UNCERTAINTY COEFFICIENT AS A METHOD FOR OPTIMIZATION
OF THE COMPETITION SYSTEM IN VARIOUS SPORTS

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Abstract

Larger equality of the matches in sport contests could hypothetical motivate the players and teams to play with greater pleasure, and to maintain that level of motivation for achievement that they can provide or maintain the progress achieved levels of achievement in a particular sport. What is the number of points scored (or other indicators of the success) at defeated teams, they are more uncertain. Coefficient of uncertainty of the competition, which proposes Bućo, is an attempt to define the uncertainty of the matches in certain competition. Based on the coefficient of uncertainty, could be proposed corrections competitive system, in terms of faster acceleration of the more successful teams in certain levels of competition. However, it should take account of the alert in making decisions on the basis of the coefficient of uncertainty, since it previously should be validated by the comparative studies, and longitudinal research of the accelerated and decelerated teams in league competitions must be performed.

Key words: *system, competition, uncertainty coefficient*

Introduction

There are two terms that usually occur in literature, important in sport economy, as same as in stimulating motivation for atheletes in some sport contest and for sport attendants, too: "competitive balance" and "outcome of uncertainty". But the "competitive balance" and "outcome of uncertainty" are not the same phenomenon. Those terms are closely linked, but the "competitive balance" studies impact of alternative point systems on the competitive balance in professional sport leagues. The "outcome of uncertainty" means an effort that competition as a whole, doesn't have a predetermined winner at the outset of competition (Halicioglu, 2006). Despite of difference described, we shall present simultaneously previous researches in these necessary connected fields (uncertainty and competitive balance). One of the important differences between sports organizations and other industrial organizations is the issue of competitive balance. Whereas most industrial enterprises attempt to keep competition to a minimum, a lack of competition in the case of sport teams makes for boring games and ultimately fans lose interest (Depken & Wilson, 2006; El Hodiri & Quirk, 1971). This lack of interest would lead to a loss of revenue, as fewer fans would attend games or listen to or watch media presentations. While fans certainly prefer to see their teams win, they want them to at least have a chance of losing. Economists refer to this as the uncertainty of outcome hypothesis (Leeds & Von Allmen, 2005). Fort & Maxcy (2003) summarize the literature on competitive balance. Different measurements are of different use, and all lines of research into competitive balance have, to date, proven quite instructive. To ignore this is to forget important insights into the behaviour of competitive balance. The North American model of resource allocation in professional sports leagues is adapted for English (association) football (Fort, 2000). Comparisons are drawn between the equilibrium allocations of playing talent under objective functions of profit maximization and win percent maximization subject to a financial constraint. An analysis of match results in the FA Cup suggests an increase in competitive imbalance between teams at different levels of the league's divisional hierarchy, as the theory suggests (Dobson & Goddard, 2004). In the models of Fort & Quirk (1995) and Vrooman (1995), competition becomes more unbalanced if the difference between populations sizes increases. Competition also becomes more unbalanced if the elasticity of revenue with respect to win ratio increases; here the equivalent condition is an increase in coefficient (Li). If this elasticity increases, it is efficient for the big-city team to employ more talent and the small-town team less, because the farmer's revenue gain exceeds the latter's loss (Fort & Quirk, 2002). Szymanski (2001) interprets declining cup attendances (FA Cup) as signifying increasing inter-divisional competitive imbalance between league teams.

Competitive balance is measured directly using match results data, rather than indirectly via a hypothesized relationship with attendance. Halicioglu (2005) aims at predicting the most likely winners of international football tournaments. He employs a relatively simple statistical method, which is based on the seasonal coefficients of variation (CVs) of the end-of-season points from domestic football leagues to measure the degree of competitive balance and to use it as a comparative indicator between the contesting countries in international football tournaments. The results based on the short, mid and long-term seasonal CV values suggest that this forecasting approach provides significantly reliable results in the case of Euro 2000 but not in the case of Euro 2004. Halicioglu (2006) considered the fundamental importance of the competitive balance for the football demand. Amongst many point systems analyzed, the most competitive football league took place when the point system of three points for a win, two points for a draw and one point for a loss was in use. However, results showed that competitive balance in a league may not be approved just by switching between the point systems. Halicioglu (2005, 2006) suggested CV-point system that is better than classical point systems. Outcome of uncertainty in professional team sports is one of the fundamental concepts in the economics of professional sports, but it's very elusive to measure it. In analyzing competitive balance, the first approach is linked to the professional sports in USA, where there is no relegation or promotion between the separate divisions. European system is based on the seasonal promotion and relegation. Peel & Thomas (1988) analyze the determinants of match attendances in the English Football League using an improved measure of match outcome uncertainty based on the probability of home team success. Simmons, Forrest & Buraimo (2008) models both the choice of which games to show and the size of audience attracted by each game, exploiting data on audience sizes for games between 1993 and 2002. They propose a new measure of match outcome uncertainty and, from our results; both the broadcaster and the audience appear interested in competitive balance. Owen & Weatherston (2004) investigate the determinants of attendance at New Zealand matches in the First Division of the National Provincial Championship (NPC) in 2000 to 2003. A general-to-specific testing procedure is used to select a set of factors that have a statistically significant effect on attendance, including previous attendance, traditional rivalries, team success and Ranfurly Shield matches. Palomino & Rigotti (2000) analyze a dynamic model of strategic interaction between

a professional sport league that organizes a tournament, the teams competing to win it, and the broadcasters paying for the rights to broadcast it on television. Demand depends positively on symmetry among teams (competitive balance) and how aggressively teams try to win (incentives to win). In order to get some idea of competitive balance, the researchers needed to measure the dispersion of winning percentages around this average. To do this, they measured the standard deviation. This statistics measures the average distance the observations lie from the mean of the observations in the data set.

$$\sigma = \sqrt{\frac{\Sigma(Wpct - .500)^2}{N}}$$

σ - standard deviation, Wpct - winning percentage,
N= total number of regular season games played

The larger the standard deviation, the greater the dispersion of winning percentages around the mean, and thus the less the competitive balance. (If all teams had a winning percentage of .500, there would be a standard deviation of zero, and there would be perfect competitive balance). Berri et al., (2005) explore the level of competitive imbalance across a variety of professional team sports we require a measure of the dispersion of wins in a league that allows inter-sport comparisons. As noted, most studies have focused upon one sport. The exception to this trend lies in the work of Fort & Quirk (1995; 2002), who sought to compare the level of competitive imbalance in Major League Baseball, the National Football League, the National Basketball Association, and the National Hockey League. To make comparisons across sports, these authors turned to the earlier work of Roger Noll (1988, from Berri et al., 2005) and Gerald Scully (1989, from Berri et al., 2005). Both Noll and Scully argued that the dispersion of wins could be measured by comparing "the actual performance" of a league to the performance that would have occurred if the league had the maximum degree of competitive balance in the sense that all teams were equal in playing strengths. The less the deviation of actual league performance from that of the ideal league is; the greater is the degree of competitive balance. The above intuition suggests the measure of competitive balance (C_B) reported in equation:

$$C_b = \frac{\delta_{actual}}{\delta_{ideal}} \text{ where } \delta_{ideal} = \frac{mu_{wp}}{\sqrt{N}}$$

C_b - *competitive balance*, mu - *mean winning percentage in the league*, δ_{actual} - *standard deviation of winning percentage for one team*, δ_{ideal} - *standard deviation of winning % if each team in a league has an equal probability of winning, N= total number of regular season games played*

Specifically, δ_{wp} is the standard deviation of winning percentages (or team points for leagues in which ties are possible) within league (i) in period (t). This is compared with the idealized standard deviation, which is defined by Fort & Quirk (1995; 2002) as the standard deviation of winning percentage if each team in a league has an equal probability of winning. The greater the actual standard deviation is relative to the ideal, the less balance exists within the professional sports league (Fort, 2000). The calculation of the idealized standard deviation employs both the mean winning percentage in the league (mu_{wp}) and the total number of regular season games played (N). Fort & Quirk (1995) argued that the above measure allows for inter-sport comparisons because it controls for the differing schedule lengths of professional sports leagues. Goossens (2006) introduce the National Measure of Seasonal Imbalance (NAMSI): the standard deviation of the winning percentages divided by the standard deviation when there is complete certainty about all outcomes of the games. He found that European competitive balance differs among countries and that depending on the interpretation of the concept other groups exist. The concepts of competitive balance and uncertainty coefficient are interesting primarily from the aspect of sports economics. Namely, greater uncertainty of a sport game or sports competition as a whole means higher interest of viewers. A growing number of viewers mean greater financial profit.

The uncertainty coefficient

Among the various means of quality analysis of the team games with a "limited" results the uncertainty coefficient (Bućo, 2007) could be the simplest and useful. Bućo originally applied this measure in of table-tennis team games, but the uncertainty coefficient could be applied in any team or individual games where the final result is limited: like in tennis, table tennis, badminton, bowling, etc. These are games where the possible score could vary from 20:0 to 10:10 (par example, like in bowling, with 20 maximum points for both teams), or from 5:0 to 5:4 (par example, like in table tennis team games, where game is finished when one of the teams reach 5 individual wins). The "logics" of the uncertainty coefficient is based on a final score of the game. One of the means of measuring uncertainty coefficient in the league (or uncertainty coefficient in an individual team game) is to follow the score. For example, the larger the number of matches won by the defeated team, the higher the uncertainty coefficient. For the championship or the chosen league (team) an average number of matches of the defeated team in the chosen league or

team can be calculated (in case of a team it is irrelevant whether it won or lost the match). Besides calculating the average, more importance could be given to uncertainty of result and instead of the average result the average of some higher exponents from the defeated teams' matches can be calculated. The simplest "version" of uncertainty coefficient is the one that offers the same coefficients for matches with the same score (an example presented here is given in team games with 10 individual matches played in the one team game). Consequently, the matches with the score 10:0 or 0:10 were given the coefficient 0, those which scores 9:1 and 1:9 the coefficient 1, scores 8:2 and 2:8 the coefficient 2, scores 7:3 and 3:7 the coefficient 3, scores 6:4 and 4:6 the coefficient 4, and the score 5:5 the coefficient 5. The total coefficients for all championship matches divided by the number of matches gives an average coefficient (shown within the results given). However, besides calculating the average, more importance could be given to uncertainty of the result and instead of the average result the average of some higher exponents from the defeated teams' matches can be calculated. In case of squares (exponent 2), or cubes (exponent 3), up to the maximum exponent 12, the uncertain matches have larger influence on the uncertainty coefficient value. These exponents could be given arbitrary, according to the researchers. Generally speaking, the uncertainty coefficient equations (Bućo, 2007) are:

$$CU_{team} = \frac{\sqrt[\exp]{\left[loss^{\exp.1.round} + loss^{\exp.2.round} + ... + loss^{\exp.last.round} \right]}}{N_{rounds}}$$

$$CU_{team} = \frac{\sqrt[\exp]{\sum loss^{\exp}}}{N_{team.games}}$$

"loss" – symbol for the number of individual matches won by the defeated team, "exp" – exponent (arbitrary), CU_{team} - team uncertainty coefficient, CU_{league} - league uncertainty coefficient, N_{rounds} – number of rounds, $N_{team.games}$ – number of team games in league championship

While the exponent is growing the main idea is weakening – the group of results (5:5, 5:5, 9:1, 10:0, 2:8) is no more uncertain than (5:5, 6:4, 4:6, 4:6, 6:4). Therefore, it is desirable to limit the value of the exponent onto potential ranges of minimum 0.1 up to maximum 12. In this research we used the simplest "version" of uncertainty coefficient, with the exponent 1. So, in our research, formulae given could be transformed into:

$$CU_{team} = \frac{loss^{1.round} + loss^{2.round} + ... + loss^{last.round}}{N_{rounds}}$$

$$CU_{league} = \frac{\sum loss}{N_{team.games}}$$

"loss" – symbol for the number of individual matches won by the defeated team, CU_{team} - team uncertainty coefficient, CU_{league} - league uncertainty coefficient, N_{rounds} – number of rounds, $N_{team.games}$– number of team games in league championship

Discussion and conclusion

The meaning and the limitations of the uncertainty coefficient

The "logic" base of the uncertainty coefficient is very simple. It depends on very low and limited range of possible results in specific type of the team games competition (10:0, 9:1, 8:2, 7:3, 6:4 and 5:5). Thus, we can say that uncertainty coefficient is a limited measure, in general. It can be applied only in the competitions with a limited number of possible results of the team matches. Utilitarian value of the uncertainty coefficient could definitely be contained in the possibility, on the basis of principally varying ''attractiveness'' of the matches (which is practically manifested in a higher number of matches with more balanced results), and on behalf of the public and the players, to modify the competition system, i.e. uncertainty of the matches. Par example, the competition in some league can be quite certain during one season (with one or two "dominant" and one or two "weak" teams), while during the other season the competition becomes in the same league becomes uncertain (when "weak" teams were relegated and the dominant teams promoted). Teams that have replaced promoted and relegated teams can have same competitive quality as the average team league in which they are now. We can also compare uncertainty level of the whole leagues (not only the teams that play in the same league). It is possible that inter-league uncertainty is realistically higher than intra-league uncertainty, which could reflect in lower correlation values between the team uncertainty coefficients and ordinary number of the league in which a team is positioned. The number of teams in some leagues is equal, and their competition with each other is uncertain. That partial uncertainty could be the reason why we are able to try to make different acceleration and deceleration systems for teams in the "weaker" and "better" leagues. The possible situation in some sport competition is an option when in "weaker" leagues in certain sport has less uncertainty in general. Motivation of players that are playing in teams in the "weaker" leagues probably differs from the motivation of players in teams in the "better" leagues.

Some teams in the "weaker" leagues are probably much more ambitious (they want to be accelerated), while the other teams play without motivation to make a progress. In the "better" leagues, most of the teams could have the similar motivation, playing more competitively and with more ambition. However, it could be possible to think of other systems of ''acceleration'' and ''deceleration'' for the purpose of increasing the uncertainty coefficient in competition, and after that check the effects by application of uncertainty coefficient after the championship. But we have to be careful with application of the proposals for these ''acceleration'' and ''deceleration'' systems, based only on the uncertainty coefficient. This measure has to be compared with other formulae for calculating competitive balance. For example, we can compare the results obtained by using formulae made by Palomino & Rigotti (2000) or Fort & Quirk (1995). This comparative study could be some type of validation of this new measure. On the other hand, it is not sufficient to analyze the uncertainty coefficient within leagues, because it doesn't incorporate any information about uncertainty coefficient if two teams from different leagues compete against each other. It would be much better to analyze the results of the teams that accelerated to better leagues. For instance, it is common that the team that won (say) 4th league and progressed to 3rd league was superior in this league, and next season progressed to second league. Then, the analysis of the performance of this team in 3rd or second league should be performed. One could see the impact of the presence of this team in 4th or 3rd league on the uncertainty coefficients. In other words, a certain longitudinal study has to be performed, to validate the uncertainty coefficient measure. A crucial flaw of the uncertainty coefficients obtained directly from the competition system is the fact that the total result does not necessarily need to be the realistic ''measure'' of the player's success. In actual competitions there may be some ''relaxing'' of the players in situations of more important result advantages or ''falling behind'' the opponent, ''prediction'' of a safe win or loss, ''teasing'' the anticipated more inferior or ''superior'' opponent during the whole match. A similar situation may occur in team matches, where for example when the result is solved there may be some ''relaxation'' or a ''fourth'' player may be introduced into the match, of weaker playing quality. It would be useful to use the uncertainty coefficient in other research work (perhaps in some other sports as well) on a multiple number of respondents in various competition ranks. Following coefficients, we can propose different ''acceleration'' and ''deceleration'' systems in inter-league competition.

However, we should make caution at decision-making only on the basis of coefficient of uncertainty, since it previously should be validated in comparative studies. Specifically, the results obtained using uncertainty coefficient should be compared with other types of indicators of competitive balance, as well as with the results in longitudinal research of "accelerated" and "decelerated" teams. Finally, we must not forget the fact that uncertainty coefficient is a limited measure. It can be applied only in the competitions with a limited number of possible results of team matches.

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KOEFICIJENT NEIZVJESNOSTI KAO METODA OPTIMIZACIJE
SUSTAVA NATJECANJA RAZNIH SPORTOVA

Sažetak

Veća izjednačenost mečeva u sportskim natjecanjima hipotetski bi mogla motivirati igrače i momčadi da igraju s većim zadovoljstvom, a i da održavaju onu razinu motivacije za postignućem koja im može omogućiti napredovanje odnosno održavanje postignute razine postignuća u pojedinom sportu. Što je broj osvojenih poena (ili drugih pokazatelja uspješnosti) poražene momčadi veći, susret je neizvjesniji. Koeficijent neizvjesnosti natjecanja koji predlaže Bućo, pokušaj je da se definira neizvjesnost mečeva u određenenom natjecanju. Na temelju koeficijenta neizvjesnosti, mogle bi se predložiti korekcije natjecateljskog sustava, u smislu brže akceleracije uspješnijih momčadi u pojedinim razinama natjecanja. Međutim, treba voditi računa o oprezu pri donošenju odluka samo na temelju koeficijenta neizvjesnosti, budući da ga prethodno treba validirati u komparativnim studijama, te u longitudinalnim istraživanjima akceleriranih i deceleriranih momčadi u ligaškim natjecanjima.

Ključne riječi: *sustav, natjecanje, koeficijent neizvjesnosti*