Test	Variable/effect	Value	Degree of freedom	Conclusion
Dickey-Fuller	DCB ex ante	-7.2424***	-	Stationary
Dickey-Fuller	DCB ex post	-6.2732***	-	Stationary
Hausman	Within/Random	1.4659 ^{ns}	1	Not significant
Breusch-Pagan	Time	0.7212 ^{ns}	1	Not significant
Breusch-Pagan	Individual	0.2355 ^{ns}	1	Not significant
Chow	Within/No pooling	3.1361***	7/136	Individual (Group)
Chow	Pooling/No pooling	1.4365 ^{ns}	14/136	No pooling

Note: $N = 152$ (19 seasons and eight groups).

^{ns}No significant, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A2 Maximum likelihood estimation of the function DCB ex post vs DCB ex ante and Dummy_09_10 with Oneway (individual) effect within model

Parameters	Estimate	R^2 (%)	F-statistic
DCB ex ante	0.3647*** (0.1034)	17.99	10.3132***
Dummy_09_10	0.0705*** (0.0319)		
Dummy_15_16	0.0438 ^{ns} (0.0420)		

Note: Standard Error in brackets.

^{ns}No significant, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.