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ORIGINAL ARTICLE

Scholarly sports: Influence of social science academe on sports rules and policy

Liam J. A. Lenten[a] and Graham Kendall[b,c]

[a]University of Adelaide, Adelaide, Australia; [b]University of Nottingham Malaysia Campus, Selangor Darul Ehsan, Malaysia; [c]University of Nottingham, Nottingham, UK

ABSTRACT

This paper is an orthogonal study to that of Kendall and Lenten (2017)—on the perverse unintended consequences of badly designed sports rules. This paper, unlike the previous one, focuses on the *positive* narrative by aggregating a collection of academic work proposing rule change ideas, some of which have been implemented already. We also discuss further compelling ideas within the multidisciplinary literature that could yet be considered and adopted by sports administrators. Many of these ideas essentially aim to "solve a problem" inherent under the current (or a previous) status quo, and invariably use tools from fields of social scientific literature such as operational research, statistics and economics.

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1. Introduction

Wright's (2014)'s 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, highlighting sport's perverse cases, via cataloging many 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 they are 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.We reiterate the same desire again here.

By contrast, the current paper focuses on desired outcomes, by aggregating and surveying a collection of academic works that have 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 (and their relevant subordinate staffers) in various sports. These ideas come from formal studies (mostly journal articles, but also 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 or 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. 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.

Analogously to Kendall and Lenten (2017), this paper could be published in one of many disciplines. However, we wanted to publish this paper in an OR journal, so as to complement the single most substantial academic contribution to sports (among others) discussed in this paper—that of Duckworth and Lewis (1998). For years, discussed extensively in

CONTACT Liam J. A. Lenten liam.lenten@adelaide.edu.au School of Economics and Public Policy, University of Adelaide, 10 Pulteney St, Adelaide 5005, Australia

the consequent OR literature—for instance, Wright (2009) or Haigh (2008)—as being the only known significant academic study to affect any professional sporting rule globally. However, in the most 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 herein) to come. Moreover, the OR preference is evidenced by the literature we cite—a total of 13 articles in specialist OR journals, of which no fewer than seven from this Journal.

We limit our analysis to the social sciences, and even more narrowly, to OR and its related business disciplines, as 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.[1] Moreover, we do not include cases of academics influencing rules through direct private consultancies with sports administrators.[2]

This paper is broadly presented in three major sections, which comprise its major contributions. Section 2 looks at what has already been done, utilizing the expertise of many disciplines, with OR and economics featuring heavily. We provide examples of where the sporting community has drawn on the academic community for advice, guidance or inspiration. However, these collaborations appear to have been on an ad-hoc basis, rather than a systematic way of operating within the sporting community and, in some cases, it is unclear why the suggestions of the academic community were not implemented. Of course, there will be valid reasons, but for future decision making, it would be useful to close the loop and document why such proposed rule changes, from academics, were rejected by the sporting community. In Kendall and Lenten (2017), we concluded the paper by saying: "*We hope that one consequence of this paper is that the scientific community and the sports industry can work more closely together in order to study the effects of potential rule changes before they are implemented, or implemented in such a way that they can be studied before wider adoption*". This, to our knowledge, still remains an aspiration, rather than a reality. We added: "*Perhaps the governing bodies of the major sports could invite academic representatives onto their committees, who would be tasked with identifying possible loopholes in proposed rule changes, perhaps in consultation with the wider scientific community*". We would restate this call to action and, respectfully, suggest that sporting authorities collaborate with academics, allowing them to simulate and comment on any proposed rule changes.

Section 3 exemplifies this point by providing references to existing work where rule changes have been proposed by the academic community, but uptake within the sporting community has not always been forthcoming. We should emphasize that there is no *blame game* here. The two sectors operate as separate entities at the moment and are largely unaware of the other sector's views. It is the responsibility of all concerned to bring these two sectors together so that they can work more closely.

By contrast Section 4 provides examples whereby sporting practitioners implemented rule changes, which were subsequently supported by academic study. Of course, the sporting authorities have the final say what rule changes they make to their respective sport, but any information/data they can collect to inform their decision, we assume, would be welcomed.

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 one-day 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 (principally 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 the same number of overs. 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, 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) fortified 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 both Duckworth and Lewis (2004) and Stern (2016), mainly in response to increases in scoring rates; while other revisions and techniques have been proposed, *inter alia*, by Jayadevan (2004), Bhattacharya et al. (2011) and McHale and Asif (2013). Refer to Duckworth et al. (2019) for a full account of the history of its progression from idea, to publication and 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.[3] 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.

2.2. First-taker advantage problem in soccer'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 soccer administrators. These efforts were somewhat successful, when the International Football Association Board (IFAB) approved the use of the standard tennis tiebreak sequence in March 2017, under the "ABBA" alias. However, it was inexplicably rescinded by IFAB in November 2018 on the curious grounds of complexity, without a proper trial to assess its effects. It had been used in several FIFA tournaments, as well as in the English Football Association (FA) Community Shield and other competitions, and was until recently still utilized by the Dutch federation (KNVB) across its domestic competitions until the end of 2019.

It is hoped that this proposal will be granted a further trial in the future, given the favorable evidence in support of the ABBA system. Other variants have also been shown to exhibit further improvement; however, the extra complexity would represent an apparent political-tractability hurdle with IFAB. As two examples, Anbarci et al. (2021) show how ABBA is indeed much fairer than the standard alternating sequence, but that it can be made even fairer still in combination with a catch-up rule—allowing the second-taking team that falls behind to go first thereafter, reverting back to ABBA if it levels proceedings. Similarly, Csató (2021a) shows that the catch-up rule combined with swapping the default order after the initial standard five spot kicks per side (provided the shoot-out is still "alive") also leads to a fairness improvement.

Similarly, this may also exist in terms of serving in tennis (Magnus & 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 tennis by Cohen-Zada et al. (2018). Meanwhile, Brams and Ismail (2018) evaluate ABBA and the catch-up rule separately in soccer, along with further applications not only to tennis, but also other "service" games; like badminton, squash and volleyball. The analogous National Football League (NFL) overtime example is discussed in subsection 3.2.

In other sports, the first-taker advantage is a well-known feature, such as in chess (González-Díaz & Palacios-Huerta, 2016), in which since 2006, the World Championship has altered the white-player order from the seventh game of a 12-game tie. Meanwhile, Kazachkov and Vardi (2020) point to a disadvantage for the first taker in ice hockey (specifically National Hockey League, NHL) penalty shoot-outs, since the typical conversion probability is lower than 0.5 (unlike soccer). Nonetheless, the first-taker issue still applies (inversely) in terms of fairness.

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. Both carry a value of one point, compared with four for a win. The first is based on losing by a narrow margin (from 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. 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 is via 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 is a 2017 Nobel Laureate—developed a functional form of "value" in the Draft-pick-order domain, with specific reference to the NFL. They concluded that 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 contribution did not result in any rule or policy changes at 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 labor-market-restriction policies unique to the AFL. Two of which, specifically, are the long-standing Father-son Rule (see Stewart et al., 2016); and the more recent Academy selections. In doing so, its intention is to establish some notional 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. For decades until 2014, the draw for the "finals" tournament placed teams into groups (currently eight groups of four teams), but with 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 compromised other objectives in achieving a desirable draw.

Guyon's computational 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—all Pots (grouped by seedings) were based on the (October 2017) FIFA Ranking, whereas previously, only Pot 1 teams were allocated via the Ranking. A more radical overhaul may be needed from the 2026 edition onwards, with a planned expansion from 32 to 48 teams, which may involve groups of three (Guyon, 2021). This raises the possible spectre of collusion, in a manner similar to the Austria v West Germany 1982 World Cup match (Kendall & Lenten, 2017, pp. 384–385).

As an important aside, the very accuracy of the World Rankings, if used to seed the World Cup draw, is a necessary condition for the group-allocation procedure itself to be valid and fair. On this note, FIFA reverted to an improved and generalized novel Elo-based formula, long used in other sports (notably chess), taking effect from the June 2018 edition. The deficiencies of the previous system (from 2006 to 2018) are summarized neatly by Lasek and Gagolewski (2018) and Cea et al. (2020). While it is unclear just how influential these studies were with FIFA in this decision, the advantages of the revision are nonetheless outlined by FIFA (2018).

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.

In a related impact, Durán et al. (2017) used integer programming to construct an improved schedule for CONMEBOL (South American Football Confederation) Qualifiers for the FIFA World Cup that overcomes numerous shortcomings of the previous system. Their proposed design was approved by CONMEBOL and used for its 2018 World Cup qualifying tournament.

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 four "major leagues" of North America by 1965 (also the National Basketball Association, NBA; 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 poorly performing teams.

However, it was this specific element that created perverse incentives for a team to lose matches towards the end of the season, once it could no longer qualify mathematically for the playoffs. This problem is anecdotally most problematic in the NBA, in which a lottery system was introduced in 1984 to reduce this perverse incentive (see also subsection 4.4). Banchio and Munro (2020) propose a dynamic version, whereby the draft-pick lottery weights evolve over the season to ensure incentive compatibility, although the procedure is numerically complex and unlikely to be understood by fans.

Given the crucial criterion of simplicity (reinforced in subsection 2.2), a far more elegant 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 season, to: "…*fewest games played when eliminated*" (p. 25). The intuition behind this idea is that following the assignment of a draft pick, the perverse incentive is removed entirely for all remaining games. 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 outlining the business case for administrators, Lenten et al. (2018) show an analogous 22 per cent improvement in the AFL, demonstrating the proposal's external validity.

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 the undesired outcome of the poorest-quality team receiving a *lower*-order pick, in contrast to its genuine need and thus to the very intention of the reverse-order element. More recently, Kazachkov and Vardi (2020) propose a further variation involving using rankings at an (unspecified) incomplete stage of the season, the ordering for which is used subsequently to allocate the draft-pick order for the teams that ultimately fail to qualify for the playoffs at the end of the regular season. They use simulation data to show the method's promise, but as simulations from a stylized league, the results are merely internally valid.

3.2. NFL overtime bias

In 1974, the NFL introduced overtime for all regular-season matches. Despite the pros and cons, 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 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 to 2009 were won by the winner of the toss, arguably creating a fairness issue, necessitating a rule change to diminish the power of the coin toss.

One innovative suggestion, rooted in economics, by Che and Hendershott (2008) was to propose an 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. The forces of "demand and supply" would offset 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.

Nonetheless, a 2010 reform was adopted for playoff matches by administrators towards the same end. Specifically, if the first possession results in the "safe" option of a field goal (worth 3 points), the

other team would receive one possession, continuing the game if it also scored a field goal (restoring parity) or winning the game if it scored a touchdown, with this rule extended to all matches from 2012. The early—albeit anecdotal—evidence suggests that the rule changes have served to reduce considerably the first-receive bias, though not eliminate it entirely. From 2012 to the end of the 2016 season, 43 of the 83 overtime regular-season matches played under this rule (counting ties as one-half) were won by the first-possession team. Despite the small sample size, the corresponding proportion of 51.8 per cent approximates the 52 per cent figure predicted by Jones (2012) from a Markov Chain model calibrated on actual NFL state-outcome data. However, this has since increased, as theory would predict, to 54.2 per cent (26 out of 48) from 2017 to 2020, over when the standard 15-minute overtime period was reduced to 10 mins.[4]

3.3. Defensive extra-time in soccer

A long-standing problem with knockout-phase soccer matches is the often defensive nature of extra time, increasing the likelihood that the contest is decided via a penalty shoot-out, which many fans see as being an unsatisfactory conclusion. Hence, this undermines the ability of extra time as a tool to "separate" the teams. A change in the 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. 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 (initially, the one that already lost the shoot-out, and then if it scores, the other one) would need to score during extra time to win and hence become more attacking than under the current rule, although the shoot-out winning team inversely (also) has an incentive to play more defensively.

Empirically (and using a quasi-experimental setting, like 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 overwhelms the defensive effect. The results provide a conclusion to an earlier theoretical model by Carrillo (2007), ruling the effect as potentially ambiguous.[5]

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

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 perverse incentives to cheat. Secondly, Wu et al. (2020) test, via economic experiments, the possible effectiveness of a conditional superannuation scheme, whereby athletes are compelled to forego a nominal portion of their earnings, held in escrow, 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 inter-temporal incentives for an athlete to stay clean throughout his/her entire career span, given the possibility of being caught retrospectively via stored samples (as in many high-profile cases).

With respect to both of these ideas, there is much 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 an intention to *lose*, invariably match-fixing (but also tanking, like in subsection 3.1), can often additionally involve the possible threat of criminal charges against the culprit (e.g. 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; such as coaches, managers/other entourage members, team officials, and umpires/referees.

3.5. Incentive compatibility in tournament design

Csató (2021b) discusses a problem experienced in the European Men's Handball Championship 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 one.

He demonstrates how such a tournament design is incentive incompatible, and therefore, is open to manipulation in the final first-group-stage match (Kendall & 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 points already earned has been an already-implemented policy in a handful of European domestic soccer leagues in which there are 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 first stage.

As a suggestion to an analogous tournament-design problem, Dagaev and Sonin (2018) demonstrated how the seeding system for the UEFA Champions League (UCL) became incentive incompatible after the 2014/15 season. The specific scenario referred to was whenever the current titleholder qualifies for the first (seeding) pot via its status as the domestic champion—ostensibly in a highly ranked league. In that case, its notional slot is redistributed to another team from a lower-ranked league. This particular idiosyncrasy could result in a top-tier team from the same domestic league as that titleholder missing out on a slot altogether, through no fault of its own. (Csató, 2020) showed that the simple tweak of filling all vacancies (directly) via each respective national league completely circumvents this.

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, the current section pays credit to the practitioners themselves. It does so by outlining cases where they were proactive in changing a rule that improved the status quo (or reversed a rule that caused perverse outcomes), and subsequent academic work ultimately vindicated their policy reforms.

4.1. Tournament design (again)

Further to subsections 2.5 and 3.5, (mainly) soccer administrators have an established track record of changes in this regard, which has been backed up subsequently by academic research. We begin with the antithetical case from the final paragraph of subsection 3.5. Up until the 2015/2016 season of the Europa League (UEL), most UEFA national federations had a policy to allocate their vacant slot to their domestic Cup runner-up, in the event that the Cup winner had instead qualified for the more prestigious UCL via the standard domestic League ranking criterion. This seemingly innocuous regulation gave rise to a possible incentive misalignment to occur. UEFA wisely rescinded this stipulation after 2015/2016. Dagaev and Sonin (2018) later showed how this rule revision guaranteed incentive compatibility under those conditions, while illustrating a real-life example from the Russian Premier League in 2012.

Even with that particular problem dealt with, for the next few seasons, until 2017/2018, the current EUL titleholder may still have perversely been incentivized to lose its match against the current UCL titleholder in its domestic League (Csató, 2019). It is conceivable that UEFA administrators previously recognized this danger, given that they undertook a substantial reform of UCL qualification. Specifically, they resolved to guarantee a slot for the UEL titleholder in the UCL group stage from the 2018/2019 season onward. Happily, this reform eliminated the pre-existing incentive-incompatibility problem.

4.2. 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 by FIFA to diminish the impact of penalty shoot-outs in soccer. It was introduced for the 1993 World Youth Cup (U/20s) in Australia and later extended to the 1998 and 2002 World Cups (and 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 of spot kicks determining the match, by removing any opportunity for the conceding team to equalize; and still send the contest to penalties.

Most observers of the sport agreed that, despite the intuition, the rule did not work as intended. Subsequently, UEFA experimented further with the watered-down "silver goal" version from 2002, whereby the match concludes at half-time of extra-time if one team is ahead, but with no sudden death. Nonetheless, both versions were scrapped in 2004.[6] 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 a counter-intuitive *increase* in the frequency of shoot-outs.

4.3. Three points for a win

The change in soccer competitions over time—starting with the English leagues in 1981—from two to three points for a win, poses a classic question about the power of incentives within sports rules. More specifically, whether it should lead to more attacking soccer and higher scoring, given the higher rewards for a win versus a draw. This appealing research question has been investigated widely; however, we note that the results have proven to be mixed.

Superficially, the three-point system should lead to both higher average scoring and consequently a lower probability of draws. While the existence of an extensive previous literature is acknowledged, we nonetheless highlight Moschini (2010) as representing 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 of the three-point rule, the empirical results are very much as hypothesized.

Nonetheless, despite this basic intuition, three points for a win also represents a higher (relative) opportunity cost 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 with greater team-quality asymmetry) playing more defensively than under the two-point system, leaving some doubt on whether administrators are vindicated on this particular rule change.

4.4. 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 product) 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 few times since the introduction of the Lottery.

A study by Price et al. (2010) compares the original system of equal weights of the non-playoff teams from 1984 with the two revised sets of weights used from 1989 to 1992 and 1993 onwards. Using reasoning of the relative magnitude of incentives to tank to infer what their model expects to find, they 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 in last place (relative to second- and third-last). This is because 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, and the cost of being unable to allocate the top emerging talent (to the team/s that need/s it most) quite as accurately in optimizing 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 remains elusive for now.

5. Discussion

In a not-too-dissimilar spirit to that of 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 provide an alternative angle on this literature. More specifically, by providing an orthogonal survey—based on constructive and useful contributions of academic work

impacting rule and policy changes in the professional sports industry, rather than focusing on cases whereby athletes exploited badly designed rules to their own ends.

These studies 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 investigating and substantiating the effect of previous rule/policy changes made by sports administrators. Our commentary places significant weight on such rule characteristics as fairness, efficiency and incentive compatibility, though we recognize that others may prefer different criteria. The catalog of relevant numerous identifiable works of each type we have presented here is not necessarily exhaustive, yet undoubtedly comprehensive.

Given the existing evidence of cases whereby academic work has positively impacted 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 and their organizational colleagues could be doing so much more to be reaching out to academics, we also reinforce the need for more academic research involvement towards this area—not only from OR, but also other social sciences with considerable scope to contribute.

6. Future research

We continue to collect examples of sports rule changes which either were successful and enhanced the sport, or which had unintended consequences and had a detrimental effect. As our database of examples grows, we may be able to focus on specific sports, or sporting structures, enabling us to delve even deeper into specific examples. Based on our observations thus far, football, tournament structures (perhaps focusing on tanking) and result resolution when the game is drawn at the end of the allotted time; would all benefit from further research, simulation and discussion.

We are also planning to suggest some changes which, although not rules related as such, will enable better data integrity, and will facilitate research. As an example, there is no one way how to refer to football clubs using a shortened version of their name. For example, "MNU" for Manchester United. If a standard adoption could emerge, this would facilitate having one database of all football-related data, which would help researchers and the sporting community alike.

Notes

1. 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)—the former case was dramatized in the 2015 motion picture, *Concussion*, starring Will Smith; and (ii) reaction time studies—for example, Lipps et al. (2011)—informing changes made to false-start rules in athletics.
2. 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).
3. Of note is that the death of Tony Lewis in April 2020 was commemorated by the ICC via an 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.
4. We believe this unconditional probability to be upward biased, due to the home team (with its natural advantage) winning the overtime toss 60.4 per cent of the time in this sub-sample.
5. Incidentally, UEFA (24 June 2021) announced on it would dispense the away-goal rule—a feature of UEFA competitions (e.g. Champions and Europa Leagues) involving two-leg knockout ties since 1965. This change will likely increase fairness (Jost, 2021, critiques its competitive-balance effects). Nevertheless, we postulate this change will produce significantly more two-legged ties advancing to (second-leg) extra-time and penalty-shootouts, which may prove unpopular. The current rule proposal is a worthy preemptive policy to circumvent penalty shootouts deciding more future ties.
6. However, it is worth noting that this rule (or a variant thereof) still persists in numerous other sports, like ice hockey (e.g. NHL) and rugby league (e.g. National Rugby League, NRL). However, these sports fundamentally tend to be higher scoring, meaning in which such a system should work more effectively as intended.

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ORCID

Liam J. A. Lenten http://orcid.org/0000-0001-7694-994X
Graham Kendall http://orcid.org/0000-0003-2006-5103

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