Estimating Doping Prevalence in Elite-Sports – An Agent-Based Computer Simulation Approach

Daniel Westmattelmann, University of Münster
Gerhard Scheve (Advisor), University of Münster
Sascha Hokamp, University of Hamburg
Marcel Goelden, University of Münster

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As long as competitive professional sports exist the phenomenon of using illicit methods like doping does maintain. Because of a seemingly endless series of scandals doping gains increasingly public attention. The official Anti-Doping Testing Figures, published annually by the World Anti-Doping Agency (WADA), show that the rate of Adverse Analytical Findings (positive Tests) is approximately 2% (WADA, 2014). But banned substances and methods may not be detectable and encompassing doping controls may not be feasible, because of causing enormous costs and organizational efforts. Therefore, we believe that the official figures underestimate the true extent of doping.

Recent research activities in this field are based on various methods to approximate an extent of doping, but estimates differ essentially. To begin with, e.g. Sottas et al. (2011) make use of a forensic approach and analyze 7,289 blood samples collected from 2,737 athletes. They detected abnormal blood profiles and figure out that approximately 14% of the tested athletes commit blood doping. Other authors try to estimate the extent of doping by using self-reports. To ensure that the athlete’s answers are anonymous, applying randomized response technique is a common practice to carry out such surveys. Although very similar methods are applied, the results vary a lot. While Pitsch, Emrich, and Klein (2007) and Breuer and Hallmann (2013) find about 5-7% as extent of doping, Plessner and Musch (2002) estimate that more than 34% of the athletes are doped and Striegel, Ulrich, and Simon (2010) present a lower interval limit of 25% and an upper limit of 48%. Looking at the results of projections methods, the estimated extent of doping varies even more and goes from 6% (Waddington, Malcolm, Roderick, & Naik, 2005) up to 72% (Anshel, 1991). To sum up, we find in the literature estimations for extents of doping at a range of 2% to 72%. Further investigations also differ in extents of doping estimated (e.g. James, Nepusz, Naughton, & Petročzi, 2013; Petróczi, Mazanov, Nepusz, Backhouse, & Naughton, 2008; Uvacsek et al., 2011) which supports our notion of a complexity problem to identify a real extent of doping.

To elude this complexity problem in professional sports researchers develop various game theory models based on rational choice theory like strategic games (e.g. Berentsen, 2002; Berentsen & Lengwiler, 2004; Breivik, 1987; Haugen, 2004; Eber, 2008; Eber & J. Thépot, 1999; Haugen, Nepusz, & Petróczi, 2013; Kräkel, 2007; Ryvkin, 2013) and inspection games (e.g. Berentsen, Brügger, & Loertscher, 2008; Büchel, Emrich, & Pohlkamp, 2013; Haugen, 2004; Kirstein, 2012; Maennig, 2002). A common feature of these models is to depict doping behavior patterns in professional sports. But we think that these models exhibit a low degree of complexity, because of being analytically solvable.

Since we recognize a lack of reliable empirical data computer simulations permit to explore and elucidate doping behavior patterns in professional sports (Petróczi & Aidman, 2008). In line with the literature, we think that agent-based modeling has potential as a ‘third way’ of doing social science in addition to argumentation and formalization (Gilbert & Terna, 2000). Making use of agent-based modeling, we are able to formalize theories on complex social processes like doping behavior patterns in professional sports. Thus, modeling a high degree of complexity is an essential advantage of an agent-based approach compared to game theory models.

Our multi-period agent-based doping concept is based on three interacting objectives which are (i) elite-athletes, (ii) anti-doping laboratory and (iii) anti-doping agency. The latter agency announces anti-doping rules and imposes fines as well as bans. Anti-doping laboratory executes doping controls whereby control frequency and efficiency are imperfect so that not any doped and tested elite-athlete is detected as a doping sinner. Each time period any elite-athlete competes for income in a rank-order tournament. We assume that usage of doping increases elite-athlete’s
chance of success in the rank-order tournament in the short term but such an illegal practice causes an adverse reaction in the long term. In particular, we consider four agent types that are (a) rational, (b) suggestible, (c) compliant and (d) erratic. Rational sportsmen may use doping substances with respect to an expected utility maximizing approach. A suggestible athlete takes into account the doping behavior committed in his social network. A compliant agent accepts and follows the rules of the anti-doping agency. An erratic player wants to act rule-compliant but may commit doping unintentional.

Using the agent-based modeling approach combined with a sensitivity analysis, we aim at testing how parameters like bans, fines, test efficiency, testing frequency, prize-money distributions and subjective detection probabilities may influence elite-athletes doping behavior. On the basis of the simulation results, policy recommendations for the fight against doping like optimal budget allocation for different prevention policies can be given.