Performance variability and team interaction in basketball: a regime switching approach

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Résumé. Dans cette contribution, nous proposons une procédure en trois étapes afin de modéliser la variabilité des performances et l'interaction des équipes au basketball. Une étude de cas utilisant les données provenant de la Ligue des champions d'Europe 2016/2017 a été utilisé pour décrire la procédure méthodologique. Nous définissons d'abord un indice de performance de tir, dont la dynamique alternée est modélisée par les modèles de Markov Switching. Deuxièmement, nous modélisons la probabilité d'être dans un bon régime de performance (amélioration de la performance de tir) en fonction de la présence de coéquipiers sur le terrain et nous identifions les interactions significatives (positives et négatives) entre les joueurs, à l'aide du modèle ARIMA avec covariables et des outils de l'analyse de réseaux. Troisièmement, nous validons les résultats et examinons comment les relations entre les joueurs permettent effectivement d'améliorer les performances de l'équipe (en termes de points marqués).

Mots-clés. Analyse du sport, analyse de la performance, modèle de Markov Switching, network analysis.

Abstract. In this contribution we propose a three-step procedure in order to model performance variability and team interaction in basketball. A case study using real play-by-play data, coming from the 2016/2017 European Champions League has been used to describe the methodological procedure. First, we define a shooting performance index, whose alternating dynamic is modelled by Markov Switching models, borrowed from econometrics. Second, we model the probability of being in a good performance regime (improving of shooting performance) as a function of the presence of teammates on the court and identify significant (both positive and negative) interactions between players, by means of ARIMA model with covariates and networks analysis tools. Third, we validate the results, investigating how the relationships among players effectively lead to improve the team performance (in terms of scored points).

Keywords. Sport analytics, performance analysis, Markov Switching model, network analysis.

1 Introduction

In the past years, the application of statistical models and methods to sports has rapidly increased. A wide variety of scientific research and collections of papers have been published with reference to a broad range of sports (see, for example, Albert et al., 2017). Due to the availability of complex and big data sets, an appropriate statistical approach is useful to many aims; focusing on basketball, examples are: predicting the outcomes of a game or a tournament, determining discriminating factors between successful and unsuccessful teams, analysing players' performance and the impact on the team's chances of winning, monitoring playing patterns, designing the kinetics of players' body movements with respect to shooting efficiency, timing and visual control on the field, depicting the players' movements, pathways, trajectories and the network of passing actions, the flow of events and the connected functional decisions, studying teams' tactics and identifying optimal game strategies, but also investigating possible referee biases, measuring psychological latent variables and their association to performance, epidemiology of basketball injuries, physical, anthropometric and physiological attributes of players, hematological parameters or other vitals, special training techniques to stimulate muscle strength, jumping ability and physical fitness in general, and many others.

Studies in the field of basketball analytics are essential in order to support coaches and teams in several decisions, such as training and playing strategies, but also in-game decisions, as the best substitution in the right moment during the match. Such kind of decision depends on the specific game moment, the team's tactics, the opponent behavior and the team interaction, that is the mutual interactions of teammates' performances able to create positive synergies.

This contribution focuses on performance variability: in particular, the attention is on players' shooting performance, with a special interest on variability.

In the scientific literature, several papers investigated players' performance analysis (for example, Metulini et al., 2018): some of them assume a broad concept of performance (taking account of both offensive and defensive abilities, for example), while others limit the analysis on shooting performance (sometimes with reference to the so-called "hot hand" effect). However, psychological studies have pointed out that typical performance is just one attribute of performance; besides average performance, other aspects should be taken into account, and one of these is certainly variability.

Performance variability can be considered over time and attention should be payed on intra-individual differences in variability. In our idea, performance variability should not be confused with the so-called momentum effect (that is changes in performance based on success or failure in recent events), although it is not a completely unrelated issue. Different levels of performance may be caused by several factors: not only psychology, but also the physical condition and the teammates, for example. Our contribution on performance variability aims at identifying cyclic patterns of shooting performance and investigating whether they may be associated or not to the lineup.

2 A proposal for modelling performance variability

As mentioned in the Introduction, the aim of this contribution is to model performance variability and team interaction in basketball. Specifically, it is concerned with the assessment of players' shooting performance - from the two-fold perspective of average and variability - and the investigation of its relationships with the team composition and the team performance. The very final aim is to give suggestions to coaches about the best substitutions during the game.

In order to achieve this aim, we propose a three-step procedure:

1. for each player of a team, we investigate the cyclical alternation of good and bad performance by means of (*i*) the definition of a smoothed index of shooting performance (Zuccolotto at al., 2017) and (*ii*) the application of Markov Switching models (see Hamilton 2010) to the shooting performance index in order to detect the possible presence of different regimes in performance;

2. for players with significantly different regimes, we (*i*) fit an ARIMA model with covariates (for example, see Cryer and Chan, 2008) in order to examine if and how the presence of a particular teammate on the court impacts on the probability of being in the good performance regime and (*ii*) we represent all the significant relationships with network analysis graphical tools;

3. we validate the results from the network obtained in Step 2, by identifying pairs or groups of teammates whose performance is positively (negatively) related and checking the impact on the team performance of their joint presence on the court.

The procedure will be described with reference to a case study using web-scraped freely available play-by-play data from International Basketball Federation (FIBA) web page (www.fiba.basketball.com) concerned with the 20 games played by Iberostar Tenerife team during the 2016/2017 European Champions League.

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