

# Scholarly Sports: Influence of Social Science Academe on Sports Rules and Policy\*

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## Abstract

This paper follows a study by Kendall and Lenten (2017)—on unintended consequences of badly designed rules of play in sports—by aggregating a collection of academic work that has proposed rule change ideas, some of which have already been implemented. We also discuss further compelling ideas within the multidisciplinary literature that could yet be considered and even adopted by sports administrators. Many of these ideas are essentially aimed at ‘solving a problem’ inherent under the current (or a previous) status quo, and invariably use tools from fields of social scientific literature such as OR, statistics and economics.

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# 1 Introduction

Wright’s (2014) survey—inspired by an Operational Research (OR) perspective—of sporting rules and tournaments, focused on cases with scope for unintended consequences to arise. He concluded that: “...*there may be plenty more such studies to come*” (p. 7), and in doing so, challenged the academic community to think more deeply about unintended consequences in this highly significant global industry.

Kendall and Lenten (2017) followed this, by cataloguing specific examples whereby rules of sports have led to unforeseen and/or unwanted consequences. They asserted a hope that their paper will be especially useful to sports administrators, by encouraging them to engage with the scientific community whenever considering making rule changes. The two groups could benefit so much more from each other than is currently the case, making such collaboration a priority.

In that spirit, the current paper aggregates and surveys a collection of academic work that has proposed ideas for regulatory change, a few of which have already been implemented, and also discusses other convincing ideas that could be considered for adoption by administrators in various sports. These ideas come from formal studies (mostly journal articles, but they also include conference and working papers) in the multidisciplinary literature, spanning several fields, but predominantly using tools in ones like OR, statistics (even extending to mathematics), sports management and economics. A key common feature is the aim of solving an identifiable problem—often created by an unintended consequence of a previous rule change—that exists under the status quo, whether the current one or a previous one.

Indeed, in so many ways, sport is a microcosm of society. And just as the ‘rules’ (whether laws, codes or merely conventions) that broadly govern the world in which we live often prove to be inefficient and/or ineffective, the analogous is also frequently true within sporting contests. Many scholars consider it their duty to use their considerable research skills and efforts to examine public policy settings for optimal social outcomes, something that was suddenly brought once again into sharp focus during the onset of the global COVID-19 crisis. Yet, a select group of academics have likewise seen their way clear to investigate whether specific sporting rules are meeting their objectives, and if not, forwarding proposals for alleviating their problems. The beneficiaries of better rules include all industry stakeholder groups, not least of all fans. Moreover, knowing how responsive certain leagues/sports are to making rule changes (whenever necessary) helps us understand the sizeable variation in their respective responsiveness to COVID-19. Some leagues

proactively suspended competition expeditiously, whereas others chose to do so only when it was realized that a forced shutdown would be inevitable otherwise.

As in Kendall and Lenten (2017), the paper could be published in any of these disciplines. However, we wanted to publish this paper in an OR journal, following what we believe to be easily the single most substantial academic contribution to sports (among others) discussed in this paper—that of Duckworth and Lewis (1998). For a long time, this contribution has been discussed extensively in the consequent OR literature—for instance, Wright (2009) or Haigh (2009)—in a manner of being the only known significant academic study to affect any professional sporting rule globally. However, in recent years, there has been a proliferation of such influential studies, albeit most of which are individually less well known, with the potential for numerous more (discussed here) to come. Moreover, the Wright (2014) paper and the Kendall and Lenten (2017) paper were both published in OR journals, and since this paper is addressing the same issues, we felt that OR was the right place for this paper.

We limit our analysis to the social sciences, and even more narrowly, to the business-related disciplines; as in OR, we are primarily interested in the role that better-designed rules can play in improving decision-making (similarly in microeconomics); whether at the athlete, team, coaching or even league or governing-body administrative level. In doing so, we hereby acknowledge the crucial role of other discipline (and interdisciplinary) areas; such as the various allied health and medical sciences, to biostatistics, even to engineering. Two very different examples of this nature include: (i) the reforms to concussion rules in American football owing to the findings of Omalu et al. (2005) and similarly the dispensing of protective headgear in amateur boxing (owing to Loosemore et al., 2017);<sup>1</sup> and (ii) reaction time studies—for example, Lipps et al. (2011)—informing changes made to false-start rules in athletics. Moreover, we do not include cases of academics influencing rules through direct private consultancy and other arrangements with sports administrators.<sup>2</sup>

The remainder of this paper proceeds as follows. Section 2 will describe a few past cases of actual academic work that played an influential role in having sports rules changed in an attempt to solve an identifiable problem. In section 3, we then use this as inspiration to consider numerous

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<sup>1</sup>The former case was dramatized in the 2015 motion picture, *Concussion*, starring Will Smith.

<sup>2</sup>As an example here, economist Jeff Borland (University of Melbourne) was commissioned by the Australian Football League (AFL) to develop a formula for the allocation of Priority picks as part of reforms to the League’s Draft system in 2012, in response to claims of ‘tanking’ (see also subsection 3.1). However, that work did not draw directly on his previous published academic work on tanking in the AFL—specifically Borland et al. (2009).

cases for which existing academic literature could be harnessed by sports administrators for the same purpose with respect to other ongoing problems. This is followed by section 4, with a brief selection of cases whereby academic literature followed (or was contemporaneous to) already implemented rule changes, somewhat vindicating the decisions that had previously been made by administrators. Finally, section 5 provides a summary and some closing remarks.

## 2 What has already been done

This section describes a series of case studies whereby academic work actually influenced sporting rules and/or policies, thereby alleviating a certain problem experienced by administrators of the respective sports. These cases span over numerous competitions, and over the last 30 years.

### 2.1 Cricket's run-chase target revision issue

The emergence of limited-overs cricket in the 1970s and 1980s was a revolution to the then century-old international history of the sport. However, one new problem that the shorter form of the game faced was that any interruption to play (mainly because of rain), which shortened the game from the now-standard 50 overs per side, caused a far bigger fairness issue than that in Test matches. Initially, the (average) run-rate per over method was used to calculate revised targets when play interruptions made it impossible for both teams to bat for the same number of overs (each team bats only once). However, this inadvertently created a significant advantage to the team batting second. Kendall and Lenten (2017, p. 381) describe one reinforcing case study in particular.

This shortcoming was supposed to have been circumvented with the subsequent move towards the most productive overs (MPO) rule, which was based on removing the lowest-scoring overs from the total of the team that batted more overs in setting the target for its opponent. However, instead of creating better balance, it severely over-corrected the problem, alternatively handing the unintended advantage to the team that batted first. A high-profile case in a World Cup semi-final (England defeating South Africa in Sydney, 1992) brought into sharp focus the need for a better-balanced target revision method.

The contribution of the Duckworth-Lewis Method (known as Duckworth-Lewis-Stern, DLS, since Steven Stern became its 'custodian' in 2014) was to treat, mathematically, both overs and wickets remaining as 'resources' so as to calculate run equivalents in setting a revised target.

The original formulation is outlined in Duckworth and Lewis (1998) and revised by Stern (2009). Refer to Duckworth et al. (2019) for a full account of the history of its progression from idea, to publication, and to full implementation. It was first used in 1997 and became officially adopted by the International Cricket Council (ICC) for all limited-overs matches in 1999.<sup>3</sup> It is arguably hitherto the most impactful scholarly contribution from the social sciences on the entire sports industry, and is undoubtedly one that has stood the test of time (despite occasional revisions).

## 2.2 First-taker advantage problem in football’s penalty shoot-outs

Ratified by FIFA in 1970, the penalty shoot-out has since played a pivotal role in deciding the winner in a large number of historically important matches. There is a whole range of issues associated with the format, but one not often discussed until recently was the apparent unfairness of the sequence of spot kicks itself. Apesteguia and Palacios-Huerta (2010) demonstrated that the result of the coin toss (to determine which team shoots first) plays a significant role, giving a clear advantage to the first taker, with a victory probability of around 60 per cent.

As an alternative, Palacios-Huerta (2012) recommended changing the sequence of spot kicks to remove this bias. He advocated the Prouhet-Thue-Morse sequence and turned his lobbying efforts towards football administrators. These efforts were somewhat successful, when the International Football Association Board (IFAB) approved the use of the standard tennis tiebreak sequence, under the ‘ABBA’ alias. At the time of writing, it had already been used in several FIFA tournaments, as well as in the English Football Association (FA) Community Shield, and most recently adopted by the Dutch federation (KNVB) across all relevant domestic competitions. Anbarci et al. (2015) show how the ABBA system is indeed much fairer than the standard alternating sequence, but that it can be made even fairer still by changing the order during the shootout to allow the team that falls behind to go first thereafter, reverting back to ABBA if it levels proceedings.

An analogous first-taker (possession) advantage has also been found to arise in National Football League (NFL) overtime, and this is discussed in subsection 3.2. Similarly, this may also exist in terms of serving in tennis (Magnus and Klaassen, 1999); however, no such analogous “problem” has been discussed widely in that particular sport. Indeed, the ABBA system is demonstrated to be fair in the tie-breaker scenario in tennis by Cohen-Zada et al. (2018).

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<sup>3</sup>Of recent note is that the death of Tony Lewis in April 2020 was commemorated by the ICC via a acknowledging press release (see <https://www.icc-cricket.com/media-releases/1651594>), in which it recognized the importance of his joint work to the sport.

## 2.3 Improving bonus point systems in rugby

Two types of bonus (competition) point systems have existed in SANZAR’s (Southern hemisphere) competitions, the Rugby Championship (national teams of Australia, Argentina, New Zealand and South Africa) and Super Rugby (their provincial teams) since 1996. They both carry a value of one point, compared with four for a win. The first is based on losing by a narrow margin (this goes back to New Zealand’s domestic competition in 1986), and the second is based on scoring a certain minimum number of tries (specifically four) in order to incentivize this method of scoring ahead of other forms, so as to increase attacking, attractive play.

While no obvious shortcomings arose with these bonuses, Winchester (2008) nonetheless put the system to the test, showing that the bonuses (particularly the latter) were not as optimal as the possible alternatives he identified, according to the objective of having the final league table reveal the truly best-performing teams over the regular season. Among other findings, he found that the try bonus threshold was inefficient; and that a ‘net’ try bonus system would perform better. Following careful consideration by SANZAR, the try bonus was changed to plus-three net tries from the 2016 season onwards, resembling a move made earlier in France’s domestic league (Top 14)—see Winchester (2016, p. 41) for an outline of how this sequence of events unfolded.

At a superficial level, the previous try-bonus system has indeed been found to be somewhat effective at incentivizing more tries to be scored, in the former European Rugby Cup (Butler et al., 2020). However, Lenten and Winchester (2015) demonstrate, using Super Rugby data, that the main mechanism through which this occurs is in the final few minutes of matches where the game is effectively decided already.

## 2.4 Draft points system reform

A well-known NBER (National Bureau Of Economics Research) Working Paper by Massey and Thaler (2005)—the latter of whom was announced in 2017 as a Nobel Laureate—famously developed a functional form of ‘value’ in the Draft-pick-order domain, with specific reference to the NFL. The headline result was that the League franchises tended to overvalue the very top picks. However, while it has since become widely used by teams in various recruitment and list-management activities—like player trading—in the current context, this (albeit valuable) contribution did not actually result in any rule or policy changes at a League level.

Nevertheless, following this theme, an analogous version for the AFL was produced in a far lesser-known study—a conference paper by O’Shaughnessy (2010). In 2015, following substantial consultations between the League and the researcher, the newly coined Draft Value Index was adopted by the League as an official tool for how player trades would be conducted and authorized during its annual trade period.

Compared to its NFL counterpart, the main role of the Index is to accommodate other labour-market-restriction policies unique to the AFL. Two of which, specifically, are the long-standing Father-son Rule (see Stewart et al., 2017); and the more recent Academy selections. In doing so, its intention is to establish some market value to every single draft selection, as well as ironing out a number of arbitrary situations whereby one team can exploit the Draft to benefit unfairly from better selections at the indirect expense of all other teams.

## **2.5 Improvements to tournament design**

Guyon (2015) examined tournament draw procedures, with specific reference to the FIFA World Cup. The draw for the ‘finals’ tournament places teams into groups (currently eight groups of four teams), but with a set of geographical constraints designed to minimize the incidence of teams from the same continental confederations drawing each other in the same group. These constraints have previously resulted in compromises to other objectives in achieving a desirable draw.

Using quantitative methodologies with a broadly OR approach, Guyon’s solution was demonstrated to improve the quality of assignment of teams into groups in terms of these other objectives, such as: (i) balance; (ii) fairness; and (iii) distribution; and without violating any of the existing constraints. After FIFA became aware of this study, it made some modifications to the 2018 World Cup draw procedures based on the recommendations.

Guyon (2018) subsequently applied a similar approach to the Union of European Football Associations (UEFA) Euro knockout bracket design—a related problem. UEFA chose more recently to adopt one of the recommended options therein (proposal no. 6) for the knockout bracket design for Euro 2020.

### 3 What more can be done

In this section, we explore a further series of existing academic works—those that propose a possible solution to an ongoing problem in sports. However, in each of these cases, the proposal is yet to be adopted. Nonetheless, we canvass the possibility for these suggestions to be implemented by sports administrators.

#### 3.1 Tanking

Reverse-order player drafts were first used by the NFL in 1934 and had subsequently spread to all “major leagues” of the four most popular sports in North America by 1965 (also the National Basketball Association, NBA; National Hockey League, NHL; and Major League Baseball, MLB). It kept players’ wages low by preventing bidding wars for entry-level recruits, by creating a monopsony for players’ labor. The reverse-order element was also presumed to help improve competitive balance by giving priority to teams that performed poorly in the previous season.

However, it was this specific element that created perverse incentives for a team to lose matches purposely towards the end of the season, once it could no longer qualify mathematically for the playoffs. This problem is generally perceived to be most problematic in the NBA, in which a lottery system was introduced in 1984 to reduce this perverse incentive (see also subsection 4.3).

However, a far simpler alternative solution to the tanking problem is described by Lenten (2016), that the determination rule for the order of picks be altered from fewest games won over the course of the season, to: “. . . *fewest games played when eliminated*” (p. 25). The intuition behind this idea is simply that following the assignment of a draft pick, the perverse incentive is removed entirely for all games still yet to be played. This policy—despite having never been trialled—is tested in the paper via a quasi-natural experiment, showing that it would significantly increase the conditional probability of victory of affected teams by 14 per cent in the NBA and 17 per cent in MLB. In a follow-up study, Lenten et al. (2018) show an analogous 22 per cent improvement in the AFL.

Gold (2010), with reference to the NHL, outlines a variant idea based on the *best* record in post-elimination games *only*. However, he merely outlines the case in favour without testing its effects formally. In comparison, this particular suggestion is arguably even sounder intuitively, but

it could nonetheless lead to an extremely poor-quality team unintentionally receiving a lower-order pick, in contrast to its genuine need.

### 3.2 NFL overtime bias

In 1974, the NFL introduced overtime for all regular-season matches. Whilst most of the pros and cons are debatable, one unintended consequence arising from the addition of a sudden-death element (first score wins) was the coin toss determining which team gets to receive the kick-off (and consequently take first possession), which would play a significant role in determining the match winner. Specifically, almost 60 per cent of the nearly 500 overtime games from 1974-2009 were won by the winner of the toss, arguably creating a fairness issue. Therefore, a rule change to diminish the power of the coin toss would seem desirable.

One innovative suggestion, rooted in economics, by Che and Hendershott (2008) was to propose a ‘yardage auction’ to determine which team kicks off in overtime—with the right to receive the kick-off given to the captain who is willing to start furthest back from the centre line—dispensing with the coin toss altogether. This way, the forces of ‘demand and supply’ would act as a shock absorber against the receiving bias to ensure a fair trade off. However, despite the academic intuitive appeal of such a solution, it is unlikely to be adopted for aesthetic and/or operational reasons. Jones (2012) proposes a not dissimilar rule, based on the analogous ‘cut-and-choose’ technique.

Nonetheless, a 2010 reform was adopted for playoff matches by administrators to the same end. Specifically, such that if the first possession results in the ‘safe’ option of a field goal (worth 3 points), the other team would still be granted one possession, continuing the game if it also scored a field goal (thus restoring parity) or winning the game if scoring a touchdown (or a safety). This was extended to all matches from 2012, while the standard 15-minute overtime period was reduced to 10 minutes in 2017. The early—albeit anecdotal—evidence suggests that the rule changes have served to reduce considerably the first-receive bias, though maybe not eliminate it entirely. From 2012 through to the end of the 2019 season, 69 of the 128 overtime matches played thus far under this rule (counting ties as one-half and including all playoff matches) have been won by the first-possession team. Despite the small sample size, the corresponding proportion of 52.9 per cent is very much in line with the 52 per cent figure predicted by Jones (2012) from a Markov Chain model calibrated on actual NFL state-outcome data.

### 3.3 Defensive extra-time in football

A long-standing problem with knockout-phase football matches is the often defensive nature of extra time, increasing the likelihood that the contest is decided via a penalty shoot-out anyway, and undermining the ability of extra time as a tool to do so on its own. A change in sequence of these phases, whereby the shoot-out would be held *before* extra time (given a draw in normal time), is argued by Lenten et al. (2013) to be a superior alternative, according to economic intuition. Under this proposal, winning the shoot-out hands the advantage to one team, insofar that it wins the match if the following extra time—which still takes place—remains level (or if that team wins extra time, anyhow). Employing this sequence circumvents the possibility of both teams jointly overestimating their chances of winning via the shoot-out and hence explicitly playing for it. Rather, it guarantees that one team (the one that lost the shoot-out) would always need to score during extra time to win and hence become more attacking than under the baseline case of the current rule, although the shoot-out winning team inversely has an incentive to play more defensively.

Empirically (and using a quasi-experimental setting, like that in subsection 3.1) the authors estimate what would happen under the proposed rule change. Their results indicate that the proposal would increase, by over 50 per cent, the probability that at least one goal would be scored in extra time of elite-level knockout-style matches, meaning that extra time would effectively decide the match—without the shoot-out result binding—much more often than currently. This also means that the attacking effect described above easily overwhelms the defensive effect. The results provide a definitive conclusion to an earlier theoretical model by Carrillo (2007), which implied that the effect was potentially ambiguous.

Some of the same authors later produced a related contribution in a different sport. Friesl et al. (2017) argue that ice hockey (specifically the NHL) had experienced an analogous decline in overall scoring over the previous two decades. They then demonstrate via formal regression modelling that the mere operational act of switching the sides of the teams' benches would lead to an estimated 5 per cent uplift in total scoring, rising to 10 per cent if the teams were instead prompted to switch between benches each period.

### 3.4 Anti-doping policy alternatives

While cheating—to win—can take numerous forms, such as technical fraud to sabotage of opponents, doping has been easily the most ubiquitous form of this type across the entire industry over the last few generations. The academic literature on various angles of the anti-doping enforcement problem is quite voluminous; however, there are not so many totally original ideas for policy augmentations, above and beyond the standard suite of standard punishments for transgressors, mainly fines and bans (and variants thereof).

Nonetheless, we henceforth briefly discuss two rare recent counterexamples. Firstly, Camporesi and Knuckles (2014) discuss the possibility of passing on the financial burden of positive tests from the guilty athletes themselves to their sponsors. Doing so, they argue, would weaken the correlation between the reward system and the ‘win-at-all-costs’ mentality that is so pervasive in the industry, causing such perverse incentives to cheat. Secondly, Wu et al. (2020) test, via economic experiments, the possible effectiveness of a conditional superannuation scheme, whereby athletes willingly forego a nominal portion of their earnings, held in escrow and with the terminal value repaid after some defined post-retirement period—but only given a perfectly clean career record. The underlying theory is that it sets superior intertemporal incentives for an athlete to stay clean throughout his/her entire career span, given the possibility of being caught retrospectively via stored samples (as has happened in a number of high-profile cases).

With respect to both of these ideas, once again there is quite a lot to like about the intuition. However, as serious proposals they would face potentially stiff opposition from multiple quarters within the sporting fraternity, even some administrators, meaning that there are considerable political tractability issues to be faced before they could be attempted to be implemented.

As an associated point, other forms of cheating that instead involve (intentionally) losing, invariably match-fixing (but also tanking, like in subsection 3.1), can often additionally involve the possible threat of criminal charges against the culprit (eg. because of betting market implications). This means a more credible civil punishment system reinforces the rules, compared with that in the case of doping. Nonetheless, the above policy suggestions could also be generalized to these forms of cheating; as well as to members of other associated stakeholder groups who were likewise found to be complicit in orchestrating the cheating regime; such as coaches, managers and other entourage members, or even team officials (not to mention umpires/referees).

### **3.5 Incentive compatibility in tournament design**

Csató (2020) brings to light a problem experienced in the European Men’s Handball Championship (held biennially, with national teams) during various editions of the tournament. Specifically, when there are multiple group rounds, and results from matches already played in the first group stage carry over into the second group stage.

He demonstrates how such a tournament design is incentive incompatible, and therefore, is open to manipulation in the final first-group-stage match (Kendall and Lenten, 2017, discuss a similar anecdote from the 1999 Cricket World Cup). One proposal forwarded to overcome this problem is simply to carry over only one-half of the competition points earned from the relevant first-group-stage matches into the second group stage. This decreased weighting given to the previously played games solves the incentive-incompatibility issue.

This is not a totally original idea—the notion of halving the points (already earned) has been an already-implemented policy in a handful of European domestic football Leagues in which there have been multiple stages for the regular-season tournament design. Lasek and Gagolewski (2018) lists seven such Leagues in which there is a second phase whereby the top and bottom teams are split into separate round-robin groups after the conclusion of the first stage. Nonetheless, this is an elegant potential application of a workable idea from one sporting construct to another.

## **4 Support for what administrators have done**

Although not the intention, the previous sections could be interpreted as focusing purely on cases of academics solving problems caused by sports administrators. In the spirit of balance, therefore, this section pays due credit to the practitioners themselves. It does so by outlining a few cases in which they were proactive in changing a rule that improved the status quo (or reversed a rule that previously caused perverse outcomes), and where subsequent academic work has vindicated their policy reforms.

### **4.1 Removal of golden goal**

Similarly to the policies discussed in subsections 2.2 and 3.3, the golden goal concept—based on sudden death—was meant to diminish the impact of penalty shoot-outs in knock-out stage football games. It was introduced for the 1993 World Youth Cup (U/20s) in Australia and later

extended to the 1998 and 2002 World Cups (and most other tournaments). By awarding the game to the team that scored the first (and, by extension, only) goal in extra time, its intention was to reduce the likelihood that the match would ultimately be decided via spot kicks, by removing any opportunity for the team that conceded to equalize and possibly send the contest to penalties, anyway.

Most observers of the sport at the time agree that, despite the intuition, the rule did not really work as intended. Subsequently, UEFA experimented further with the watered-down ‘silver goal’ version from 2002; while later both versions were scrapped in 2004. Concurrently, Brocas and Carrillo (2004) showed a theoretical model demonstrating conditions under which both teams jointly become sufficiently more defensive under golden goal, that the frequency of tie-breaking goals falls so dramatically that it perversely overwhelms the more obvious effect referred to above and ultimately leads to an *increase* in the frequency of shoot-outs.

However, it is worth noting that this rule (or a variant thereof) still persists in numerous other sports, like ice hockey (eg. NHL) and rugby league (eg. National Rugby League, NRL). However, these sports fundamentally tend to be higher scoring, which should consequently mean that such a system will work more effectively as intended in such sports.

## 4.2 Three points for a win

The change in virtually all football competitions over time—starting with the English domestic league in 1981—from two points to three points for a win, poses a classic question about the power of incentives contained in sports rules. More specifically, whether it should lead to more attacking football and higher scoring, given the higher (relative) rewards for a win versus a draw. As a research question of broad appeal, it has been investigated widely; however, it must be noted that the results have ultimately proved to be somewhat mixed.

On the surface, it seems like the three-point system should lead to both higher scoring (i.e. average goals per game) and consequently a lower probability of a draw in any given match. Moschini (2010) represents a nice general example of the mechanism by which we might expect to see this intuition work out. Indeed, using a large set of national elite-level league results from several countries, and exploiting variation of the date of introduction (by country) of the three-point rule, the empirical results are very much as hypothesized.

Nonetheless, despite this basic intuition, by the same token, three points for a win also represents a higher opportunity cost (again, relatively) of *not* winning, which could counterintuitively lead to the opposite result. Guedes and Machado (2002) demonstrate—both theoretically and empirically—how this can happen, mainly through the underdog (particularly in matches with a greater quality asymmetry of teams) playing more defensively than under the two-point system. In summary, it is still not completely beyond doubt whether the administrators have been vindicated on this particular rule change.

### 4.3 NBA Draft Lottery

Following on from subsection 3.1, this lottery is now a much-hyped television event, generating substantial media rights revenue (as a stand-alone event) for the NBA. However, as a distinct issue, the probability structure—used to determine the likelihood of receiving the first pick in the Draft according to finish place—has been altered a number of times since the introduction of the Lottery.

In a study by Price et al. (2010), they compare the original system of equal weights of the non-playoff teams from 1984 with each of the two revised sets of weights used from 1989-1992 and 1993 onwards. Using reasoning of the relative magnitude of incentives to tank as their basis for what their model expects to find, they do indeed demonstrate that perverse incentives to lose post-elimination matches were greater during the years in which the probability of winning the top draft pick was more skewed in favor of team that finished the standings in last place (relative to second- and third-last). This conclusion is reached via the finding that the conditional probability of the team of interest losing a given match was significantly higher in those eras.

This finding highlights a trade-off in the NBA between mitigating the incentives to tank on one hand, but at the possible cost of not being able to allocate the top emerging talent (to the team/s that truly need/s it most) quite as accurately, in order to optimize competitive balance. While the NBA recently revised their weights yet again in advance of the 2019 Draft, such that the bottom three teams now all have an equal probability of drawing the top pick (14 per cent each), the silver bullet to solving the tanking issue definitively, ultimately remains elusive for now.

## 5 Concluding thoughts

Following in the spirit of both Wright’s (2014) OR survey of rules/tournaments, and Kendall and Lenten’s (2017) case-study collection of sports rules leading to unforeseen consequences, the current paper has sought to extend this line of work. More specifically, by providing a similar survey—based on contributions of academic work impacting rule and policy changes in the professional sports industry.

The studies referred to herein comprise of three types: (i) those that have informed and/or led directly to rule or policy changes; (ii) those with compelling ideas that could still yet be considered and even implemented; and (iii) those that have investigated and substantiated the effect of previous rule or policy changes made by sports administrators. As can be seen, there are numerous identifiable cases fitting each of these three types, which we have explored here. In a similar disclaimer to that of Kendall and Lenten (2017), we do not assert that our catalog of relevant works presented here is necessarily exhaustive. It is, however, quite comprehensive.

Given the existing evidence of cases we outlined whereby academic work has positively impacted on sports rules, and the volume of compelling ideas for even more comparable impact, the case in favor of greater future collaboration between practitioners and academics to attempt to ‘solve’ all of sport’s great ‘problems’ appears to be watertight. In this light, while sports administrators could be doing so much more to be reaching out to academics, we also reinforce that the environment is ripe for far more academic research involvement and contributions towards this area—not only from OR, but also from the other various social sciences that have considerable scope to contribute.

## Declarations

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