# Champions League for dummies

## 1 Introduction

In the autumn of 1987, Napoli, led by Diego Maradona, was eliminated in the first round of the European Cup by Real Madrid. This triggered, then, AC Milan president Silvio Berlusconi to criticise the tournament, referring to it as a "historical anachronism" and proposing a new European competition to address UEFA's format problems. Fearing early exits and broadcaster demands for reliable fixtures, UEFA responded by introducing a revamped format with a group stage for the 1992/93 season, rebranding the competition as the now well-known "Champions League" (FootballBH, 2026). While these changes have expanded European football commercially, thriving in the competition remains complicated. Winning relies not just on individual talent but also on opponent strength, performance dominance, and effective tactics across the competition. Instead of viewing Champions League victories purely based on opinions or common narratives, Mathematics offers a fair way to analyse these factors equitably. By applying Mathematical reasoning, this essay examines how European success can be assessed, predicted, and understood more accurately with quantitative methods.

## 2 Methodology: Determining the best Champions League winner

Whether it's conversations at the lunch table or phone calls late at night, debates regarding football have been a common point of discussion for a very long time. Unfortunately, just like most discussions, whether it's about football or not, reaching a conclusion is practically impossible due to bias, which usually arises from limited information and social influence. In football, bias usually arises from factors like fan loyalty, as people tend to naturally defend their clubs and rate them higher. However, what has been growing increasingly, especially in modern times, is media influence. Trying to decide the best Champions League winner is complicated, as since 1993, its long history has meant that due to changes in tactics, finances, competition level, and tournament formats, comparing teams from different eras is difficult. Mathematical modelling, however, can be used to solve this by considering key concepts to calculate the overall level of a campaign and compare the winners of the competition effectively.

It's vital to remember that despite all the winners having the same ending, getting to that point has been very different for all of them. The idea of the model is to assess the overall performance of a winner's campaign by analysing three components. First, the strength of opponents is measured using an opponent strength score, which considers the quality of the teams faced en route to victory. Second, the poise of the champion's performance is calculated with the performance dominance score, which considers results, goal difference, and away performances. Finally, a format factor is also used to consider tweaks in the competition's format, ensuring a campaign that had fewer matches than another isn't handicapped. These components are then merged and weighted to quantify a rating of the entire road to victory.

$$G = (0.55(OSS \cdot FF) + 0.45(PDS)$$

To work out our OSS, we first need to calculate the Team Strength Metric ($TSM_i$), which combines factors such as the UEFA coefficient and league coefficient, together with the team's domestic performances over the last 5 years. The UEFA coefficient helps highlight European performance, whilst the combination of league coefficient and domestic performances is used to show the

overall strength of the league, whilst also helping to account for the team's consistency and success domestically.

$$\text{TSMi} = 0.5\log(\frac{U\text{i}}{\sum U} + 1) + (0.2\log(\frac{L\text{i}}{\sum L} + 1) \cdot 0.3(\text{Di}))$$

Where $U$ is the UEFA coefficient of the team, $L$ is the coefficient of the team's league and $D$ is the domestic performance. Logarithmic scaling is applied to the coefficient terms to reduce the impact of extreme values and prevent large coefficients from dominating the model. We then use weighing so the model can choose how much each component contributes, reflecting each one's importance.

Domestic performance ($D$) is calculated with the equation below

$$\text{Di} = \frac{1}{5}\sum_{k=1}^{5}(\frac{N - P\kappa + 1}{N})$$

Where $p\kappa$ represents the league position in season K, and N is used to represent the number of teams in the league.

For every team, the team strength metric is multiplied by a round weight(Ri) which varies depending on the stage of the competition, with group stage games being given the lowest values and the latter stages the highest. This helps to reflect the increased difficulty of each opponent faced due to the rise in stakes as the competition goes on.

***Table 1: The round weights used in the model***

| Stage | Round Weight (Ri) |
|---|---|
| Group Stage | 0.8 |
| Round of 16 | 1.2 |
| Quarter-final | 1.5 |
| Semi-final | 2 |
| Final | 2.5 |

As a result, we now sum all our weighted values to obtain our OSS value.

$$\text{OSS} = \sum(TSM\text{i} \cdot \text{Ri})$$

To calculate the Performance Dominance Score (PDS), we use the team's weighted win rate (WWR), weighted goal difference (WGD), and weighted away win rate (WAWR). These factors give us an idea of the team's performance throughout the competition.

$$\text{WWR} = \frac{\sum(R\text{i} \cdot W\text{i})}{\sum R\text{i}}$$

Where $W$ illustrates the result of the match and Ri is the round weight.

$$\text{WGD} = \frac{\sum R\text{i} \cdot GD\text{i})}{\sum R\text{i}}$$

Where $GD$ represents the goal difference in the match, which is calculated by subtracting goals scored from goals conceded.

$$\text{WAWR} = \frac{\sum(R\text{i} \cdot A\text{i})}{\sum R\text{i}}$$

Where $A$ outlines the result of the away match.

***Table 2: match outcomes converted into numerical scores below***

| Result | $Wi/Ai$ |
|---|---|
| Win | 1 |
| Draw | 0.5 |
| Loss | 0 |

Now that we've got our three components, we can add them up to get our Performance Dominance Score and weigh them.

$$PDS = 0.4(WWR)+0.4(WGD)+0.2(WAWR)$$

Lastly, we can now work out the format factor (FF) quite simply.

$$FF = \frac{13}{M}$$

Where 13 is the maximum number of opponents that can be played in the newest format, and M is the actual number of opponents faced.

We now have all our components to work out the Greatness score.

A great way to show that bias exists in choosing the greatest Champions League winner is to compare nonobjective rankings with results made from the model. In this case, we will use former Liverpool defender Jamie Carragher as our example.


***Figure 1: Rankings of the greatest Champions League winning teams by the CBS crew (CBS Sports Golazo, 2023)***

As we can see from the rankings, Jamie Carragher's top five consists of the 2008/09 and 2010/11 Barcelona sides, followed by AC Milan 93/94 then Real Madrid 2017/18, and finally, Ajax 94/95. Even though cases can be made, all these teams are elite and deserve to be on his list. Our model can show how bias can even affect the biggest names in the sport.

***Table 3: Model results for selected teams***

| Team | Score(3.S.F) |
|---|---|
| 1)Milan 93/94 | 0.603 |
| 2)Barca 10/11 | 0.559 |
| 3)Real Madrid 17/18 | 0.497 |
| 4)Barca 08/09 | 0.494 |
| 5)Ajax 94/95 | 0.475 |

***Source: Data collected using Kassiesa and Transfermarkt (Kassiesa, 2026; Transfermarkt, 2026).***

As we can see, the difference between the model's results and Carragher's rankings highlights that subjective bias does, in fact, exist in debates regarding football. Whilst Jamie Carragher based his rankings on iconic moments, big names, and aesthetics. The model has removed most of this bias and instead used key factors and consistently quantified methods to give us more accurate rankings. Although it must be stated that the model isn't completely unbiased, since choices regarding measure choice and weighing can still affect results. Regardless, the model helps to deliver and offer a much more systematic and data-driven tactic for determining the best Champions League winner.

# 3 Optimisation: Decision making in the Champions League


**Figure 2: Frank Rijkaard at the 2006 Champions League final (Footballia, n.d, cropped by author)**

Put yourself in Frank Rijkaard's shoes. It's the 2006 Champions League final in Paris, and at the 61st minute, Rijkaard's got a big decision to make. Despite going down to 10 men, Arsenal took the lead on a set piece in the 37th minute and have been in the lead since. Even with the man advantage, Barcelona has struggled to find a goal and hasn't been able to rely on individual brilliance from their stars like Ronaldinho and Deco. So, at the hour mark, Rijkaard thinks it's time to make a substitution, but who does he take on and off? An attacking-minded player for a defensive one may increase the chances of scoring; it also coincides with an increased chance of conceding. This decision can be made using the concept of expected value.

Expected Value is defined as the average outcome of a single instance over the long run (Jeremy Blitz-Jones, 2024). It can be written as:

$$E(X) = \sum X_i \cdot P_i$$

In this context, the expected value can help us compare the different tactical substations using the possible results of each. To put this into practice, we need to define the potential outcomes in the context of a tactical change. Our main outcomes in this case are scoring or conceding. In this scenario, our outcomes can also be variable based on the situation, which gives us the general formula:

$$E(X) = P_S \cdot V_S - P_C \cdot V_C$$

Where $P_S$ is the probability of scoring and $V_S$ is the value of scoring. Then $P_C$ is the probability of conceding, and $V_C$ Is the value of conceding. This formula is used to show the net benefit of a tactical change. The higher the expected outcome, the more likely of achieving a positive outcome

In the context of Rijkaard's decision, since Barcelona is behind and with time running out, scoring is more valuable than conceding. If Barcelona doesn't score, it wouldn't make a difference, as regardless of whether Arsenal scored again or not, they'd still lose the final. To show this in the model, we assign a greater value to scoring than to conceding. So, we could make $V_S = 2$ and $V_C = 1$.


***Figure 3: Team sheet from the 2006 UEFA Champions League Final (Reddit, 2016; cropped by the author)***

Let's analyse 2 potential changes that Frank could've made at this stage.

Firstly, it would make sense that Rijkaard keeps his approach the same and swaps out Van Bronckhorst for someone in his position, like Sylvinho, that way keeping the style of play the same to not over-complicate things and getting fresh legs in defence. Doing this would help give us a relatively balanced approach to the game. Let's assume that this change leads to a $P_S = 0.25$ and $P_C = 0.15$ along with using the previously stated outcome values. The expected value is shown as:

$$EV(Sylvinho) = (0.25)(2) - (0.15)(1) = 0.35$$

However, looking at it at a more tactical perspective based on the current situation using a more attacking and aggressive approach may be the more sensible choice in the eyes of Rijkaard as given the score it would make sense to go all out on attack by subbing on our only attacker which is Larsson in for a defensive minded player like Van Bommel. which while increasing the defensive vulnerability it will help by increasing our attacking threat given the addition of an another attacking player. Let's assume this change leads to a $P_S = 0.35$ and $P_C = 0.25$, along with again using our previously stated outcomes, the expected value is shown as:

$$EV(Larsson) = (0.35)(2) - (0.25)(1) = 0.45$$

Comparing the results shows us that the more optimal approach is the Larsson sub, as it produced a higher expected value, meaning a higher chance of success in the game. This conclusion can be supported by what happened in real life as Rijkaard went on to make the Larsson sub, and not only did they win the game, but Larsson was involved in both the equalizer and the winner.

However, even with the model's ability to frame an understanding of tactical decision-making in football, it still has severe limitations. This is because the probabilities used are estimated values, and so the results of our formula rely more on assumptions rather than exact data. We also do the same with our scoring and conceding variables, so that different assumptions can lead to big changes in results. These values depend on many factors such as opposition tactics, player quality, and atmosphere. Thus, while the model may have some gaps, its simplicity helps and remains effective in explaining managerial decision-making.

# 4 conclusion

In conclusion, I hope this essay has successfully shown you that mathematical modelling can be used to help evaluate not only the greatest Champions League winner but also decision-making within the competition using a range of key factors across both topics, with necessary weighting and variables. Overall, this shows how mathematical thinking can be used and applied not just in theory, allowing us to delve into understanding both performance and strategy in football.

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