

# Quantifying the unfairness of the 2018 FIFA World Cup qualification

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Aber so viel ist an sich klar, daß dieser, wie jeder Gegenstand, der unser Begreifungsvermögen nicht übersteigt, durch einen untersuchenden Geist aufgeheilt und in seinem inneren Zusammenhang mehr oder weniger deutlich gemacht werden kann, und das allein reicht schon hin, den Begriff der Theorie zu verwirklichen.<sup>1</sup>

(Carl von Clausewitz: *Vom Kriege*)

## Abstract

This paper investigates the fairness of the 2018 FIFA World Cup qualifying competition via Monte-Carlo simulations. The qualifying probabilities are calculated for 102 nations, all teams except for African and European countries. A method is proposed to quantify the degree of unfairness. Although the qualifications within four FIFA confederations are constructed fairly, serious differences are found between the continents: for instance, a South American team could have doubled its chances by playing in Asia. Choosing a fixed matchup in the inter-continental play-offs instead of the current random draw can reduce the level of unfairness. The move of Australia from the Oceanian to the Asian zone is shown to increase its probability of participating in the 2018 FIFA World Cup by about 75%. Our results provide important insights for the administrators on how to reallocate the qualifying berths.

**Keywords:** OR in sports; FIFA World Cup; simulation; soccer; tournament design

**MSC class:** 62F07, 68U20

**JEL classification number:** C44, C63, Z20

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<sup>1</sup> “But so much is evident in itself, that this, like every other subject which does not surpass our powers of understanding, may be lighted up, and be made more or less plain in its inner relations by an enquiring mind, and that alone is sufficient to realise the idea of a theory.” (Source: Carl von Clausewitz: *On War*, Book 2, Chapter 3—Art or Science of War, translated by Colonel James John Graham, London, N. Trübner, 1873. <http://clausewitz.com/readings/OnWar1873/TOC.htm>)

# 1 Introduction

The FIFA World Cup, the most prestigious soccer tournament around the world, is followed by millions of fans. According to [Palacios-Huerta \(2014\)](#), 5% of all the people who *ever* lived on the Earth watched the final of the 2010 FIFA World Cup played by the Netherlands and Spain. Qualification to the FIFA World Cup creates widespread media coverage in the competing countries ([Frawley and Van den Hoven, 2015](#)) and brings significant economic benefits ([Stone and Rod, 2016](#)): each participating team has received at least 9.5 million USD in the 2018 FIFA World Cup ([FIFA, 2017](#)). Success in soccer can even help build nations ([Depetris-Chauvin et al., 2020](#)).

Obviously, every national team cannot play in the FIFA World Cup. Thus there is a World Cup qualification competition, consisting of a series of tournaments organised by the six FIFA confederations. In 2006, Australia, left the Oceania Football Confederation (OFC) to join the Asian Football Confederation (AFC). Since then, the country qualified for all FIFA World Cups (2010, 2014, 2018), although it played only twice before (1974, 2006). Is this a mere coincidence, the result of a fruitful team development strategy, or can be partially explained by the change of affiliation? The current paper discusses the third issue by analysing the fairness of the 2018 FIFA World Cup qualification.

Some scientific research has addressed the World Cup qualifiers. [Flégl \(2014\)](#) applies Data Envelopment Analysis (DEA) to evaluate the performance of national soccer teams during the 2014 FIFA World Cup qualification. [Stone and Rod \(2016\)](#) aim to assess the degree to which the allocation of qualification berths among the six FIFA confederations reflects the quality of the teams from their specific region, mainly by descriptive statistics. [Durán et al. \(2017\)](#) recommend integer programming to construct alternative schedules for the South American qualifiers that overcome the main drawbacks of the previous approach. Their proposal has been unanimously approved by the South American associations to use in the 2018 FIFA World Cup qualification. [Pollard and Armatas \(2017\)](#) investigate home advantage in the FIFA World Cup qualification games. [Csató \(2020a\)](#) identifies an incentive incompatibility problem in the European section of the recent FIFA World Cup qualifications.

However, the FIFA World Cup qualification competition has never been studied before with respect to the chances of the participating teams. A possible reason is the complexity of the qualifying system as will be seen in Section 3.

Our paper aims to fill this research gap. In particular, the probability of qualification to the 2018 FIFA World Cup is quantified for the 102 nations of the AFC, CONCACAF (Confederation of North, Central American and Caribbean Association Football), CONMEBOL (South American Football Confederation), and OFC to answer three questions: (a) Is the qualification process designed *fairly* in the sense that it provides a higher chance for a better team both within and between the confederations? (b) Is it possible to improve fairness without reallocating the qualifying berths? (c) How did the move of Australia from the OFC to the AFC in 2006 affect the teams?

The main contributions can be summarised as follows:

1. First in the academic literature, the paper calculates the qualifying probabilities for the FIFA World Cup based on the Elo ratings of the national teams.
2. A method is proposed to measure the degree of unfairness. It shows that all the four qualifiers are constructed in a fair way. On the contrary, substantial differences are found between the confederations.

3. Using a well-devised fixed matchup in the inter-continental play-offs—a policy applied in the 2010 FIFA World Cup qualification—instead of the current random draw can reduce unfairness by about 10%.
4. Australia has increased its probability of playing in the 2018 FIFA World Cup by 75% as a result of leaving the OFC and joining the AFC. The move has been detrimental to all AFC nations, while it has favoured any other countries, especially New Zealand.

Our approach can be applied in any sports where teams contest in parallel tournaments for the same prize, hence the natural issue of equal treatment of equals emerges. While these designs have recently been analysed with respect to incentive incompatibility (Vong, 2017; Dagaev and Sonin, 2018; Csató, 2020b), the numerical investigation of fairness is currently limited to the qualification for the UEFA Euro 2020 (Csató, 2021, Chapter 6.4).

Regarding the structure of the article, Section 2 gives a concise overview of connected works. The designs of the four FIFA World Cup qualifiers and the inter-confederation play-offs are described in Section 3. The simulation methodology is detailed in Section 4. Section 5 presents the suggested measure of unfairness and numerical results, while Section 6 concludes.

## 2 Related literature

The paper contributes to three different fields of research: fairness in sports, analysis of FIFA competitions and rules, and simulation of tournament designs.

A usual interpretation of fairness is that (1) stronger players should be preferred to weaker players; and (2) equal players should be treated equally. Otherwise, an incentive might exist to manipulate the tournament. Groh et al. (2012) check which seedings in elimination tournaments satisfy the two properties. Arlegi and Dimitrov (2020) apply these requirements to different kinds of knockout contests and characterise the appropriate structures. Csató (2021, Chapter 6.4) shows the unfairness of the qualification for the 2020 UEFA European Championship with important lessons for sports management (Haugen and Krumer, 2021). Both theoretical (Krumer et al., 2017, 2020; Laica et al., 2021; Sahm, 2019) and empirical (Krumer and Lechner, 2017) investigations reveal that the ex-ante winning probabilities in round-robin tournaments with three and four symmetric players may depend on the schedule, which can lead to severe problems in the 2026 FIFA World Cup (Guyon, 2020). Soccer penalty shootouts seem to be advantageous for the first shooter (Apesteguia and Palacios-Huerta, 2010; Palacios-Huerta, 2014; Vandebroek et al., 2018) but this bias can be mitigated by a carefully devised mechanism (Anbarcı et al., 2021; Brams and Ismail, 2018; Csató and Petróczy, 2021; Lambers and Spieksma, 2021; Palacios-Huerta, 2012). The knockout bracket of the 2016 UEFA European Championship has created imbalances among the six round-robin groups of four teams each (Guyon, 2018). Vaziri et al. (2018) state some fairness properties of sports ranking methods.

In contrast to the World Cup qualifiers, several attempts have been made to forecast the FIFA World Cup final tournament games. Dyte and Clarke (2000) treat the goals scored by the teams as independent Poisson variables to simulate the 1998 FIFA World Cup. Deutsch (2011) aims to judge the impact of the draw in the 2010 World Cup, as well as to look back and identify surprises, disappointments, and upsets. Groll et al. (2015) fit and examine two models to forecast the 2014 FIFA World Cup. O’Leary (2017) finds

that the Yahoo crowd was statistically significantly better at predicting the outcomes of matches in the 2014 World Cup compared to the experts and was similar in performance to established betting odds.

Further aspects of the FIFA World Cup have also been researched extensively. [Jones \(1990\)](#) and [Rathgeber and Rathgeber \(2007\)](#) discuss the consequences of the unevenly distributed draw procedures for the 1990 and 2006 FIFA World Cups, respectively. [Scarf and Yusof \(2011\)](#) reveal the effect of seeding policy and other design changes on the progression of competitors in the World Cup final tournament. [Guyon \(2015\)](#) collects some flaws and criticisms of the World Cup seeding system. [Laliena and López \(2019\)](#) and [Cea et al. \(2020\)](#) provide a detailed analysis of group assignment in the FIFA World Cup.

Finally, since historical data usually do not make it possible to calculate the majority of tournament metrics such as qualifying probabilities, it is necessary to use computer simulations for this purpose, especially for evaluating new designs ([Scarf et al., 2009](#)). Any simulation model should be based on a prediction model for individual ties. According to [Lasek et al. \(2013\)](#), the best performing algorithm of ranking systems in soccer with respect to accuracy is a version of the famous Elo rating. [Baker and McHale \(2018\)](#) provide time-varying ratings for international soccer teams. [Van Eetvelde and Ley \(2019\)](#) overview the most common ranking methods in soccer. [Ley et al. \(2019\)](#) build a ranking reflecting the teams' current strengths and illustrate its usefulness by examples where the existing rankings fail to provide enough information or lead to peculiar results. [Corona et al. \(2019\)](#) propose a Bayesian approach to take into account the uncertainty of parameter estimates in the underlying match-level forecasting model.

### 3 The 2018 FIFA World Cup qualification

The [FIFA World Cup qualification](#) is a series of tournaments to determine the participants of the [FIFA World Cup](#). Since 1998, the final competition contains 32 teams such that the host nation(s) receive(s) a guaranteed slot. The number of qualifying berths for the continents is fixed from 2006 to 2022 as follows:

- AFC (Asian Football Confederation): 4.5;
- CAF (Confederation of African Football): 5;
- CONCACAF (Confederation of North, Central American and Caribbean Association Football): 3.5;
- CONMEBOL (South American Football Confederation): 4.5;
- OFC (Oceania Football Confederation): 0.5;
- UEFA (Union of European Football Associations): 13.

The six confederations organise their own contests. The 0.5 slots represent a place in the inter-continental play-offs, which is the only interaction between the qualifying tournaments of different geographical zones.

The qualifications of all confederations are played in rounds. Each round is designed either in a *knockout* format (where two teams play two-legged home-away matches) or in a *round-robin* format (where more than two teams play in a single or home-away group against every other team of the group). The rounds are often *seeded*, that is, the

participating countries are divided into the same number of pots as the number of teams per group (meaning two pots in the knockout format) and one team from each pot goes to a given group. The *traditional seeding* is based on an exogenously given ranking—usually the FIFA World Ranking at a specific date—such that, if a pot contains  $k$  teams, the best  $k$  teams are in the first pot, the next  $k$  are in the second pot, and so on.

Our paper focuses on four qualifications, the AFC, the CONCACAF, the CONMEBOL, and the OFC because (1) contrary to the CAF and UEFA competitions, they are connected to each other; (2) the largest and most successful nation of the OFC, Australia, switched to the AFC in 2006.

The [2018 FIFA World Cup qualification \(AFC\)](#) contained 46 nations and four rounds. The starting access list was determined by the FIFA World Ranking of January 2015.

- **First round**

Format: knockout

Competitors: the 12 lowest-ranked teams (35–46)

Seeding: traditional; based on the FIFA World Ranking of January 2015

- **Second round**

Format: home-away round-robin, 8 groups of five teams each

Competitors: the 34 highest-ranked teams (1–34) + the six winners from the first round

Seeding: traditional; based on the FIFA World Ranking of April 2015<sup>2</sup>

- **Third round**

Format: home-away round-robin, 2 groups of six teams each

Competitors: the eight group winners and the four best runners-up in the second round<sup>3</sup>

Seeding: traditional; based on the FIFA World Ranking of April 2016

The two group winners and the two runners-up qualified to the 2018 FIFA World Cup.

- **Fourth round**

Format: knockout

Competitors: the third-placed teams from the groups in the third round

Seeding: redundant

The winner advanced to the [inter-confederation play-offs](#).

The [2018 FIFA World Cup qualification \(CONCACAF\)](#) contained 35 nations and five rounds. The access list was determined by the FIFA World Ranking of August 2014.

- **First round**

Format: knockout

Competitors: the 14 lowest-ranked teams (22–35)

Seeding: traditional; based on the FIFA World Ranking of August 2014

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<sup>2</sup> Since the seeding order differed from the ranking in the AFC entrant list, three winners in the first round (India, Timor-Leste, Bhutan) were not seeded in the weakest pot 5.

<sup>3</sup> Group F in the second round consisted of only four teams because Indonesia was disqualified by the FIFA. Therefore, the matches played against the fifth-placed team were disregarded in the comparison of the runners-up.

- **Second round**

Format: knockout

Competitors: the teams ranked 9–21 in the access list + the seven winners from the first round

Seeding: the seven teams of pot 5 (ranked 9–15) were drawn against the teams of pot 6 (the winners from the first round) and the three teams of pot 3 (ranked 16–18) were drawn against the three teams of pot 4 (ranked 19–21); based on the FIFA World Ranking of August 2014

- **Third round**

Format: knockout

Competitors: the teams ranked 7–8 in the access list + the 10 winners from the second round

Seeding: traditional; based on the FIFA World Ranking of August 2014

- **Fourth round**

Format: home-away round-robin, 3 groups of four teams each

Competitors: the teams ranked 1–6 in the access list + the six winners from the third round

Seeding: pot 1 (teams ranked 1–3), pot 2 (teams ranked 4–6), pot 3 (the winners from the third round) such that each group contained a team from pot 1, a team from pot 2, and two teams from pot 3; based on the FIFA World Ranking of August 2014

- **Fifth round**

Format: home-away round-robin, one group of six teams

Competitors: the group winners and the runners-up in the fourth round

Seeding: redundant

The top three teams qualified to the 2018 FIFA World Cup and the fourth-placed team advanced to the [inter-confederation play-offs](#).

The [2018 FIFA World Cup qualification \(CONMEBOL\)](#) contained 10 nations, which contested in a home-away round-robin tournament ([Durán et al., 2017](#)). The top four teams qualified to the 2018 FIFA World Cup, and the fifth-placed team advanced to the [inter-confederation play-offs](#).

The [2018 FIFA World Cup qualification \(OFC\)](#) contained 11 nations and four rounds.

- **First round**

Format: single round-robin, one group organised in a country (Tonga was chosen later)

Competitors: the four lowest-ranked teams (8–11), based on FIFA World Ranking and sporting reasons

Seeding: redundant

- **Second round**

Format: single round-robin, 2 groups of four teams each, all matches played in one country

Competitors: the seven strongest teams (1–7) + the group winner in the first round

Seeding: traditional; based on the FIFA World Ranking of July 2015



- **Third round**

Format: home-away round-robin, 2 groups of three teams each

Competitors: the top three teams from each group in the second round

Seeding: pot 1 (2016 OFC Nations Cup finalists), pot 2 (2016 OFC Nations Cup semifinalists), pot 3 (third-placed teams in the second round) such that each group contained one team from pots 1–3 each<sup>4</sup>

- **Fourth round**

Format: knockout

Competitors: the group winners in the third round

Seeding: redundant

The winner advanced to the [inter-confederation play-offs](#).

Consequently, the [inter-confederation play-offs](#) were contested by four teams from the four confederations (AFC, CONCACAF, CONMEBOL, OFC), and were played in a knockout format. The four nations were drawn randomly into two pairs without seeding. The two winners qualified to the 2018 FIFA World Cup. The inter-confederation play-offs of the [2006 FIFA World Cup](#) and the [2014 FIFA World Cup qualification](#) were also drawn randomly. This policy will be followed in the [2022 FIFA World Cup](#), too. However, FIFA fixed the ties in the [inter-continental play-offs of the 2010 FIFA World Cup qualification](#) as AFC vs. OFC and CONCACAF vs. CONMEBOL to pair teams being in closer time zones.<sup>5</sup>

## 4 Methodology and implementation

In order to quantify a particular tournament metric of the FIFA World Cup qualification, it is necessary to follow a simulation technique because historical data are limited: the national teams do not play many matches and the outcome of a qualification is only a single realisation of several random variables. Such a model should be based on predicting the result of individual games. For this purpose, the strengths of the teams are measured by the [World Football Elo Ratings](#), available at the website [eloratings.net](#). Elo-inspired methods are usually good in forecasting ([Lasek et al., 2013](#)), and have been widely used in academic research ([Hvattum and Arntzen, 2010](#); [Lasek et al., 2016](#); [Cea et al., 2020](#)).

Elo ratings depend on the results of previous matches but the same result is worth more when the opponent is stronger. Furthermore, playing new games decreases the weight of earlier matches. Since there is no official Elo rating for national teams, this approach can be implemented in various ways. For instance, while the official [FIFA World Ranking](#) adopted the Elo method of calculation after the 2018 FIFA World Cup ([FIFA, 2018a,b](#)), it does not contain any adjustment for home or away games. However, home advantage has been presented to be a crucial factor in international soccer, even though its influence appears to be narrowing ([Baker and McHale, 2018](#)). The World Football Elo Ratings takes into account some soccer-specific parameters such as the margin of victory, home advantage, and the tournament where the match was played.

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<sup>4</sup> The group stage of the [2016 OFC Nations Cup](#) served as the second round of the 2018 FIFA World Cup qualification (OFC). Any group winner was matched with the runner-up of the other group in the semifinals of the 2016 OFC Nations Cup.

<sup>5</sup> Similarly, FIFA matched a randomly drawn UEFA runner-up with the AFC team, and two nations from CONMEBOL and OFC in the two [inter-continental play-offs of the 2002 FIFA World Cup qualification](#).

In the 2018 FIFA World Cup qualification, three types of matches were played: group matches in a home-away format, single group matches in a randomly chosen country that is assumed to be a neutral field (only in the first and the second rounds in the OFC zone), and home-away knockout matches. For group matches, the win expectancy can be directly obtained from the formula of Elo rating according to the system of World Football Elo Ratings (see <http://elratings.net/about>):

$$W_{RR}^e = \frac{1}{1 + 10^{-d/400}}, \quad (1)$$

where  $d$  equals the difference in the Elo ratings of the two teams, and the home advantage is fixed at 100.

On the other hand, in knockout clashes, the teams focus primarily on advancing to the next round rather than winning one match. Therefore, we have followed the solution of the ClubElo rating (see <http://clubelo.com/System>), namely, such two-legged matches are considered as one long match with a corresponding increase in the difference between the strengths of the teams:

$$W_{KO}^e = \frac{1}{1 + 10^{-\sqrt{2}d/400}}. \quad (2)$$

The Elo ratings are dynamic but we have fixed them for the sake of simplicity. In each of the four confederations, the ratings of all teams on the day before the first match of the relevant qualification tournament and the last day of the inter-confederation play-offs (15 November 2015) have been averaged. Four tables in the Appendix show the corresponding measures of strength: Table A.1 for the 35 CONCACAF teams; Table A.2 for the 46 AFC teams; Table A.3 for the 10 CONMEBOL teams; and Table A.4 for the 11 OFC teams.

On the basis of formulas (1) and (2), each individual game can be simulated repeatedly. In particular, the win probability  $w_i$  of team  $i$  is determined for a match played by teams  $i$  and  $j$ . A random number  $r$  is drawn uniformly between 0 and 1, team  $i$  wins if  $r < w_i$ , and team  $j$  wins otherwise. Thus draws are not allowed, and group rankings are calculated by simply counting the number of wins. Ties in the group rankings are broken randomly.

Our computer code closely follows the rules of the qualification process described in Section 3. Pot assignment and seeding is based on the Elo rating of the teams in each case since the strength of the teams are given by this measure instead of the FIFA ranking, which was a rather bad predictor before the 2018 reform (Lasek et al., 2013; Cea et al., 2020). Hence, although the official AFC qualification updated the ranking of the teams before the seeding in each round (see Section 3)—thus the results of matches played already during the qualification may have affected the subsequent rounds—, that complication is disregarded in our simulations. Using the Elo rating for seeding is also necessary to guarantee the consistency of the simulations since the proposed fairness measure will be based on the Elo ratings. Therefore, every instance of unfairness will be intrinsic to the tournament design.

Finally, the move of Australia from the OFC to the AFC will also be evaluated. Accordingly, an alternative design of the FIFA World Cup qualification should be chosen with Australia being in the OFC instead of the AFC. Since then there are only 45 countries in Asia, a straightforward format would be to organise the first knockout round with the 10 lowest-ranked teams (36–45), while the second round is contested by the 35 highest-ranked teams (1–35) plus the five winners from the first round. Together with Australia, the OFC qualification contains 12 teams. Fortunately, the design of the [2006 FIFA World Cup qualification \(OFC\)](#) can be adopted without any changes:



- **First round**

Format: single round-robin, 2 groups of five teams each, held in one country

Competitors: the 10 lowest-ranked teams, that is, all nations except for Australia and New Zealand

Seeding: traditional<sup>6</sup>

- **Second round**

Format: single round-robin, one group of six teams, held in one country

Competitors: the two highest-ranked teams (Australia, New Zealand) + the group winners and the runners-up in the first round

Seeding: redundant

- **Third round**

Format: knockout

Competitors: the group winner and the runner-up in the second round

Seeding: redundant

The winner advanced to the [inter-confederation play-offs](#).

Any theoretical model is only as good as its assumptions. Therefore, it is worth summarising the main limitations:

- The strength of the teams is exogenously given and fixed during the whole qualification process.
- Goal difference is not accounted for in any stage of the qualification.
- Draws are not allowed, which is not in line with the rules of soccer.
- Home advantage does not differ between the confederations despite the findings of [Pollard and Armatas \(2017\)](#). However, the influence of the corresponding parameter is minimal since all matches are played both home and away except for Oceania, where some games are hosted by a randomly drawn country.
- The efforts of the teams do not change even if they have already qualified as a group winner.

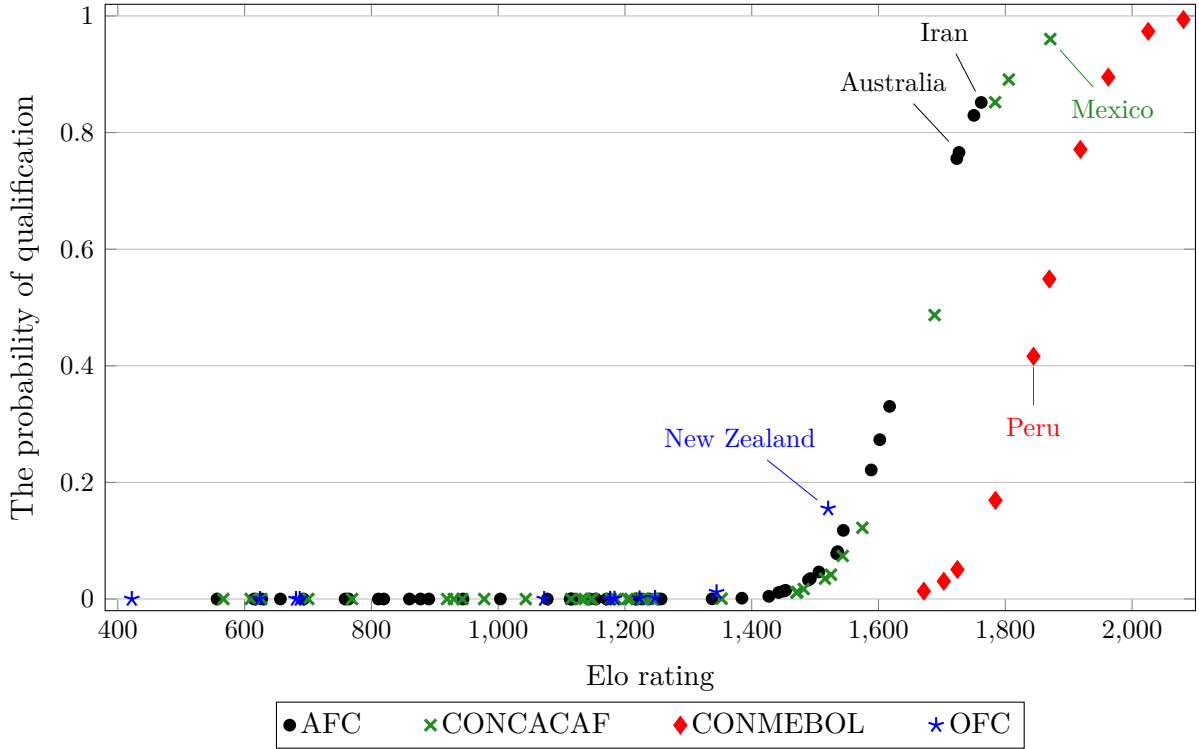
These mean that our numerical results are primarily for comparative purposes. Consequently, the direction of changes in the tournament metrics after modifying the tournament design is more reliable than, for example, the computed probability of qualification for the FIFA World Cup.

Each simulation has been carried out with 10 million independent runs. A further increase does not reduce statistical errors considerably, and would be a futile exercise anyway in the view of the above model limitations.

## 5 Results

The three main research questions, presented in the Introduction, will be discussed in separate subsections.

Figure 1: The probability of qualification for the 2018 FIFA World Cup



## 5.1 Quantifying unfairness

Figure 1 shows the probability of qualification for the 2018 FIFA World Cup as the function of the Elo rating. Unsurprisingly, the simple round-robin format of the CONMEBOL qualification guarantees that this tournament metric depends monotonically on the strength of the teams. The structure of the OFC qualification does not necessarily satisfy the fairness condition but it still holds because only the four weakest teams should play in the first round and the seeding is based on the strengths of the teams. Similarly, the AFC and CONCACAF qualifications are also essentially conforming to the principle of giving higher chances for better teams.

The degree of unfairness can be quantified by ranking the teams according to their Elo rating and summing the differences of qualifying probabilities that do not fall into line with this ranking. Formally, the measure of unfairness  $UF$  is defined as:

$$UF = \sum_{\text{Elo}(i) \geq \text{Elo}(j)} \max\{0; p(j) - p(i)\}, \quad (3)$$

where  $\text{Elo}(i)$  and  $p(i)$  are the Elo rating and the probability of qualification for team  $i$ , respectively. Formula (3) only considers the ordinal strength of the teams because prescribing how the differences in Elo rating should be converted into differences in qualifying probabilities would require further assumptions, which seem to be challenging to justify. While the above metric depends on the number of teams as well as the number of slots available, it does not mean a problem when both of these variables are fixed.

As Table 1 reveals, the qualification tournaments of all confederations are constructed fairly. The negligible numbers for AFC and CONCACAF are only due to the stochastic nature of the simulation, which leads to volatile qualifying probabilities for weak teams.

<sup>6</sup> This is only a (reasonable) conjecture as we have not found the official regulation.

Table 1: The level of unfairness within the confederations

Confederation	Value of $UF$
AFC	0.0000005
CONCACAF	0.0000002
CONMEBOL	0.0000000
OFC	0.0000000

Table 2: Qualifying probabilities when Peru is moved to another confederation

Team	Original confederation	Peru plays in			
		AFC	CONCACAF	CONMEBOL	OFC
Iran	AFC	0.156	0.825	0.852	0.818
Mexico	CONCACAF	0.958	0.539	0.960	0.955
Peru	CONMEBOL	0.937	0.938	0.416	0.495
New Zealand	OFC	0.199	0.196	0.155	0.000

Unfairness has another dimension, that is, between the confederations. In order to investigate this issue, Peru (the 6th strongest team in CONMEBOL, Elo: 1844.5) has been exchanged sequentially with the strongest teams in the other three confederations: Iran (AFC, Elo: 1762), Mexico (CONCACAF, Elo: 1871), and New Zealand (OFC, Elo: 1520.5). These countries are highlighted in Figure 1.

Table 2 reports the probabilities of qualification for the four nations if Peru would contest in various confederations. According to the numbers in the diagonal, any team is the worst off when playing in the CONMEBOL qualifiers. On the other hand, the chance of Peru to participate in the 2018 FIFA World Cup would more than double by playing in the AFC or CONCACAF zone. Compared to these options, being a member of the OFC would be less beneficial for Peru due to the lack of a direct qualification slot. Its effect can be seen to some extent in the qualifying probabilities of Iran and Mexico: since Peru would qualify with more than 96% probability from the OFC qualifiers to the inter-confederation play-offs, the two teams would have a larger probability to face Peru there, which would reduce their chances to advance to the World Cup finals.

## 5.2 A potential improvement of fairness

The straightforward solution to handle unfairness between the confederations would be to reallocate the slots available for them, especially because the current allocation system lacks any statistical validation, does not ensure the qualification of the best teams in the world, and does not reflect the number of teams per federation (Stone and Rod, 2016). The whole process is far from being transparent and is mainly determined by political, cultural, and historical factors. Consequently, operations research has a limited role to influence the allocation of World Cup slots between the FIFA confederations.

However, the matching in the two inter-confederation play-offs is probably a variable to be chosen freely by the FIFA executives who are responsible for the tournament design, as illustrated by the two policies used recently (see the last paragraph of Section 3). We have considered three possibilities:

- *Random draw* for the play-offs: the four participants from the confederations

Table 3: Unfairness and the draw for the play-offs

(a) The overall level of unfairness				
Draw policy for the play-offs				
	Random	Close	Fair	
	14.39	16.18	13.12	

(b) The qualifying probabilities of certain teams				
Team	Confederation	Draw policy for the play-offs		
		Random	Close	Fair
Australia	AFC	0.765	0.798	0.768
Iran	AFC	0.852	0.876	0.856
Mexico	CONCACAF	0.960	0.948	0.964
Peru	CONMEBOL	0.416	0.402	0.436
New Zealand	OFC	0.155	0.216	0.046

AFC, CONCACAF, CONMEBOL, and OFC are drawn randomly into two pairs;

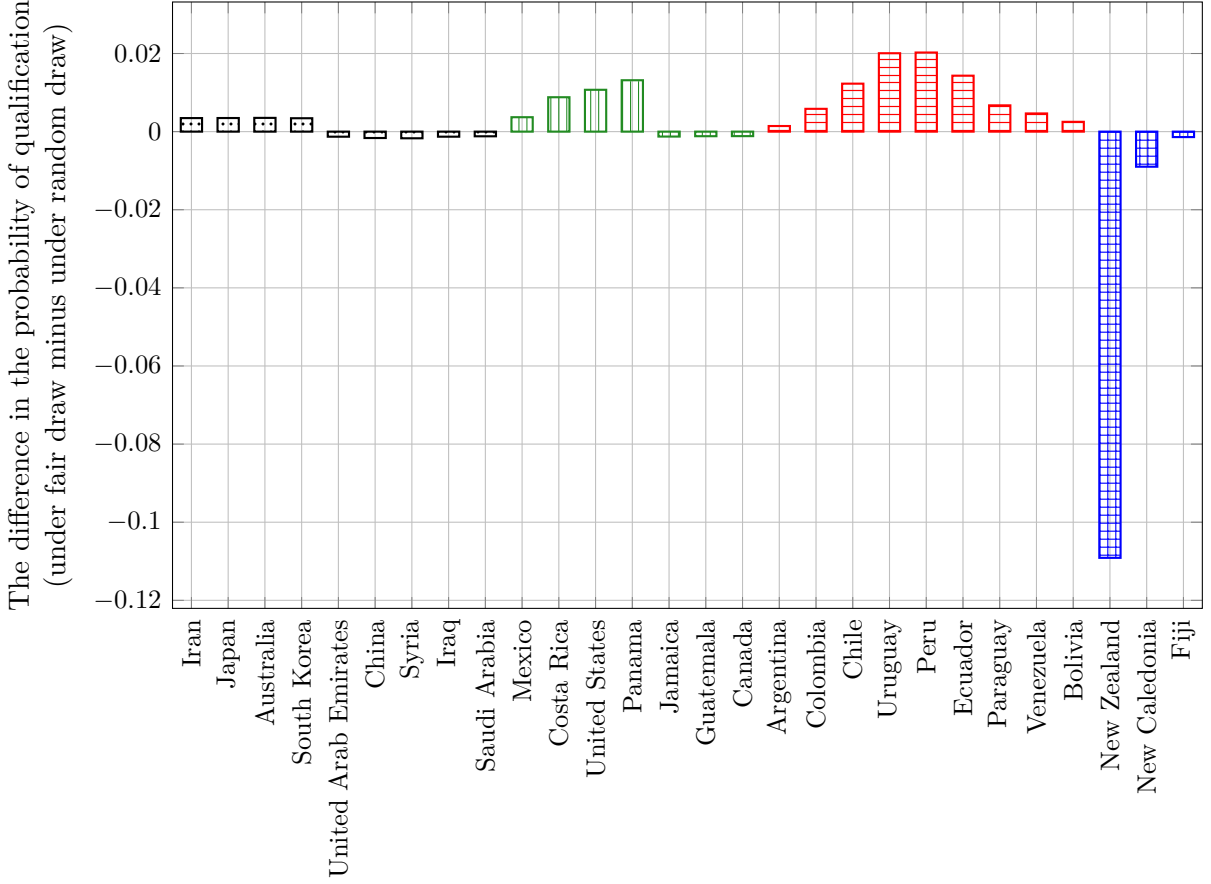
- *Close draw* for the play-offs: the four participants are paired such that AFC vs. OFC and CONCACAF vs. CONMEBOL;
- *Fair draw* for the play-offs: the four participants are paired such that AFC vs. CONCACAF and CONMEBOL vs. OFC.

The random draw has been used in the [2006 FIFA World Cup qualification](#), as well as since the [2014 FIFA World Cup qualifiers](#). The close draw has been used in the [2010 FIFA World Cup qualification competition](#): it matches nations from closer time zones, which allows for better kick-off times, and it can be optimal for the players, as well as may maximise gate revenue and the value of television rights. Finally, the fair draw is inspired by Figure 1 and Table 2 since the CONMEBOL team is usually the strongest and the OFC team is usually the weakest in the play-offs.

The draws for the play-offs are compared in Table 3, the measure of unfairness  $UF$  (formula (3)) is presented in Table 3.a, while Table 3.b provides the probability of qualification for some countries. Intuitively, the fair draw is the closest to fairness. The close draw mostly favours AFC and OFC, however, it is detrimental to the CONCACAF and CONMEBOL members, implying the most severe unfairness.

The effect of a fair draw is detailed in Figure 2 for the teams with at least 0.1 percentage points change in the probability of qualification to the 2018 FIFA World Cup. Compared to the current random design, all South American countries would be better off and the strongest AFC and CONCACAF countries are also preferred. On the other hand, all nations of the OFC, in particular, the dominating New Zealand, would lose substantially from this reform. The gains are distributed more equally because there is no such a prominent team in the other zones. Some weak AFC and CONCACAF members are worse off due to the impossibility of playing against New Zealand in the inter-confederation play-offs.

Figure 2: The effect of improving the fairness of the 2018 FIFA World Cup qualification via modifying the draw for inter-confederation play-offs



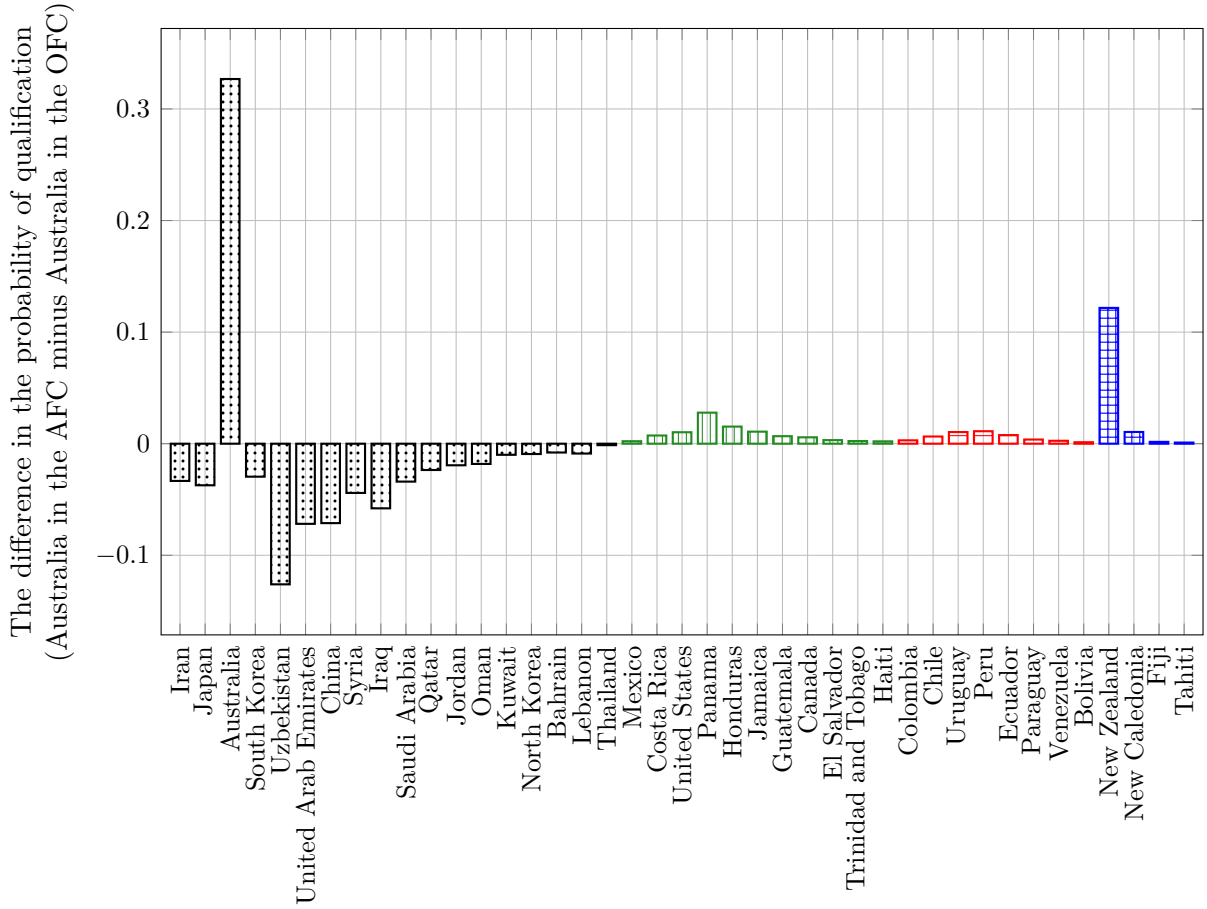
### 5.3 Counterfactual: was it favourable for Australia to join the AFC?

FIFA president *Sepp Blatter* had promised a full slot to the OFC as part of his re-election campaign in November 2002 but the suggestion was reconsidered in June 2003 (ABC, 2003). Subsequently, the largest and most successful nation of the OFC, Australia, left to join the AFC in 2006. It raises the interesting issue of how this move has affected the 2018 FIFA World Cup qualification.

First, the unfairness measure  $UF$  would be 15.87 with Australia playing in the OFC, which corresponds to an increase of more than 9% as opposed to the current situation. The action of Australia has contributed to the fairness of the 2018 FIFA World Cup qualification. The magnitude of the improvement is similar to the proposed novel draw for the inter-confederation play-offs.

Second, the probabilities of qualification are computed if Australia would have remained in the OFC. Figure 3 plots the effects for the national teams facing a change of at least 0.1 percentage points. Notably, Australia has increased the probability of participating in the 2018 FIFA World Cup from 44% to 77% by leaving the OFC for the AFC. The move has also been strongly favourable for New Zealand, which is now the strongest OFC team and has more than 70% chance to grab the slot guaranteed in the play-offs for Oceania. Every CONCACAF and CONMEBOL member has been better off due to the reduction in the expected strength of the countries contesting in the play-offs. However, all original

Figure 3: The effect of Australia being a member of the AFC on the 2018 FIFA World Cup qualification



AFC nations have lost with the entrance of Australia, especially those teams that are only marginally weaker than Australia.

## 6 Conclusions

We have analysed four series of qualification tournaments for the 2018 FIFA World Cup via Monte-Carlo simulations. Their design does not suffer from serious problems but the CONCACAF competition can be criticised for the great role attributed to the FIFA World Ranking. Perhaps it is not only a coincidence that this confederation has fundamentally restructured its [qualifying tournament for the 2022 FIFA World Cup](#) (CONCACAF, 2019). On the other hand, there are substantial differences between the chances of nations playing in different continents: Peru would have doubled its probability of qualification by competing in the AFC or CONCACAF zone, while New Zealand would have lost any prospect of participation by being a member of the CONMEBOL. Australia is found to have greatly benefited from leaving the OFC for the AFC in 2006.

In addition, probably first in the literature, a measure of unfairness has been proposed to quantify to which extent weaker teams are preferred over stronger teams by a tournament design. A simple modification in the format of the inter-confederation play-offs can reduce this metric by about 10%, hence the novel policy shall be seriously considered by FIFA.

Hopefully, this paper will become only a pioneering attempt of academic researchers



to study the qualification to the soccer World Cup. There remains a huge scope for improving the prediction model, especially concerning the prediction of individual matches. Nonetheless, even these results might be useful for sports governing bodies: we believe that FIFA could further increase the economic success of World Cups by using a more transparent and statistically validated method in the allocation of qualifying berths and the design of confederation-level qualification tournaments.

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# Appendix

Table A.1: CONCACAF nations participating in the 2018 FIFA World Cup qualification

Country	Elo rating		Average
	21 March 2015	15 November 2017	
<b>Costa Rica</b>	1866	1745	1805.5
<b>Mexico</b>	1893	1849	1871
United States	1816	1752	1784
<i>Honduras</i>	1539	1610	1574.5
<b>Panama</b>	1706	1671	1688.5
Trinidad and Tobago	1525	1419	1472
Jamaica	1522	1565	1543.5
Haiti	1446	1495	1470.5
Canada	1507	1524	1515.5
Cuba	1396	1309	1352.5
Aruba	941	919	930
Dominican Republic	1235	1250	1242.5
El Salvador	1507	1457	1482
Suriname	1244	1245	1244.5
Guatemala	1539	1511	1525
Saint Vincent and the Grenadines	1162	1101	1131.5
Saint Lucia	1132	1098	1115
Grenada	1158	1115	1136.5
Antigua and Barbuda	1271	1203	1237
Guyana	1221	1196	1208.5
Puerto Rico	1059	1028	1043.5
Saint Kitts and Nevis	1204	1252	1228
Belize	1138	1159	1148.5
Montserrat	619	634	626.5
Dominica	951	1005	978
Barbados	1155	1138	1146.5
Bermuda	1210	1198	1204
Nicaragua	1105	1267	1186
Turks and Caicos Islands	776	763	769.5
Curacao	1087	1268	1177.5
U.S. Virgin Islands	679	722	700.5
Bahamas	933	906	919.5
Cayman Islands	937	950	943.5
British Virgin Islands	612	607	609.5
Anguilla	575	558	566.5

The countries are ranked according to the FIFA World Ranking of August 2014. The first match in the first round was played on 22 March 2015.

The team(s) written in **bold** (*italics*) qualified for the 2018 FIFA World Cup (inter-confederation play-offs).

Table A.2: AFC nations participating in the 2018 FIFA World Cup qualification

Country	Elo rating		Average
	11 March 2015	15 November 2017	
<b>Iran</b>	1724	1800	1762
<b>Japan</b>	1757	1744	1750.5
<b>South Korea</b>	1736	1711	1723.5
<b><i>Australia</i></b>	1727	1727	1727
United Arab Emirates	1666	1538	1602
Uzbekistan	1625	1610	1617.5
China	1606	1571	1588.5
Iraq	1509	1562	1535.5
<b>Saudi Arabia</b>	1474	1594	1534
Oman	1522	1457	1489.5
Qatar	1525	1487	1506
Jordan	1503	1482	1492.5
Bahrain	1487	1398	1442.5
Vietnam	1236	1271	1253.5
Syria	1478	1611	1544.5
Kuwait	1446	1461	1453.5
Afghanistan	1084	1150	1117
Philippines	1225	1225	1225
Palestine	1274	1401	1337.5
Maldives	1068	939	1003.5
Thailand	1363	1406	1384.5
Tajikistan	1262	1214	1238
Lebanon	1403	1451	1427
Kyrgyzstan	1100	1208	1154
North Korea	1446	1454	1450
Myanmar	1062	1093	1077.5
Turkmenistan	1261	1253	1257
Indonesia	1207	1228	1217.5
Singapore	1173	1058	1115.5
Malaysia	1225	1063	1144
Hong Kong	1152	1190	1171
Bangladesh	952	803	877.5
Guam	806	833	819.5
Laos	837	785	811
India	1068	1159	1113.5
Sri Lanka	829	688	758.5
Yemen	1211	1224	1217.5
Cambodia	717	811	764
Chinese Taipei	795	925	860
Timor-Leste	639	615	627
Nepal	883	898	890.5
Macau	636	677	656.5
Pakistan	943	946	944.5
Mongolia	734	652	693
Brunei	606	624	615
Bhutan	521	592	556.5

The countries are ranked according to the FIFA World Ranking of January 2015 (35–46) and April 2015 (1–34). The first match in the first round was played on 12 March 2015.

The team(s) written in **bold** (*italics*) qualified for the 2018 FIFA World Cup (inter-confederation play-offs).



Table A.3: CONMEBOL nations participating in the 2018 FIFA World Cup qualification

Country	Elo rating		Average
	7 October 2015	15 November 2017	
<b>Argentina</b>	2067	1984	2025.5
<b>Colombia</b>	1999	1926	1962.5
<b>Brazil</b>	2048	2114	2081
Chile	1977	1860	1918.5
<b>Uruguay</b>	1873	1866	1869.5
Ecuador	1822	1747	1784.5
<b><i>Peru</i></b>	1807	1882	1844.5
Paraguay	1696	1753	1724.5
Bolivia	1636	1707	1671.5
Venezuela	1668	1738	1703

The countries are ranked according to the FIFA World Ranking of October 2015. The first matchday was 8 October 2015.

The team(s) written in **bold** (*italics*) qualified for the 2018 FIFA World Cup (inter-confederation play-offs).

Table A.4: OFC nations participating in the 2018 FIFA World Cup qualification

Country	Elo rating		Average
	30 August 2015	15 November 2017	
<i>New Zealand</i>	1516	1525	1520.5
New Caledonia	1357	1332	1344.5
Tahiti	1226	1220	1223
Solomon Islands	1175	1178	1176.5
Vanuatu	1174	1193	1183.5
Fiji	1281	1214	1247.5
Papua New Guinea	1053	1092	1072.5
Samoa	681	693	687
Tonga	684	564	624
American Samoa	381	463	422
Cook Islands	675	687	681

The countries are ranked according to the FIFA World Ranking of July 2015, separately for the positions 1–7 (byes in the first round) and 8–11 (playing in the first round). The first match in the first round was played on 31 August 2015.

The team written in *italics* qualified for the inter-confederation play-offs of the 2018 FIFA World Cup.