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What detrended fluctuation analysis can tell us about NBA results

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HIGHLIGHTS

- It is applied the DFA to analyse the results of 28 NBA teams.
- All the teams show persistence in their results.
- The degree of persistence is different among teams.

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ABSTRACT

Basketball is one of the favourite sports in the United States and NBA the most popular basketball league in the world, followed not only by Americans but by fans everywhere. At present, people are increasingly interested in betting on sports in general and on basketball in particular. So analysis of trends in the results could be important for gamblers. In this paper, detrended fluctuation analysis is applied to 28 NBA teams, in order to understand if their results have (or not) any kind of memory. Our results show that all the teams are persistent in their results. Nevertheless, some teams have higher persistence than others, which could be important for gamblers in deciding how to bet.

1. Introduction

The National Basketball Association (NBA) is the main basketball league in the US and probably the most exciting in the world. Besides, NBA is also one of the world's sport leagues with the highest revenues. According to Forbes, in 2017 it was expected that the 30 teams could reach a total revenue of almost 5.9 billion USD and teams are valued at about 40.7 billion USD. The attendance report shows that the whole 2016/2017 season had about 22 million spectators while about 1.2 million people, on average, watch the games on TV.

As in other sports, NBA also attracts gamblers, with many people interested in betting on the results. There are several ways to bet: points per team, per quarter or the final result are just some examples. So besides the technical analysis made by gamblers, it is also possible to try to find patterns in the results, to infer about them.

Sports in general and basketball games in particular are influenced by several factors: where the game is played (home or away), the number of supporters, the possibility of injuries and suspension of players, how players feel on match day or even

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other personal issues. Besides, the different agents interact, meaning that a given game could be considered as a complex system.

In the last years, the study of complex systems has increased greatly. Research areas such as condensed matters (see, for example, [1] or [2]) biology ([3] or [4], among others) financial markets ([5] or [6]) and ecosystems ([7] or [8]) are some of those analysed as complex systems. On purpose, only a few studies for each research area were identified, due to the huge amount of research. Research in sports also considers complex systems: injuries ([9] or [10]), the behaviour of football players [11] or analysis of golf and football matches [12] are just some examples.

Some analyses of complex systems resort to statistical physics methodologies. One methodology used is detrended fluctuation analysis (DFA). DFA has the ability to analyse the randomness of a given series, which could reveal predictability. In this paper, we extend the use of DFA to analyse the time series of NBA teams' results. The possibility or not of predicting results, based on previous ones, could help agents to make their decisions. In this case, people interested in placing bets, have more information on which to base their decisions.

As we can notice, this kind of analysis was not previously performed in particular sports leagues. However, the work of Petersen and Penner [13] develops a detrending method with the objective of comparing career statistics of players over time, including not only NBA information but also about the baseball league.

Our main results show that all teams have persistent behaviour in their results, which means that after a given result, it will probably be repeated. However, the degree of persistence is different, with Chicago Bulls having the most persistent results and Houston Rockets the least persistent ones.

The remainder of the paper is organized as follows: Section 2 presents the data and the methodology used in the paper; Section 3 presents the results; Section 4 concludes.

2. Data and methodology

Founded in 1946 and called the Basketball Association of America (BAA), the NBA was formally born in 1949 when the BAA absorbed the National Basketball League (NBL). In the first season, 11 teams played in the Championship and after the fusion there were 17 teams. During the 1970s the NBA's popularity increased, and with it, the number of teams: 14 teams in 1969/1970, 22 teams in 1979/1980 and 27 teams in 1989/1990. In 1995 the league expanded into Canada and is currently composed of 30 teams. Each team plays a regular season, facing all the remaining teams, and the best classified teams follow on to the playoffs (which decide the champion).

In this paper, as previously mentioned, we intend to analyse the results of different teams. Because we are interested in comparing teams, we only analyse the results of the teams in the regular season (in the playoffs fewer teams compete and the series will be shorter). We start our analysis from the season 1995/1996, when two new teams entered the league (the Canadian Toronto and Vancouver). Of the current 30 teams, we analyse 28, excluding Charlotte Hornets and New Orleans Pelicans: the first because the team did not participate in 2002/2003 and 2003/2004; the second because it only entered the league in 2002. So we analyse a total of 22 seasons, and each team as a time series of 1756 results.[1] The list of teams is presented in Table 1. For each team we retrieved the information of the results (sourced in www.landofbasketball.com) and transformed the result in a binary result: 1 for wins and 0 for defeats. So the time series analysed are binary series.

Detrended fluctuation analysis (DFA) is a method proposed by Peng et al. [14] and was used originally to analyse DNA behaviour. Like several statistical physics methodologies, it has been used in different research areas, such as heart beat [15], machinery diagnosis [16], health [17] wind speed [18] and criminology [19], in a huge amount of literature. The use of DFA is also very common in analysing economic and financial data: from stock indices (see, for example, [20], or [21]) to exchange rates (see [22] among others), including derivatives [23,24] and the analysis of football clubs' shares [25]. However, to our knowledge, DFA has not yet been used to analyse sporting results.

Considering a time series x_k with $k = 1, \ldots, t$ equidistant observations (in this case, successive games), the first step of DFA is the integration of that time series, i.e., $x(k) = \sum_{t=1}^{k} x(t) - \langle x \rangle$, $\langle x \rangle$ being the average of x. This new series is then divided in N/s mutual exclusive boxes of equal dimension s. For each segment i, the trend $z_i(t)$ is calculated based on ordinary least squares estimation. The previous series is detrended, using $x_s(t) = x(k) - z_i(t)$. This calculation produces the DFA function given by $F(s) = \sqrt{\frac{1}{N}\sum_{t=1}^{N}[x_s(t)]^2}$. The procedure is repeated for all different values of s (box), and the results show a power-law behaviour, $F(s) \propto s^{\alpha}$.

The long-range power-law exponent α gives information about the randomness of a time series. If $\alpha = 0.5$, the time series is represented by a random walk, which means it has no long memory. If $0.5 < \alpha < 1$, the time series is persistent (has a positive long-range dependence), which means that if a given series has been up/down in the last period, it is more probable that it will repeat the results. In the context of our analysis, a persistent series means that the last result is more likely to be repeated. If $\alpha < 0.5$, the time series has the contrary behaviour, i.e., it is anti-persistent (has a negative long-range dependence). In our analysis, this will mean that the team is more likely to invert the result in the following period. Finally, if $\alpha > 1$, a given process is non-stationary, a more common result to be found in biological processes (see, for example, [26,27] or [28]).

[1] Due to lockouts, in 1998/1999 each team played just 50 games in the regular season and in 2011/2012 played 66 games.