Entropy, competitiveness and UEFA football ranking

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Abstract:

This paper intends to explore the utilization of entropy through football, generalizing the interpretation of entropy. We consider it as a measure of competitiveness of football leagues and relate it to the UEFA ranking, which ranks yearly the performance of countries in European Cups. We expect that more competitive leagues, meaning that a championship is more leveled, have a better UEFA ranking. Correlating entropy with UEFA ranking, we find evidence of that relationship.

Keywords: entropy, football, competitiveness, UEFA ranking

1. INTRODUCTION

Entropy is a measure of information and uncertainty originally used in physics but used also in several different areas: financial economics (e.g. Dionísio et al, 2006), sociology (e.g. Bailey, 1990, 1993), psychology (e.g. Chen, 2003) or elections (e.g. Ferreira and Dionísio, 2012). Entropy was also used in sports by Sarkar (2008), when the author used different industry concentration measures, including entropy, in order to indicate an alternative ranking to the UEFA ranking.

In this paper, we use entropy with other purpose. In the study considered the base of the Information Theory, Shannon (1948) defines discrete entropy as

$$H(X) = - \sum p_i * ln(p_i) \qquad (1)$$

where p_i is the probability of the event *i*. Shannon's entropy is a measure of uncertainty which is non-negative. Zero is its minimum value, and it is only verified when exist one single event, which implies total certainty. The maximum entropy value is verified when the distribution is uniform, meaning that all events have equal probability ($p_i = 1/n$).

In this study, we use entropy in a different way. We want to compare the competitiveness of European Leagues to the annual UEFA ranking, which ranks European clubs and countries according to its performance in European football competitions (actually Champions League and Europa League). We use entropy to measures the competitiveness of each league, according to the distribution of points of each club. League standings do not give to us probabilities. However, we can transform it to relative frequencies, which verify some of the main properties of probabilities: $p_i > 0$ and $\sum p_i = 1$. So, the estimation of entropy is done with the proportions of points of each club. Because entropy is a measure sensitive to the number of events, we use in the study the relative entropy: the ration between the entropy and its maximum value. Suppose that in a given league, composed by three clubs, we have the following vector of the proportions of points: {0.5; 0.3; 0.2}. In this case, the estimation of entropy following equation 1, would take the value of 1.0297. Entropy takes its maximum value when the distribution is uniform, which implies the following proportion of points: {1/3; 1/3; 1/3}. So, entropy would take its maximum value, with 1.0986, and relative entropy would be 0.9372. Using relative entropy, we could compare leagues with different number of clubs.

A football league is more competitive when the difference of points between clubs is smaller. In this case relative entropy is closer to one. Our objective is to compare the competitiveness of leagues with the respective position in the UEFA ranking. We expect that how much competitive the league is, a better position that country has in the UEFA ranking. We make this interpretation because we consider that most competitive leagues make countries' club stronger to face their challenges in European cups.

Our results point to a significant correlation between the variables we use. We can conclude that the competitiveness of European leagues is correlated with the position of the country in the UEFA ranking.

The paper proceeds as follows. In the next section we present our data and methodology, explaining the relationship between the variables we use. Finally, we make a discussion on our results.

2. DATA, METHODOLOGY AND RESULTS

UEFA is the governing body of European football and each year ranks European countries according to the performance of countries' clubs in previous years. This is an important ranking because it determines the number of teams from each country that can participate in UEFA competitions. Actually 54 countries are ranked (you can consult the rules of the ranking in UEFA website). For this ranking, we used data for five seasons, from 2009/2010 to 2013/2014. For each year, we ordered countries from 1 to 53, according to its position in the ranking in the respective year. We excluded Liechtenstein of our list because it has not football league once clubs are included in Swiss league.

After this, we recovered the standing results for all 53 countries, for the same five seasons. As explained before, we got the points of each club in the final standing, transformed them to proportions and proceeded calculating the relative entropy of each country. We do not present data due to the dimension of tables. However, data is given upon request.

The objective of this paper is to find if exist any relation between the competitiveness of football leagues and the position of the country in the UEFA ranking. In order to analyze this relationship we used both Pearson and Spearman correlation coefficients. We tested the null hypothesis that variables are uncorrelated against the hypothesis that exit correlation between variables.

Pearson coefficient measures the correlation between data. We applied it to the correlation between the results of relative entropy and the UEFA ranking. Higher values of entropy mean more competitiveness while lower UEFA ranking mean that countries are better raked. So, we expect a negative correlation between variables.

Spearman coefficient measures correlation between ranks. In order to use this coefficient, we ranked also the value of relative entropy in different countries from 1 (higher relative entropy) to 53 (lower relative entropy). In this case, we expect a positive correlation, because lower ranks of relative entropy (meaning higher positions in competitiveness ranking) should be related with lower UEFA rankings.

Results are present in Table 1 and confirm that how much competitive is a European league is (given by a better distribution of points), better is the UEFA ranking of that country. All the coefficients are significant at least at 5% level.

Table 1 Correlation between league competitiveness and UEFA ranking

Correlation coefficient	2013/2014	2012/2013	2011/2012	2010/2011	2009/2010
Pearson	-0,3722**	-0,3524*	-0,6221**	-0,5463**	-0,3896**
Spearman	0,3071*	0,3605**	0,6691**	0,4832**	0,3084*

** denote significance at 1% level and * denote significance at 5% level

3. DISCUSSION OF RESULTS

We use entropy as a measure of equity distribution of points in European football leagues and interpret that equity distribution as a more competitive league. We also prove that more competitive leagues have better UEFA rankings.

This could be important for different football agents. First, for clubs and federations, that should fight to impose measures to ensure more competitive leagues. Those measures could be, for example, make leagues with a less number of clubs or other measures that federations think proper. Second for the players and/or its agents, for example, if their decisions of transfers are based on playing in clubs that have more probability to play in UEFA competitions (once better ranked countries qualify more teams for those competitions). Third, it could also be important for governments, once in Europe football has large popularity and is also a business that moves yearly millions of euros. Finally, in a world where bets are more frequent, this could also be important for betters: if we have all kind of bets, since the simpler related to bet about the result of a game to more composed bets (like the probability of Luis Suarez bit any player in the World Cup), why not to organize bets about the performance of a country in the UEFA ranking in the future?

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