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2018 FIFA World Cup qualification can be manipulated*

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Ein Fehler in der ursprünglichen Versammlung der Heere ist
im ganzen Verlauf des Feldzuges kaum wieder gut zu machen.

(Helmuth Karl Bernhard von Moltke: *Taktisch-strategische
Aufsätze aus den Jahren 1857 bis 1871*)

Abstract

In the European section of the 2018 FIFA World Cup qualification, 13 national teams, which are members of the Union of European Football Associations (UEFA), can qualify for the final competition. The 54 teams are divided into nine groups to play home-and-away round-robin matches in 10 matchdays. The winners of each group qualify, while the eight best second-placed teams advance to play-offs such that the four winners of play-offs also qualify. Ranking of second-placed teams differs from ranking in groups since group matches against the sixth-placed team are discarded.

It is shown that this feature opens a way for manipulation: it may happen that a team is eliminated if it wins in the last matchday of group stage, but it advances to play-offs by playing a draw, provided that all other results are fixed. An example reveals that this situation might even occur in October 2017, after eight matchdays are already played in the qualification. Furthermore, by adjusting the result of only two matches played before October 2017 with an addition of one goal each, a team can strictly prefer a draw over a win in its last match as the former may advance it to play-offs, but the latter certainly leads to its elimination.

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* Scientific research is typically not a race against time. But not in this case: the whole issue have come to our mind on 7 September 2017, and we wanted to publish it as soon as possible because of the actuality of the topic. Consequently, the paper may contain more mistakes than usual.

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1 Introduction

One important role of Operations Research (OR) is to inform decision-makers about the possible properties, especially failures of different rules and formulas. It is an essential issue on the field of sport, since a bad regulation can easily lead to public outrage: one recent example occurred in [Badminton at the 2012 Summer Olympics – Women’s doubles](#) (Kendall and Lenten, 2017, Section 3.3.1). It is not an unknown phenomenon in *football*¹, too, as illustrated by [Barbados vs. Grenada \(1994 Caribbean Cup qualification\)](#) (Kendall and Lenten, 2017, Section 3.9.4), or the notorious ‘[Nichtangriffspakt \(or Schande\) von Gijón](#)’² (Kendall and Lenten, 2017, Section 3.9.1). A number of similar cases are discussed in Kendall and Lenten (2017).

Perhaps these negative events have contributed to the increasing popularity of OR analysis of sport ranking rules (Gerchak, 1994; Wright, 2009, 2014), and to the recent discussion of an axiomatic approach towards sporting rankings (Berker, 2014; Csató, 2017a,b; Vaziri et al., 2017). We aim to continue this research direction by proposing two axioms concerning the manipulability of tournaments in Section 2. If they are not satisfied, *teams*³ might have a possibility to gain by performing worse. Section 3 presents the European section of the 2018 FIFA⁴ World Cup qualification. This qualification can be manipulated manipulability as proved in Section 4: it might happen that a team is eliminated if it wins in the last matchday of group stage, but it advances to play-offs by playing a draw, provided that all other results are fixed. Crucially, the example takes the results of matches played before October 2017 (and the publication of the first version of the current paper) as given. Section 5 reveals that this manipulation is not without risk, but by adjusting the result of only two matches played before October 2017 with an addition of one goal each, a team can strictly prefer a draw over a win in its last match as the former may advance it to play-offs, but the latter certainly leads to its elimination. Finally, Section 6 concludes.

The paper is written both for the public and the scientific community. Readers not interested in or not familiar with the axiomatic background of manipulation can skip Sections 2 and 5.

2 Axioms of manipulation

Consider a *tournament* containing an arbitrary number of sequential rounds. Teams can in each round (1) directly qualify for a later (not for the next) round; or (2) advance to the next round and retain the chance to qualify; or (3) be eliminated. Teams are divided into groups. A play-off match can be regarded as a group with two teams.

Matches are decided by scoring goals. Match outcome is measured on a scale with at most five grades: win \succ extra-time win \succ draw \succ extra-time loss \succ loss, where \succ means that the former is more valuable than the latter. Ranking of teams in each round is based on greater number of points such that a more valuable outcome means more points, for example, 3 for a win, 2 for an extra-time win, 1 for an extra-time loss, and 0 for loss. Tie-breaking rules can be arbitrary.

Since the ranking is based on greater number of points, teams usually have an incentive to achieve as many points as possible in the tournament. However, there may be some special rules implying that a team might gain from changing the outcome of one of its matches to a

¹ Throughout the paper, we take the meaning of football to be the European meaning, rather than the US meaning.

² Kendall and Lenten (2017) use the term ‘Shame of Gijón’, and Wikipedia calls it ‘Disgrace of Gijón’.

³ Throughout the paper, we use the term team because of the example discussed, but they can also be players in other settings.

⁴ FIFA stands for *Fédération Internationale de Football Association*, French for International Federation of Association Football, the international governing body of association football, futsal, and beach soccer.

less valuable one (for example, by playing a draw instead of a win). In this case we speak about the *manipulation* of the tournament.

Definition 2.1. *Gain with respect to qualification:* A team *gains with respect to qualification* if by changing the outcome of some matches:

- it advances to the next round after the change such that it was eliminated before the change; or
- it directly qualifies after the change such that it was eliminated or advanced to the next round before the change.

Definition 2.2. *Loss with respect to qualification:* A team *loses with respect to qualification* if by changing the outcome of some matches:

- it advances to the next round after the change such that it was directly qualified before the change; or
- it is eliminated after the change such that it was advanced to the next round or directly qualified before the change.

Definition 2.3. *Ex-post manipulation:* A team can *ex-post manipulate* a tournament if by changing the outcome of one of its matches to a less valuable one, provided that all other match results are fixed, it gains with respect to qualification from this change.

Definition 2.4. *Ex-post non-manipulability (EPNM):* A tournament is *ex-post non-manipulable* if there exists no team which can ex-post manipulate it.

Ex-post manipulation may be a too tolerating concept since teams face the uncertainty on the result of matches to be played later. A more restrictive notion of manipulation can be introduced by taking into account the information structure

Definition 2.5. *Ex-ante manipulation:* A team can *ex-ante manipulate* a tournament if by changing the outcome of one of its matches to a less valuable one provided that all known match results are fixed:

- it cannot lose with respect to qualification under any set of unknown results; and
- it gains with respect to qualification under some set of unknown results.

Ex-ante manipulation is a strong notion since it involves an extreme risk-averse of the team planning to manipulate.

Definition 2.6. *Ex-ante non-manipulability (EANM):* A tournament is *ex-ante non-manipulable* if there exists no team which can ex-ante manipulate it.

We assume the following information structure. A team can play at most one match on each day. Match results are not known by teams when they play on the same day, but all results are common knowledge on subsequent days.

Note that teams have usually partial information on the matches played at the same time, but we disregard it, strengthening ex-ante manipulation and weakening *EANM*.

Lemma 2.1. *EANM implies EPNM, that is, an ex-ante non-manipulable tournament is ex-post non-manipulable.*

The difference of the two kinds of manipulations is illustrated by the following example.

Table 1: The tournament of Example 2.1

(a) Match results of Example 2.1				(b) Final standing of Example 2.1	
Day	Team 1	Team 2	Result	Team	Points
1	<i>A</i>	<i>B</i>	<i>B</i> won	<i>A</i>	5
1	<i>C</i>	<i>D</i>	<i>C</i> won	<i>B</i>	5
2	<i>A</i>	<i>D</i>	<i>A</i> won	<i>C</i>	5
2	<i>C</i>	<i>E</i>	<i>E</i> won	<i>D</i>	3
3	<i>B</i>	<i>C</i>	<i>C</i> won	<i>E</i>	2
3	<i>D</i>	<i>E</i>	<i>D</i> won		
4	<i>A</i>	<i>C</i>	draw		
4	<i>B</i>	<i>E</i>	<i>B</i> won		
5	<i>A</i>	<i>E</i>	<i>A</i> won		
5	<i>B</i>	<i>D</i>	draw		

Example 2.1. A tournament involves a group of five teams such that the first two qualify and the last three are eliminated. Match result can be a win, a draw, or a loss. The ranking of teams is based on the following criteria:

1. Greater number of points (2 points for a win, 1 point for a draw, 0 points for a loss);
2. Name of the team in alphabetic order.

If the first two teams have the same number of points, they qualify. If the first team has more points than the runner-up, the first team qualifies, and the remaining four teams are ranked on the basis of the criteria above but the match played against the first team is discarded.

Match results are shown in Table 1.a, and final standing is shown in Table 1.b, so teams *A* and *B* qualify. Consider what happens if team *C* loses against team *A* on day 4. Then team *A* has 6 points, so it qualifies. However, team *B* has only 3 points without the match against team *A*, and team *C* has still 4 points, so team *C* qualifies. According to Definition 2.3, team *C* can ex-post manipulate the tournament.

But it is not an ex-ante manipulation because the outcome of the match between teams *A* and *E* is unknown on day 4. If team *E* wins against team *A* on day 5, and team *C* has lost against team *A* (as an attempt to manipulate), then team *B* will be the first with 5 points, hence it qualifies together with team *A*. In other words, playing a draw against team *A* on day 4 is a risky strategy for team *C*, therefore it is not an ex-ante manipulation.

Ex-ante and ex-post manipulations will be further highlighted in Section 5.

3 2018 FIFA World Cup qualification (UEFA)

2018 FIFA World Cup qualification (UEFA) is the European section of the 2018 FIFA World Cup qualification, the qualifier of national teams which are members of UEFA⁵ for the 2018 FIFA World Cup, to be held in Russia.⁶ With the admission of Gibraltar and Kosovo as FIFA

⁵ UEFA stands for Union of European Football Associations, the administrative body for association football in Europe, however, several member states are primarily or entirely located in Asia. It is one of the six continental confederations of world football's governing body FIFA.

⁶ This section is mainly based on the [Wikipedia page of 2018 FIFA World Cup qualification \(UEFA\)](#). We will cite only those FIFA documents which concern the ranking of teams.

Strangely, [FIFA \(2016, Article 20.6\)](#) does not state explicitly that greater goal differences and fair play points are preferred.⁷ Choice of the eight best second-placed teams is also not addressed here. [FIFA \(2016, Article 20.8\)](#) only states that

Should the best second- or third-placed team within a group stage qualify for the next stage or for the final competition, the criteria to decide such best second- or third-placed team shall depend on the competition format and shall require the approval of FIFA following proposals from the confederations.

Unfortunately, we were not able to find the relevant regulation of UEFA. But, according to a recent FIFA Media Release ([FIFA, 2017](#)),

the eight best runners-up will be decided by ranking criteria as stated in the 2018 FIFA World Cup Regulations, namely points, goal difference, goals scored, goals scored away from home and disciplinary ranking, with the results against teams ranked 6th not being taken into account.

Since head-to-head results are nonexistent in the comparison of runners-up, the ranking of second-placed teams strictly follow tie-breaking in groups, with the crucial difference of discarding two matches played against the last team of the group.⁸

We will see that this, seemingly minor, modification has some unintended consequences regarding manipulation.

⁷ The purpose of mixing words *greater* and *greatest* is not clear.

⁸ It is reinforced by an UEFA news titled '[Focus switches to World Cup qualifying](#)', released on 22 August 2016.

However, it seems that there is some controversy around the ranking of second-placed teams. According to our knowledge, FIFA and UEFA do not publish these rankings. The [Spanish Wikipedia page of 2018 FIFA World Cup qualification \(UEFA\)](#) ranked the runners-up on the basis of all matches played even on 12 September 2017. Most Wikipedia pages of the qualification, like the [English](#), [French](#), or [Hungarian](#) have placed Sweden as the 6th and Montenegro as the 7th second-placed team on 12 September 2017, after eight matchdays were played. On the other hand, Montenegro was the 6th and Sweden the 7th in [German](#) and [Italian](#). As one can check in [Tables 2](#) and [A.4](#), Sweden and Montenegro had the same goal difference (+3) and number of goals scored (10). Furthermore, both teams scored 4 goals away from home. There is a difference in the goals against them, other teams of the group (without the last) had scored 2 goals in Sweden and 3 in Montenegro. It is a weak argument to rank higher Sweden, nevertheless, in the lack of exact rules, we are not sure. It is also possible that disciplinary points count, but then with or without the matches against the last team? Anyway, it is rather an academic issue as it does not influence advancing to play-offs.

Second-placed teams should also be ranked in the second round of the [Asian section of the 2018 FIFA World Cup qualification](#), organized for national teams which are members of AFC (Asian Football Confederation). AFC has published a Media Release ([AFC, 2015](#)) listing the following criteria as tie-breaking rules for the comparison of runners-up: *greatest number of points obtained from group matches; goal difference in group matches; greatest number of goals scored in group matches; fewer number of points calculated according to the number of yellow and red cards received by the team; drawing of lots*. Number of goals scored away from home does not appear among the criteria and the preferred direction of goal difference is not specified, although it is provided for fair play points in contrast to [FIFA \(2017, Article 20.6\)](#). Furthermore, it says only that all points, goal scored and goals conceded in discarded matches will not be taken into account, so it is still not clear whether yellow and red cards in the discarded matches are considered or not.

[AFC \(2015, Case 2\)](#) provides an illustration on how to calculate a ranking of second-placed teams when some group matches are discarded.

4 How 2018 FIFA World Cup qualification (UEFA) can be manipulated?

In the following we present a possible way of manipulation for the European section of the 2018 FIFA World Cup qualification. Match results of the first eight matchdays – to be played between 4 September 2016 and 5 September 2017 – are assumed to be fixed (they were known when the first version of this paper was published).⁹

Theorem 4.1. *It might still happen after eight matchdays are over that 2018 FIFA World Cup qualification (UEFA) can be manipulated by Bulgaria playing a draw instead of a win against Luxembourg in the last matchday, on 10 October 2017.*

Proof. We provide an example by generating the results of the last two matchdays, to be played between 5 October 2017 and 10 October 2017.¹⁰ Eight groups are shown in the Appendix:

- Table [A.1](#) presents Group B;
- Table [A.2](#) presents Group C;
- Table [A.3](#) presents Group D;
- Table [A.4](#) presents Group E;
- Table [A.5](#) presents Group F;
- Table [A.6](#) presents Group G;
- Table [A.7](#) presents Group H;
- Table [A.8](#) presents Group I.

Since the manipulation concerns Group A, it is discussed in detail. Table [2](#) shows a possible set of match results in this group. Note that some fictitious results of Table [2.b](#) may be unreasonable, like Belarus defeating Netherlands by 7-0. They are necessary to create the appropriate conditions for manipulation. Nevertheless, it has at least positive probability after only eight matchdays are over.

On the basis of Group A-I standings, ranking of the best runners-up is summarized in Table [3](#). Only the eight best second-placed team advance to play-offs, hence Bulgaria is eliminated.

Now consider what happens if Bulgaria plays a draw of 1-1 against Luxembourg in the last matchday, which takes place on 10 October 2017 in Group A. It is clear that this change worsen Bulgaria's standing in the group. However, it still remains on the second place with 16 points as both Bulgaria and Sweden has the same goal difference (+4) with Bulgaria scoring more goals in all group matches (22 vs. 18) in this alternative scenario. On the other hand, Luxembourg overtakes Belarus in Group A thanks to its newly achieved draw (it has the same goal difference with more goals scored). In the ranking of second-placed teams, matches against the last team are discarded, consequently, Bulgaria will have 13 points, placing it seventh among the second-placed teams according to Table [3](#) (it has the same goal difference as Greece with more goals scored). Consequently, Bulgaria advances to play-offs instead of Montenegro. \square

⁹ Perhaps the best summary of 2018 FIFA World Cup qualification (UEFA) is its [Wikipedia page](#). However, a national team in Group G was referred to as Macedonia (at least on 12 September 2017), while its name used by FIFA and UEFA is FYR Macedonia, as the country was admitted by United Nations the country under the provisional description *the former Yugoslav Republic of Macedonia*.

¹⁰ It is worth to note that all teams play one match home and one away in the last two matchdays, which is not necessarily true for two subsequent matchdays.

Table 2: 2018 FIFA World Cup qualification – UEFA Group A

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	France	—	2-1	4-0	4-1	0-0	10 Oct
2	Sweden	2-1	—	1-1	3-0	7 Oct	4-0
3	Netherlands	0-1	10 Oct	—	3-1	5-0	4-1
4	Bulgaria	7 Oct	3-2	2-0	—	4-3	1-0
5	Luxembourg	1-3	0-1	1-3	10 Oct	—	1-0
6	Belarus	0-0	0-4	7 Oct	2-1	1-1	—

(b) Fictitious match results of the last two matchdays

Last row shows an alternative result, obtained if Bulgaria manipulates

Date	Home team	Away team	Result
7 October 2017	Sweden	Luxemburg	0-4
7 October 2017	Belarus	Netherlands	7-0
7 October 2017	Bulgaria	France	8-0
10 October 2017	France	Belarus	1-0
10 October 2017	Luxembourg	Bulgaria	0-1
10 October 2017	Netherlands	Sweden	3-0
10 October 2017*	Luxembourg	Bulgaria	1-1*

(c) Final standing with the runner-up results

Pos = Position; W = Won; D = Drawn; L = Loss; GF = Goals for; GA = Goals against; GD = Goal difference; Pts = Points. All teams have played 10 matches.

Last but one row contains the second-placed team's benchmark results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#).

Last row contains the second-placed team's alternative results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#), obtained if Bulgaria manipulates.

Pos	Team	W	D	L	GF	GA	GD	Pts
1	France	6	2	2	16	13	3	20
2	Bulgaria	6	0	4	22	17	5	18
3	Sweden	5	1	4	18	14	4	16
4	Netherlands	5	1	4	19	18	1	16
5	Belarus	2	2	6	11	17	-6	8
6	Luxembourg	2	2	6	11	18	-7	8
2	Bulgaria	4	0	4	17	14	3	12
2*	Bulgaria*	4*	1*	3*	20*	16*	4*	13*

To summarize, there exists a set of match results (even after eight matchdays are over) such that Bulgaria advances to play-offs instead of being eliminated if it 'succeeds' to concede a goal in its last match, provided that all other match results are fixed. Since Montenegro is eliminated by this unfair act, it has a strong argument to protest against the current rules applied by FIFA and UEFA.

Table 3: 2018 FIFA World Cup qualification – Ranking of second-placed teams

Pos = Position; W = Won; D = Drawn; L = Loss; GF = Goals for; GA = Goals against; GD = Goal difference; Pts = Points.

Since matches played against the 6th team in each group are discarded (FIFA, 2017), all teams have played 8 matches taken into account.

Last row contains Bulgaria’s alternative results, obtained if it manipulates.

Pos	Team	Group	W	D	L	GF	GA	GD	Pts
1	Portugal	B	6	1	1	23	5	18	19
2	Italy	G	6	1	1	14	8	6	19
3	Northern Ireland	C	4	2	2	9	3	6	14
4	Wales	D	3	5	0	8	5	3	14
5	Turkey	I	4	2	2	8	8	0	14
6	Slovakia	F	4	1	3	11	5	6	13
7	Greece	H	3	4	1	8	4	4	13
8	Montenegro	E	3	3	2	12	6	6	12
9	Bulgaria	A	4	0	4	17	14	3	12
7*	Bulgaria*	A	4*	1*	3*	20*	16*	4*	13*

5 2018 FIFA World Cup qualification (UEFA) and the axioms of manipulation

In this section, we analyse 2018 FIFA World Cup qualification (UEFA) with respect to the two axioms introduced in Section 2.

Proposition 5.1. *2018 FIFA World Cup qualification (UEFA) does not satisfy ex-post non-manipulability.*

Proof. The example presented in the proof of Theorem 4.1 shows a violation of *EPNM*. \square

While Bulgaria can ex-post manipulate due to Proposition 5.1, playing a draw against Luxembourg in the last matchday is not an ex-ante manipulation. For instance, if France vs. Belarus is 2-0, then Belarus and Luxembourg have the same goal difference (-6) and the same number of goals scored (11), so Luxembourg is the fifth to due head-to-head results even if Bulgaria defeats it by 1-0. So Bulgaria might not risk to kick an own goal in the last minute, because if Sweden draws against Netherlands, it might lose its second place by playing a draw. Note that the definition of ex-ante manipulation excludes a loss with respect to qualification to emerge under any set of possible match results, and arbitrary results of matches played on the same day are allowed by our information structure.

However, it turns out that some adjustment of results of matches played on the first eight matchdays makes even ex-ante manipulation possible.

Theorem 5.1. *2018 FIFA World Cup qualification (UEFA) does not satisfy ex-ante non-manipulability.*

Proof. We customize the example presented as a proof of Theorem 4.1 by changing:

- the known result of France vs. Luxembourg, played on 3 September 2016, to 1-0 (instead of 0-0);¹¹
- the fictitious result of Belarus vs. Netherlands to the slightly more reasonable 6-0 (instead of 7-0);

¹¹ The win of the group leader may even more reasonable.

Table 4: 2018 FIFA World Cup qualification – UEFA Group A

Final standing with the runner-up results

Pos = Position; W = Won; D = Drawn; L = Loss; GF = Goals for; GA = Goals against; GD = Goal difference; Pts = Points. All teams have played 10 matches.

Last but one row contains the second-placed team’s benchmark results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#).

Last row contains the second-placed team’s alternative results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#), obtained if Bulgaria manipulates.

Pos	Team	W	D	L	GF	GA	GD	Pts
1	France	7	1	2	17	13	3	22
2	Bulgaria	6	0	4	22	17	5	18
3	Sweden	5	1	4	18	14	4	16
4	Netherlands	5	1	4	19	17	2	16
5	Belarus	2	2	6	10	17	-7	8
6	Luxembourg	2	1	7	11	19	-8	7
2	Bulgaria	4	0	4	17	14	3	12
2*	Bulgaria*	4*	1*	3*	20*	16*	4*	13*

- the known result of Greece vs. Bosnia and Herzegovina, played on 13 November 2016, to 2-1 (instead of 1-1).

Table 4 shows the final standing of Group A after these adjustments.

The crucial difference is that with this set of results, Luxembourg is guaranteed to be the sixth unless it does not achieve at least a draw against Bulgaria as well as France is guaranteed to be the first independently of its last match.¹² Therefore, Bulgaria has 12 points and a goal difference of +3 in the ranking of runners-up if it defeats Luxembourg. Consequently, Bulgaria knows on 10 October 2017 (which is the last day of the qualification, so six groups C, D, E, F, G and I are still finished) that it cannot be a second-placed team better than any other in Groups B-I by a win, as illustrated by Table 3: from the two groups still playing on the same day, Portugal in Group B has at least 18 points among the runners-up even if it loses against Switzerland (see Table A.1), and Greece has 13 points among the runners-up independently of its last match against Gibraltar (see Table A.7).¹³

To conclude, Bulgaria faces a certain elimination if it wins against Luxembourg as it will be the worst among second-placed teams. On the other hand, a draw may advance Bulgaria to play-offs, so playing for the latter is an ex-ante manipulation.¹⁴ □

6 Discussion

There are at least two possible directions for future research. First, other sport rules can be analysed from the perspective of the axioms concerning manipulability, introduced here. We plan

¹² This necessitates the change of France vs. Luxembourg.

¹³ Without changing Greece vs. Bosnia and Herzegovina to 2-1, Greece has only 16 points if it loses against Gibraltar, so Bosnia and Herzegovina is the runner-up with our fictitious results, but it has only 11 points among the second-placed teams. It is a problem for ex-ante manipulation, as then Bulgaria may advance to play-offs even by defeating Luxembourg, but when deliberately plays a draw, it loses the second place and is eliminated if Sweden draws against Netherlands. Similarly, the first place should be beyond the reach of Bulgaria, otherwise, it has some incentives to win.

Strength of ex-ante manipulation is clearly revealed by this complicated reasoning.

¹⁴ Note that the adjustment of the fictitious result of Belarus vs. Netherlands to 6-0 provides that Luxembourg is the fifth if it draws against Bulgaria.

to write some follow-up papers on this topic.¹⁵ Second, following [Berker \(2014\)](#), the current theory-oriented investigation can be supplemented by estimating the probability of manipulation with the use of historical and Monte-Carlo simulated data.

We think [Theorem 4.1](#) carries a really frightening message for FIFA and UEFA: it has a positive probability that a serious scandal may occur during 2018 FIFA World Cup qualification (UEFA) in October 2017. In a sense, it would be even more disturbing than the 'Nichtsangriffspakt von Gijón' as one team has an incentive not only to stop attacking, but to kick an own goal. Furthermore, it would be a more unfair case than Barbados vs. Grenada (1994 Caribbean Cup qualification) as the latter has not affected the qualification of a third team. Fortunately, this situation is not very likely to materialize.

One can also argue that the presented manipulation is risky since Bulgaria might lose from playing deliberate a draw instead of a win. However, [Theorem 5.1](#) proves that – with a customization of two matches played in the first eight matchdays by adding one goal each – 2018 FIFA World Cup qualification (UEFA) is even susceptible to ex-ante manipulation, that is, in certain cases playing a draw might advance a team to play-offs, while a win certainly results in its elimination.

Consequently, the current rules of the 2018 FIFA World Cup qualification (UEFA) are beyond recovery from an axiomatic point of view. The root of the problem is the difference of group and second-places teams ranking. It seems probable that the application of different tie-breaking rules for the two purposes might always create the conditions for manipulability. We do not know what was the exact cause for discarding the matches against the sixth-placed teams in the comparison of runners-up, but note that when the qualifying format was confirmed, there were only 52 national teams. In such a case it is impossible to balance nine groups, but discarding certain matches can lead to manipulability.

Therefore we suggest that groups should always contain the same number of teams. If the number of teams is not divisible by the number of groups, the weakest teams (like Gibraltar, Liechtenstein, San Marino etc.) should be relegated to an extra group, where they play against each other without the possibility of directly qualification. The winner of this extra group may advance to play-offs with runners-up (or third-placed teams), by playing with the best of them. Besides excluding manipulability, this solution has another benefit by giving more chance for lower-ranked national teams, mainly composed of amateur players, to compete in their own league and achieve more success than scoring some lucky goals against professional sportsmen.

Hopefully, this paper has reinforced that the scientific community and the sports industry should work more closely together in order to study the effects of potential rules and rule changes even before they are implemented. For instance, the governing bodies of the major sports may invite academics to identify possible loopholes in proposed rules, and in this way prevent serious scandals.

¹⁵ As a preliminary, we have examined 2018 FIFA World Cup qualification of the other five confederations AFC (Asian Football Confederation), CAF (Confederation of African Football), CONCACAF (Confederation of North, Central American and Caribbean Association Football), CONMEBOL (South American Football Confederation) and OCF (Oceania Football Confederation). In the second round of AFC qualification, 40 teams were divided into eight groups of five teams such that the eight group winners and the four best group runners-up advance to the third round. As a result of Indonesia being disqualified due to FIFA suspension, one group contained only four teams compared to five teams in all other groups. Therefore, the results against the fifth-placed team were not counted in the ranking of the runner-up teams according to the related AFC regulation ([AFC, 2015](#), Case 2).

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References

- AFC (3 June 2015). *Media Releases: Criteria to determine the rankings of best-placed teams among the groups*. <http://www.the-afc.com/download/criteria-to-determine-the-rankings-of-best-placed-teams-among-the-groups>.
- Berker, Y. (2014). Tie-breaking in round-robin soccer tournaments and its influence on the autonomy of relative rankings: UEFA vs. FIFA regulations. *European Sport Management Quarterly*, 14(2):194–210.
- Csató, L. (2017a). Impossibilities of ranking in sport tournaments. Manuscript. [arXiv:1701.06539](https://arxiv.org/abs/1701.06539).
- Csató, L. (2017b). On the ranking of a Swiss system chess team tournament. *Annals of Operations Research*, 254(1-2):17–36.
- FIFA (2016). *Regulations: 2018 FIFA World Cup Russia™. 14 June – 15 July 2018*. http://resources.fifa.com/mm/document/tournament/competition/02/84/35/19/regulationsfwc2018en_neutral.pdf.
- FIFA (6 September 2017). *Media Release: FIFA World Cup European play-off draw to take place on 17 October 2018*. <http://www.fifa.com/worldcup/news/y=2017/m=9/news=fifa-world-cup-european-play-off-draw-to-take-place-on-17-october-2906954.html>.
- Gerchak, Y. (1994). Operations research in sports. In Pollock, S. M., editor, *Handbooks in Operations Research & Management Science*, pages 507–527. Elsevier, Amsterdam.
- Kendall, G. and Lenten, L. J. (2017). When sports rules go awry. *European Journal of Operational Research*, 257(2):377–394.
- Vaziri, B., Dabadghao, S., Yih, Y., and Morin, T. L. (2017). Properties of sports ranking methods. *Journal of the Operational Research Society*, forthcoming. DOI: [10.1057/s41274-017-0266-8](https://doi.org/10.1057/s41274-017-0266-8).
- Wright, M. (2009). 50 years of OR in sport. *The Journal of the Operational Research Society*, 60(Supplement 1):S161–S168.
- Wright, M. (2014). OR analysis of sporting rules – A survey. *European Journal of Operational Research*, 232(1):1–8.

Appendix

Table A.1: 2018 FIFA World Cup qualification – UEFA Group B

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	Switzerland	—	2-0	7 Oct	2-0	3-0	1-0
2	Portugal	10 Oct	—	3-0	5-1	6-0	4-1
3	Hungary	2-3	0-1	—	10 Oct	4-0	3-1
4	Faroe Islands	0-2	0-6	0-0	—	1-0	7 Oct
5	Andorra	1-2	7 Oct	1-0	0-0	—	0-1
6	Latvia	0-3	0-3	0-2	0-2	10 Oct	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
7 October 2017	Faroe Islands	Latvia	0-0
7 October 2017	Andorra	Portugal	0-3
7 October 2017	Switzerland	Hungary	2-0
10 October 2017	Hungary	Faroe Islands	2-0
10 October 2017	Latvia	Andorra	1-1
10 October 2017	Portugal	Switzerland	1-1

(c) Final standing with the runner-up results

Pos = Position; W = Won; D = Drawn; L = Loss; GF = Goals for; GA = Goals against; GD = Goal difference; Pts = Points. All teams have played 10 matches.

Last row contains the second-placed team's results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#).

Pos	Team	W	D	L	GF	GA	GD	Pts
1	Switzerland	9	1	0	21	4	17	28
2	Portugal	8	1	1	32	5	27	25
3	Hungary	4	1	5	13	11	2	13
4	Faroe Islands	2	3	5	4	17	-13	9
5	Latvia	1	2	7	4	19	-15	5
6	Andorra	1	2	7	3	21	-18	5
2	Portugal	6	1	1	23	5	18	19

Table A.2: 2018 FIFA World Cup qualification – UEFA Group C

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	Germany	—	2-0	8 Oct	3-0	6-0	7-0
2	Northern Ireland	5 Oct	—	4-0	2-0	2-0	4-0
3	Azerbaijan	1-4	0-1	—	5 Oct	1-0	5-1
4	Czech Republic	1-2	0-0	0-0	—	2-1	8 Oct
5	Norway	0-3	8 Oct	2-0	1-1	—	4-1
6	San Marino	0-8	0-3	0-1	0-6	5 Oct	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
5 October 2017	Azerbaijan	Czech Republic	1-1
5 October 2017	Northern Ireland	Germany	0-1
5 October 2017	San Marino	Norway	0-2
8 October 2017	Czech Republic	San Marino	3-0
8 October 2017	Germany	Azerbaijan	2-0
8 October 2017	Norway	Northern Ireland	0-0

(c) Final standing with the runner-up results

Pos = Position; W = Won; D = Drawn; L = Loss; GF = Goals for; GA = Goals against; GD = Goal difference; Pts = Points. All teams have played 10 matches.

Last row contains the second-placed team's results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#).

Pos	Team	W	D	L	GF	GA	GD	Pts
1	Germany	10	0	0	38	2	36	30
2	Northern Ireland	6	2	2	16	3	13	20
3	Czech Republic	3	4	3	14	10	4	13
4	Norway	3	2	5	10	16	-6	11
5	Azerbaijan	3	2	5	9	15	-6	11
6	San Marino	0	0	10	2	43	-41	0
2	Northern Ireland	4	2	2	9	3	6	14

Table A.3: 2018 FIFA World Cup qualification – UEFA Group D

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	Serbia	—	1-1	2-2	3-2	9 Oct	3-0
2	Wales	1-1	—	9 Oct	1-0	1-1	4-0
3	Republic of Ireland	0-1	0-0	—	1-1	1-0	6 Oct
4	Austria	6 Oct	2-2	0-1	—	1-1	2-0
5	Georgia	1-3	6 Oct	1-1	1-2	—	1-1
6	Moldova	0-3	0-2	1-3	9 Oct	2-2	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
6 October 2017	Georgia	Wales	0-1
6 October 2017	Austria	Serbia	0-0
6 October 2017	Republic of Ireland	Moldova	2-0
9 October 2017	Moldova	Austria	1-2
9 October 2017	Serbia	Georgia	1-1
9 October 2017	Wales	Republic of Ireland	1-0

(c) Final standing with the runner-up results

Pos = Position; W = Won; D = Drawn; L = Loss; GF = Goals for; GA = Goals against; GD = Goal difference; Pts = Points. All teams have played 10 matches.

Last row contains the second-placed team's results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#).

Pos	Team	W	D	L	GF	GA	GD	Pts
1	Serbia	5	5	0	18	8	10	20
2	Wales	5	5	0	14	5	9	20
3	Republic of Ireland	4	4	2	11	7	4	16
4	Austria	3	4	3	12	11	1	13
5	Georgia	0	6	4	9	14	-5	6
6	Moldova	0	2	8	5	24	-19	2
2	Wales	3	5	0	8	5	3	14

Table A.4: 2018 FIFA World Cup qualification – UEFA Group E

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	Poland	—	8 Oct	3-2	3-1	2-1	3-0
2	Montenegro	1-2	—	5 Oct	1-0	4-1	5-0
3	Denmark	4-0	0-1	—	8 Oct	1-0	4-1
4	Romania	0-3	1-1	0-0	—	1-0	5 Oct
5	Armenia	5 Oct	3-2	1-4	0-5	—	2-0
6	Kazakhstan	2-2	0-3	1-3	0-0	8 Oct	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
5 October 2017	Armenia	Poland	1-5
5 October 2017	Montenegro	Denmark	0-0
5 October 2017	Romania	Kazakhstan	2-0
8 October 2017	Denmark	Romania	1-1
8 October 2017	Kazakhstan	Armenia	1-0
8 October 2017	Poland	Montenegro	1-1

(c) Final standing with the runner-up results

Pos = Position; W = Won; D = Drawn; L = Loss; GF = Goals for; GA = Goals against; GD = Goal difference; Pts = Points. All teams have played 10 matches.

Last row contains the second-placed team's results, corrected for the ranking of the runners-up (matches played against the 6th team are discarded) according to [FIFA \(2017\)](#).

Note: Montenegro is ranked above Denmark because it has obtained 4 points against Denmark, while Denmark has obtained 1 point against it, so [FIFA \(2016, Article 20.6d\)](#) applies.

Pos	Team	W	D	L	GF	GA	GD	Pts
1	Poland	7	2	1	24	13	11	23
2	Montenegro	5	3	2	19	8	11	18
3	Denmark	5	3	2	19	8	11	18
4	Romania	3	4	3	11	9	2	13
5	Armenia	2	0	8	9	25	-16	6
6	Kazakhstan	1	2	7	5	24	-19	5
2	Montenegro	3	3	2	12	6	6	12

Table A.5: 2018 FIFA World Cup qualification – UEFA Group F

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	England	—	2-1	5 Oct	3-0	2-0	2-0
2	Slovakia	0-1	—	1-0	3-0	4-0	8 Oct
3	Slovenia	0-0	1-0	—	8 Oct	4-0	2-0
4	Scotland	2-2	5 Oct	1-0	—	1-1	2-0
5	Lithuania	8 Oct	1-2	2-2	0-3	—	2-0
6	Malta	0-4	1-3	0-1	1-5	5 Oct	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
5 October 2017	England	Slovenia	2-1
5 October 2017	Malta	Lithuania	0-1
5 October 2017	Scotland	Slovakia	0-0
8 October 2017	Lithuania	England	1-3
8 October 2017	Slovakia	Malta	3-0
8 October 2017	Slovenia	Scotland	1-0

(c) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Pos	Team	W	D	L	GF	GA	GD	Pts
1	England	8	2	0	21	5	16	26
2	Slovakia	6	1	3	17	6	11	19
3	Slovenia	5	2	3	12	6	6	17
4	Scotland	4	3	3	14	11	3	15
5	Lithuania	2	2	6	8	21	-13	8
6	Malta	0	0	10	2	25	-23	0
2	Slovakia	4	1	3	11	5	6	13

Table A.6: 2018 FIFA World Cup qualification – UEFA Group G

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	Spain	—	3-0	6 Oct	4-1	4-0	8-0
2	Italy	1-1	—	2-0	1-0	6 Oct	5-0
3	Albania	0-2	9 Oct	—	0-3	2-1	2-0
4	Israel	9 Oct	1-3	0-3	—	0-1	2-1
5	FYR Macedonia	1-2	2-3	1-1	1-2	—	9 Oct
6	Liechtenstein	0-8	0-4	0-2	6 Oct	0-3	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
6 October 2017	Italy	FYR Macedonia	2-0
6 October 2017	Liechtenstein	Israel	0-1
6 October 2017	Spain	Albania	3-1
9 October 2017	Albania	Italy	1-2
9 October 2017	Israel	Spain	0-3
9 October 2017	FYR Macedonia	Liechtenstein	2-1

(c) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Pos	Team	W	D	L	GF	GA	GD	Pts
1	Spain	9	1	0	36	3	33	28
2	Italy	8	1	1	23	8	15	25
3	Albania	4	1	5	12	14	-2	13
4	Israel	4	0	6	10	17	-7	12
5	FYR Macedonia	3	1	6	12	17	-5	10
6	Liechtenstein	0	0	10	2	36	-34	0
2	Italy	6	1	1	14	8	6	19

Table A.7: 2018 FIFA World Cup qualification – UEFA Group H

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	Belgium	—	4-0	1-1	10 Oct	8-1	9-0
2	Bosnia and Herzegovina	7 Oct	—	0-0	2-0	5-0	5-0
3	Greece	1-2	1-1	—	2-0	0-0	10 Oct
4	Cyprus	0-3	3-2	7 Oct	—	0-0	3-1
5	Estonia	0-2	10 Oct	0-2	1-0	—	4-0
6	Gibraltar	0-6	0-4	1-4	1-2	7 Oct	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
7 October 2017	Gibraltar	Estonia	0-1
7 October 2017	Bosnia and Herzegovina	Belgium	0-3
7 October 2017	Cyprus	Greece	0-1
10 October 2017	Belgium	Cyprus	3-1
10 October 2017	Estonia	Bosnia and Herzegovina	1-2
10 October 2017	Greece	Gibraltar	3-0

(c) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Pos	Team	W	D	L	GF	GA	GD	Pts
1	Belgium	9	1	0	40	4	36	28
2	Greece	5	4	1	15	5	10	19
3	Bosnia and Herzegovina	5	2	3	21	11	10	17
4	Cyprus	3	1	5	9	16	-7	11
5	Estonia	3	2	5	8	19	-11	11
6	Gibraltar	0	0	10	3	41	-38	0
2	Greece	3	4	1	8	4	4	13

Table A.8: 2018 FIFA World Cup qualification – UEFA Group I

(a) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Position	Team	1	2	3	4	5	6
1	Croatia	—	2-0	1-1	1-0	6 Oct	1-0
2	Iceland	1-0	—	2-0	2-0	3-2	9 Oct
3	Turkey	1-0	6 Oct	—	2-2	2-0	2-0
4	Ukraine	9 Oct	1-1	2-0	—	1-0	3-0
5	Finland	0-1	1-0	9 Oct	1-2	—	1-1
6	Kosovo	0-6	1-2	1-4	6 Oct	0-1	—

(b) Fictitious but reasonable match results of the last two matchdays

Date	Home team	Away team	Result
6 October 2017	Croatia	Finland	2-0
6 October 2017	Kosovo	Ukraine	0-2
6 October 2017	Turkey	Iceland	2-1
9 October 2017	Finland	Turkey	0-1
9 October 2017	Iceland	Kosovo	1-0
9 October 2017	Ukraine	Croatia	0-0

(c) Match results of the first eight matchdays

Position is given according to the eight matches already played

Home team is in the row, away team (represented by its position) is in the column

Dates are given for the matches to be played on the last two matchdays in 2017

Pos	Team	W	D	L	GF	GA	GD	Pts
1	Croatia	6	2	2	14	3	11	20
2	Turkey	6	2	2	14	9	5	20
3	Ukraine	5	3	2	13	7	6	19
4	Iceland	6	1	3	13	9	4	19
5	Finland	2	1	7	6	12	-6	7
6	Kosovo	0	1	9	3	23	-20	1
2	Turkey	4	2	2	8	8	0	14