

# Home Advantage in Popular Team Sports

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4<sup>th</sup> February 2019

## Abstract

This paper investigates whether there is a clear advantage associated with being the home team in the four sports, football, rugby union, T20 cricket and basketball. Data is compiled to back up this idea with a reasoning section which gives some background and possible reasons for the advantage. The outcome of this paper is that there seems to be a clear correlation between the number of wins and the team playing at home.

## Premise

This paper will be investigating whether the advantage of the home team is consistent between the different sports. Before each of the sets of data, there is a brief introduction into each league. The term 'home' refers to the stadium which the team owns and plays games. For this paper, a random number generator will select four random popular leagues for each sport. This is explained more below in the next section. The data for each league will be taken from the last fully completed season. The calculations will only include the regular season matches so will not include any play-off games played. In some of these sports, it is possible for two teams to draw. A draw is worth points towards a team's overall total. By disregarding draws, no points will be obtained for a draw for either team. This is to distinctly look at the home advantage associated with winning alone. To allow the comparison between leagues from the different sports, a standardised three points, shall be awarded in the event of a win.

## Deciding on Leagues

This section looks into the process behind deciding the leagues to investigate. The best way to compare the four sports would be to select a range of four different leagues from each sport and use a random number generator [1] to select each league, as briefly explained in the premise. The best leagues to look at from across the world were chosen. These leagues are some of the most competitive leagues in their respective sports. Figure 1 below shows the sixteen different leagues considered.

**Figure 1:** Initial choice of leagues

| Team Sports |                          |                                  |                                  |                            |
|-------------|--------------------------|----------------------------------|----------------------------------|----------------------------|
| Numbers     | Football                 | Rugby Union                      | Cricket (T20)                    | Basketball                 |
| 1           | Premier League (England) | Aviva Premiership (England)      | IPL (India)                      | BBL (UK)                   |
| 2           | La Liga (Spain)          | French Top 14 (France)           | Big Bash League (Australia)      | NBA (USA/Canada)           |
| 3           | Serie A (Italy)          | Principality Premiership (Wales) | NatWest T20 Blast (England)      | VTB League (Russia))       |
| 4           | Bundesliga (Germany)     | Super Rugby (Australasia/Asia)   | Pakistan Super League (Pakistan) | Turkish Süper Lig (Turkey) |

Figure 2 shows the leagues chosen by the random generator. There is a wide range of leagues from the biggest to the smallest (out of the four selected). This will greatly improve the legitimacy of the paper with different qualities of leagues being selected rather than the best leagues from each sport.

**Figure 2:** Leagues chosen by random generator

| Team Sport    | League Generated      |
|---------------|-----------------------|
| Football      | Bundesliga (4)        |
| Rugby Union   | Aviva Premiership (1) |
| Cricket (T20) | IPL (1)               |
| Basketball    | VTB League (3)        |

## Data Calculations

To look at the different leagues in a comparative way, this paper looks at the points per game (PPG) for each team at home and away. Then calculates the difference between the PPG (Home) and PPG (Away) to see the difference. The PPG (Home) and PPG (away) are calculated using the following formulae:

$$PPG (Home) = \frac{(no. home wins) \times 3}{no. home games played}$$

$$PPG (Away) = \frac{(no. away wins) \times 3}{no. away games played}$$

$$Difference = PPG (Home) - PPG (Away)$$

For each league, to more accurately understand the data, the mean ( $\mu$ ), average PPG (Home), average PPG (Away) and average PPG (Both) are calculated. Then the standard deviation ( $\sigma$ ) and variance ( $\sigma^2$ ) for PPG (Home), PPG (Away) and PPG (Both) are calculated. These calculations will allow a more effective comparison between the leagues.

Standard deviation measures how much the data differs from the mean value. This gives us a value for different the data is from the mean value. The variance is the standard deviation squared. The variance also shows how dispersed the data is from the mean value.

The formulas for those calculations are given below:

$$\mu (PPG (Home)) = \frac{\Sigma(PPG (Home))}{(no. of teams)}$$

$$\mu (PPG (Away)) = \frac{\Sigma(PPG (Away))}{(no. of teams)}$$

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$$

$$\sigma^2 = \frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2$$

# Data

## Bundesliga data

The Bundesliga is the highest division of football in Germany [2]. It is widely considered one of the top leagues in the world. The Bundesliga contains eighteen teams each season. Every team plays each other once at home and once away creating a total of 34 games. The winner of the 2017/2018 Bundesliga was Bayern Munich. Figure 3 shows the findings.

**Figure 3:** Bundesliga data [3]

| Team                     | No. home wins | No. away wins | PPG (Home) | PPG (Away) | Difference (PPG(H)-PPG(A)) |
|--------------------------|---------------|---------------|------------|------------|----------------------------|
| Bayern Munich            | 14            | 13            | 2.471      | 2.294      | 0.176                      |
| Schalke                  | 10            | 8             | 1.765      | 1.412      | 0.353                      |
| Hoffenheim               | 11            | 4             | 1.941      | 0.706      | 1.235                      |
| Borussia Dortmund        | 9             | 6             | 1.588      | 1.059      | 0.529                      |
| Bayer Leverkusen         | 8             | 7             | 1.412      | 1.235      | 0.176                      |
| RB Leipzig               | 9             | 6             | 1.588      | 1.059      | 0.529                      |
| Stuttgart                | 10            | 5             | 1.765      | 0.882      | 0.882                      |
| Eintracht Frankfurt      | 8             | 6             | 1.412      | 1.059      | 0.353                      |
| Borussia Mönchengladbach | 9             | 4             | 1.588      | 0.706      | 0.882                      |
| Hertha Berlin            | 5             | 5             | 0.882      | 0.882      | 0.000                      |
| Werder Bremen            | 6             | 4             | 1.059      | 0.706      | 0.353                      |
| Augsburg                 | 6             | 4             | 1.059      | 0.706      | 0.353                      |
| Hannover 96              | 8             | 2             | 1.412      | 0.353      | 1.059                      |
| Mainz                    | 7             | 2             | 1.235      | 0.353      | 0.882                      |
| Freiburg                 | 7             | 1             | 1.235      | 0.176      | 1.059                      |
| Wolfsburg                | 3             | 3             | 0.529      | 0.529      | 0.000                      |
| Hamburger SV             | 6             | 2             | 1.059      | 0.353      | 0.706                      |
| FC Koln                  | 3             | 2             | 0.529      | 0.353      | 0.176                      |

| Team               | Home  | Away  | Both  |
|--------------------|-------|-------|-------|
| Mean average       | 1.363 | 0.824 | 1.093 |
| Standard deviation | 0.483 | 0.503 | 0.558 |
| Variance           | 0.234 | 0.253 | 0.311 |

## Aviva Premiership data

Now moving onto the sport, rugby union. The Aviva Premiership is the top rugby union league in England. The Aviva Premiership is made up of twelve teams with each team playing each other once at home and once away, totalling twenty-two fixtures in a season. The winner of the Aviva Premiership, for the chosen season of 2017/2018, was Saracens due to their end of season play-off structure. Below in Figure 4, the data is shown for this league.

The results for the rugby union are as follows:

**Figure 4:** Aviva Premiership data [4]

| Team               | No. home wins | No. away wins | PPG (Home) | PPG (Away) | Difference (PPG(H)-PPG(A)) |
|--------------------|---------------|---------------|------------|------------|----------------------------|
| Exeter Chiefs      | 10            | 7             | 2.727      | 1.909      | 0.818                      |
| Saracens           | 9             | 7             | 2.455      | 1.909      | 0.545                      |
| Wasps              | 8             | 6             | 2.182      | 1.636      | 0.545                      |
| Newcastle Falcons  | 7             | 7             | 1.909      | 1.909      | 0.000                      |
| Leicester Tigers   | 6             | 7             | 1.636      | 1.909      | -0.273                     |
| Bath Rugby         | 6             | 5             | 1.636      | 1.364      | 0.273                      |
| Gloucester Rugby   | 8             | 3             | 2.182      | 0.818      | 1.364                      |
| Sale Sharks        | 7             | 3             | 1.909      | 0.818      | 1.091                      |
| Northampton Saints | 6             | 2             | 1.636      | 0.545      | 1.091                      |
| Harlequins         | 6             | 1             | 1.636      | 0.273      | 1.364                      |
| Worcester Warriors | 5             | 2             | 1.364      | 0.545      | 0.818                      |
| London Irish       | 2             | 1             | 0.545      | 0.273      | 0.273                      |

| Team               | Home  | Away  | Both  |
|--------------------|-------|-------|-------|
| Mean average       | 1.818 | 1.159 | 1.489 |
| Standard deviation | 0.562 | 0.679 | 0.696 |
| Variance           | 0.316 | 0.461 | 0.485 |

## Indian Premier League (IPL) data

Next, moving onto the IPL (Indian Premier League) in cricket. The IPL is regarded by most to be the biggest and best T20 cricket league in the world [6]. This league consists of eight teams who play each other once at home and once away each playing a total of fourteen games. In the IPL 2018 season, the winners were the Chennai Super Kings who defeated the Sunrisers Hyderabad in the final. Figure 5 shows our findings.

**Figure 5:** Indian Premier League data [5]

| Team                        | No. home wins | No. away wins | PPG (Home) | PPG (Away) | Difference (PPG(H)-PPG(A)) |
|-----------------------------|---------------|---------------|------------|------------|----------------------------|
| Sunrisers Hyderabad         | 5             | 4             | 2.143      | 1.714      | 0.429                      |
| Chennai Super Kings         | 6             | 3             | 2.571      | 1.286      | 1.286                      |
| Kolkata Knight Riders       | 4             | 4             | 1.714      | 1.714      | 0.000                      |
| Rajasthan Royals            | 5             | 2             | 2.143      | 0.857      | 1.286                      |
| Mumbai Indians              | 3             | 3             | 1.286      | 1.286      | 0.000                      |
| Royal Challengers Bangalore | 3             | 3             | 1.286      | 1.286      | 0.000                      |
| Kings XI Punjab             | 4             | 2             | 1.714      | 0.857      | 0.857                      |
| Delhi Daredevils            | 4             | 1             | 1.714      | 0.429      | 1.286                      |

| Team               | Home  | Away  | Both  |
|--------------------|-------|-------|-------|
| Mean average       | 1.821 | 1.179 | 1.500 |
| Standard deviation | 0.444 | 0.444 | 0.542 |
| Variance           | 0.197 | 0.197 | 0.294 |

## VTB League data

Now moving onto basketball where the VTB League from Russia was chosen. This is a league not very widely known outside of Russia. The VTB league contains thirteen teams which all play each other once at home and once away meaning that each team competes in twenty-four fixtures. In the 2017/2018 campaign, the champions were CSKA Moscow with a 95-84 win over Khimki. M. Figure 6 shows our findings.

**Figure 6:** VTB League data [7]

| Team             | No. home wins | No. away wins | PPG (Home) | PPG (Away) | Difference (PPG(H)-PPG(A)) |
|------------------|---------------|---------------|------------|------------|----------------------------|
| CSKA Moscow      | 11            | 11            | 2.750      | 2.750      | 0.000                      |
| Unics Kazan      | 11            | 11            | 2.750      | 2.750      | 0.000                      |
| Lokomotiv Kuban  | 9             | 8             | 2.250      | 2.000      | 0.250                      |
| Zenit Petersburg | 9             | 7             | 2.250      | 1.750      | 0.500                      |
| Saratov          | 7             | 7             | 1.750      | 1.750      | 0.000                      |
| Khimki M.        | 7             | 6             | 1.750      | 1.500      | 0.250                      |
| Nizhny Novgorod  | 6             | 4             | 1.500      | 1.000      | 0.500                      |
| VEF Riga         | 6             | 2             | 1.500      | 0.500      | 1.000                      |
| Tsmoki Minsk     | 5             | 3             | 1.250      | 0.750      | 0.500                      |
| Astana           | 6             | 1             | 1.500      | 0.250      | 1.250                      |
| Parama Perm      | 3             | 4             | 0.750      | 1.000      | -0.250                     |
| BC Kalev/Cramo   | 5             | 1             | 1.250      | 0.250      | 1.000                      |
| Enisey           | 4             | 2             | 1.000      | 0.500      | 0.500                      |

| Team               | Home  | Away  | Both  |
|--------------------|-------|-------|-------|
| Mean average       | 1.712 | 1.288 | 1.500 |
| Standard deviation | 0.628 | 0.871 | 0.711 |
| Variance           | 0.394 | 0.759 | 0.600 |

## Findings

Now that all the data is compiled, this section can start looking at any trends, comparisons or differences between teams within a league as well as between leagues.

**Figure 7:** Mean Average PPG data

| League                      | Mean Average PPG (Home) | Mean Average PPG (Away) | Difference | Mean Average PPG (Both) |
|-----------------------------|-------------------------|-------------------------|------------|-------------------------|
| Bundesliga (Germany)        | 1.363                   | 0.824                   | 0.539      | 1.093                   |
| Aviva Premiership (England) | 1.818                   | 1.159                   | 0.659      | 1.489                   |
| IPL (India)                 | 1.821                   | 1.179                   | 0.643      | 1.500                   |
| VTB League (Russia)         | 1.712                   | 1.288                   | 0.423      | 1.500                   |

Instantly, the data shows that home advantage is clearly present in all these leagues. In terms of wins, teams perform much better at home. There are a couple of outliers with the Leicester Tigers in the Aviva Premiership and Parama Perm in the VTB League. Straightaway, the data shows that there is a home advantage in these four leagues due to only two out of the fifty-one teams having a higher number of away wins than home wins.

The mode for each of the leagues was calculated to see if there was a trend which supports this claim. The calculation of the modes gives some expected answers. The outcome for the mode was expected to always be higher for home wins than away wins as that is the trend in the data. The mode values for the Bundesliga don't give any indication of any trend. The modal values for the Bundesliga gave two or more values for home and away. This doesn't give me much indication of a trend due to the number of values for each. But for the Aviva Premiership, the mode for the away wins (7) was higher than for the home wins (6) which is a surprising result. I was surprised with the result due to every trend in my data so far leaning significantly to the home win advantage. With the VTB league, there were five different values for the mode for away wins from the highest value 11 to the lowest value 1. Nothing can be taken from this data due to the number of values for the mode.

From Figure 7, the 'Mean Average PPG (Both)' is shown to be very close for the Aviva Premiership, IPL and VTB League. For the Bundesliga, there is a big difference which could suggest that home advantage is not as big in this league, but it is more likely that draw is a lot more likely in football than the other three sports. Looking at the mean average PPG for each league, there is a very close resemblance. Before this paper, it was expected for there to be sports that would have a more significant advantage of playing at home than others. This answers one of my original questions which was whether there is much difference between sports. This gives a clear indication to us that there a home advantage associated with team sports.



## Reasoning

There are lots of reasons why a team could perform better at home. The first reason is that the home team plays at that ground half of the time throughout the season so is much more comfortable. This might not seem like a big influence but psychologically it will make the home players feel more relaxed and therefore perform better during the game. In football especially, there is always a huge majority of the supporters being home supporters which can only help the home team. This can give a big lift to the home team with the home fans being able to give more support than the away fans due to pure numbers of supporters for each side. The choice of kits worn by each team could also play a psychological role in the game due to a set of players usually feeling more comfortable wearing their home kit over their away kit. This will have a small impact on any home advantage, the effect will most likely be very small but can make all the difference. One example is if the home teams kit looks like the home kit of the away team. This might cause more mistakes from the away team due to the automatic impulse to pass to that colour.

The quality of the facilities at the home ground can also play a big role. For example, Bayern Munich has some of the best stadium facilities in the world. They have a state-of-the-art stadium with big dressing rooms and a pristine pitch [8]. When a team goes to Allianz Arena (Bayern Munich's stadium), they will probably up their game because of the world-class facilities available to them. But when Bayern Munich go to a smaller team in Germany, the facilities will be a lot more basic with smaller dressing rooms and a pitch that is not as well looked after.

Away teams will have to travel to the home team and most often this will be via coach travel and rarely plane. An example is from Freiburg to Hertha Berlin which is 501 miles (806 kilometres) [9]. Using the TomTom my drive route planner [10], it would take six hours and forty-five minutes without any traffic. The distance between teams can also negatively impact the number of away team fans that will travel to the game due to the distance and cost. Also, the away players and fans can be impacted by fatigue. A lot of travelling before a game is not the best preparation.

The home crowd, due to their large numbers, could possibly have an impact on the match officials. The home crowd can react badly to a challenge by an opposition player which could influence the colour of the card brandished to the player. If there is a penalty claim, then the loud roar of the home team could sway the match officials thinking. If a decision like one of these is made in error, then it can drastically change the outcome of the game in the home teams' favour. Although the officials should never allow the crowd to affect the decisions that they make. The decision should be purely made by the officials, but the crowd will always influence the officials in some way. In big countries like the USA, there are areas which have vastly differing climates. The NBA has not been investigated within this paper, but this league gives a perfect example of this. The best example of this is the vast difference in climate between the Utah Jazz and Los Angeles Lakers in January. The Utah Jazz play in Utah where it can get very cold whereas the Los Angeles Lakers are from LA in California. They are completely different climates and can negatively or positively impact either side before a game. This is shown through the climate data found. In Utah the average high temperature is 3.6°C and average low temperature is -3.1°C from reference [12]. In Los Angeles the average high temperature is 19.5°C and average low temperature is 10.5°C from reference [11]. These temperatures show the big difference

in climates between home teams. This may not have a big impact on the result of a game but cannot be ignored.

## Conclusion

So, to conclude, this paper shows that the home team will always have a big advantage over the away team (if the quality of each team is disregarded) due to the reasons given. To further this research, it would make sense to look at more sports, more leagues from the sports already selected or take more seasons into account when calculating the data. The only issue with this is that in some of the leagues the teams change slightly each year.

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