ORIGINAL ARTICLE

Attacking players and goal scoring

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ABSTRACT

This paper investigates optimal coaching strategies in the combination of players football managers should have on the field. It does so by examining how goal scoring and conceding respond to changes in the number of attacking players on the field in European football matches. The paper tests the hypotheses that more attacking players raise both the rates at which the team scores and concedes goals. The paper shows that managers play more defenders when their team is an underdog and it tests whether this strategy is successful. The estimates show that teams are nearly always better off including more attacking players on the field. In the typical match, teams score at a greater rate and (surprisingly) concede at a lower rate when they have more attacking players on the field. The gain in net goals from playing more attacking players is larger the more a team is favoured over its opponent. Teams that are heavy underdogs playing away from home are the only ones that may be better off playing more defensive players. Coaching strategies should shift toward being less defensive in most cases.

Keywords: Performance analysis, Home advantage, Managerial decisions, Football, Goal scoring, Sports performance.

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INTRODUCTION

Managers of football clubs seek to combine players on the field in a way that will give them the best chance of outscoring their opponents. One common tendency is for teams to play more defensively when they are underdogs or on the road than they do when they are favourites or at home. Are those decisions rational or should managers adopt different strategies? This paper explores optimal coaching strategies by investigating how the combinations of defenders, midfielders, and attackers on the field affect the team's rates of scoring and of conceding goals. The estimates show that in the vast majority of cases, a team has a higher net scoring rate if it has more attacking players on the field. Only heavy underdogs playing away from home do better by adding more defensive players to their lineup on the field. In all other situations, a team that brings attacking players onto the field and removes defensive players increases its rates of scoring relative to that of the opposition.

A natural response to seeing this result might be to wonder if better teams tend to play more attacking players while weaker teams set up more defensively. Thus, teams with more attacking players score more (and are scored on less) because of their quality rather than because of their formation. The empirical model in this paper controls for relative team quality by including a fixed effect for each match. The fixed effects control for the relative strength of the two teams on the day the game is played. In the regressions, the estimation thus captures the difference within the game in scoring between minutes when a team has fewer attacking players on the field and minutes when the team has more attacking players. In all regressions, the score of the game is controlled for to eliminate the possibility that teams try harder to score (and use more attacking players) when they are behind than when they are ahead.

Many studies have examined goal scoring in European football leagues. Rodenas et al. (2020), Pratas et al. (2018), and Sarmento et al. (2014) provide reviews of this literature. Pratas et al. (2018) note that most articles provide only a static analysis that mainly describes key performance indicators rather than examining the dynamics of performance during matches. Sarmento et al. (2014) recommends that researchers incorporate "*situational and interactional contexts into the analysis of football performance*." This paper follows that recommendation.

Several studies examine different methods of attack to see what is most effective. Tenga et al. (2010) compare counter attacks (a more direct style) to elaborate attacks (emphasizing longer spells of possession). They find that counter attacks are more effective than elaborate attacks in home games if the defence is imbalanced or out of its normal shape. This result does not hold in away games, however. Wright et al. (2011) analysed 1788 attempts on goal (of which 167 were scored) in English Premier League games. They find that 85% of goals were scored after a spell of possession less than four passes. Thus, most goals are scored in transition situations.

Coaches and their tactics are the subject of a study by Staufenbiel et al. (2015). Based on survey data, they showed that managers had higher expectations about how they would do and were less satisfied with a 0-0 score when at home than when they were playing an away game. The coaches also tended to choose tactics considered more "*dominant*" and more "*courageous*" when at home. When coaches made a substitution in a tie game in the 70th minute, the home coach substitutions were more offensive than the away coach substitutions. Interestingly, the tactics for all coaches shifted and became more dominant and courageous in the second half than they were at the start of the game. That is consistent with Brocas & Carrillo (2004), who show that coaches adopt a more attacking strategy later in the game if it remains tied.

The increasingly attacking tactics late in the game may help explain a common result in the literature, which is that goal scoring rates tend to rise over the course of the game. Studies finding this result include Ridder, Cramer, & Hopstaken (1994), Dixon and Robinson (1998), Palomino, Rigotti, & Rustichini (1999), Abt, Dickson, & Mummery (2001), Armatas, Yiannakos, & Sileloglou (2007), Alberti et al. (2013), Simiyu (2014), and others. Another potential explanation for rising goal scoring rates as a game nears its end is substitutions, which tend to occur in the later stages of most games. Amez et al. (2021) show that substitutes significantly raise the scoring rates of the substituting team and reduce the scoring rates of the opposing team.

The game score affects scoring rates for both teams. Dixon and Robinson (1998) find that home scoring falls and away scoring rises if the home team is leading. Both teams' scoring rates rise (compared to a tie game) if the away team is in the lead. The difference in goal scoring rates based on game situation may be a result of a change in style of play. Lago (2009) finds that the Espanyol football club in La Liga possessed the ball more while they were losing than they did when they were winning or drawing. Compared to losing positions, possession fell by 3% when the game was tied and fell by 11% when Espanyol was ahead. A similar result emerges in Lago-Peñas and Gómez-López (2014), who found that ball possession decreased when a team was one goal ahead. They show that shots on goal and the probability of reaching the final third of the pitch also fell when a team was one goal ahead.

MATERIAL AND METHODS

This paper uses data from 7,204 matches played in the first divisions of the five largest professional leagues in Europe (England, France, Germany, Italy, and Spain) during the 2017-18, 2018-19, 2019-20, and 2020-21 seasons. The data set includes all of the goals scored in those matches, the timing of each goal, and the players who were on the field in each minute of the game. Each player is identified as either a defender, midfielder, or a forward[1].

The goal of this paper is to identify how the scoring rates of each team are affected by the number of defenders, midfielders, and forwards the two teams have on the field. The first two hypotheses to be tested in the paper relate to how goal scoring and conceding rates are related to the number of attacking players that a team has on the field.

Hypothesis 1: A team with more attacking players on the field will score goals at a faster rate than they would if they had more defensive players.

Hypothesis 2: A team with more attacking players on the field will concede more goals than they would if they had more defensive players.

These hypotheses are intuitive. A team composed primarily of defenders tends to sit deep in its own end, making it hard for the opposition to score but creating few chances of its own to score goals. A team composed of more attacking players will tend to create more scoring opportunities but may be more vulnerable to opposition attacks. Perhaps surprisingly, the estimates in this paper show that only Hypothesis 1 is supported in the data. Hypothesis 2 is rejected emphatically by the empirical tests as the results in the next section show.

[1] *This does not mean that the exact formation being played by the manager can be identified since players are occasionally used in ways that differ from their primary position. What the data can show is how many players of a certain type are on the field at each point in time.*

A third hypothesis examined in this paper, and perhaps one that is less obvious, is that teams with an advantage over their opponents benefit from more attacking lineups while underdogs benefit from including more defenders.

Hypothesis 3: Favoured teams are better off playing more attacking players while underdogs are better off including more defenders on the field.

Based on their home and away lineups, coaches seem to believe Hypothesis 3 to be true. Away managers include significantly more defenders on the field (4.27 on average) than home teams (4.22) while home teams have more forwards (2.22) than away teams (2.15). Using power indexes[2] of each team to measure relative team strength, it is even clearer that managers play more defensive players when they are underdogs. If the home team has a higher power index than the away team, the home team averages 4.16 defenders on the field while the away team averages 4.34 defenders. When the home team has a lower power index, the home team averages 4.28 defenders on the field, significantly more than the away team's 4.20 defenders. Thus, managers send out more defensive players when their teams are at a disadvantage. This paper will assess whether that strategy of playing more defensive players when the opposing team has an advantage makes sense.

To evaluate the hypotheses, the empirical model examines the determinants of goal scoring rates for the home and away team. Each observation is for a single minute in a particular game. There are 648,360 minutes observed across the 7,204 matches played.

The key question of interest is the effect on scoring rates of how attacking the lineup of each team is. To measure the attacking value of the lineup, I assign an attacking value of zero to each defender, one to each midfielder, and two to each forward. The attacking value of the lineup is the sum of these values across all ten field players, and it ranges from three to 14 in the data set. The median value of eight reflects the most common lineup combination in the dataset: four defenders, four midfielders, and two forwards. The regressions include the attacking value of the lineup for the home team and for the away team, as well as the square and the cube of these values. Including the square and the cube of the two attacking value variables allows the lineup attacking values to have nonlinear effects on the scoring rates of the two teams.

Testing Hypothesis 3 requires a model in which the impact of the lineup attacking value on goal scoring rates depends on whether the team is a favourite or an underdog. The models measure the relative strength of the two teams using the difference between the home and away team power indexes. This variable measuring relative team strength is interacted with the attacking values of the home team and the away team lineups.

Other variables related to the game situation can also affect scoring rates and are included in the model as control variables. Because scoring rates rise as the game approaches its end, the model includes the minute of the game and the minute squared. Previous research has found that scoring rates rise faster over the course of the match when there is greater attendance, so the model also includes an interaction term between the log of attendance and the minute variable. The referees add extra time at the end of each half to account for injuries, and all goals scored in stoppage time are recorded as occurring in minute 45 or minute 90. Thus, the model includes dummy variables for minute 45 and for minute 90.

[2] *The power index for each team is FiveThirtyEight's rating of overall team strength ahead of each game, described more fully at https://data.fivethirtyeight.com/#soccer-spi. The power ratings include offensive and defensive ratings for each team based on the market value of the players, and they are adjusted after each match based on the team's performances.*

The game score can influence scoring rates if the team that is behind tries harder to score or gives up trying to score if it is too far behind. Thus, the model includes six dummy variables indicating game score: home team ahead by three or more goals, home ahead by two goals, home ahead by one, and away ahead by one, two, or three or more goals. The omitted category is a tie game. The effects of the game score on scoring may differ, however, depending on whether it is early in the game or late (the urgency to catch up may be greater for the trailing team if it is late in the match, for instance). To account for this possibility, the model includes interaction terms between the minute of the game and each of the game score variables. To allow substitutions to affect scoring, the model includes the number of home team substitutes in the game and the number of away team substitutes in the game. Finally, if a team has gotten a red card, they are forced to play down a player the rest of the match, which affects both teams' scoring, so the numbers of red cards for the home and away teams are also included.

In addition to the control variables listed above, the regressions all include a fixed effect for each match, which controls for any factors specific to the game that affect the outcome. These include attendance, the referee, the relative strength of the teams and their form at the time, the distance the away team had to travel, injuries each team had coming into the game, and other factors even more difficult to measure such as any differences between the matches that were played during the pandemic and those played before it. Any factor that is constant across all the minutes within a particular game will be captured by the match fixed effects. With the fixed effects in the regression, the coefficients on the attack value variables measure how changes in the team's attack value within the match are related to changes in scoring rates within the match.

RESULTS

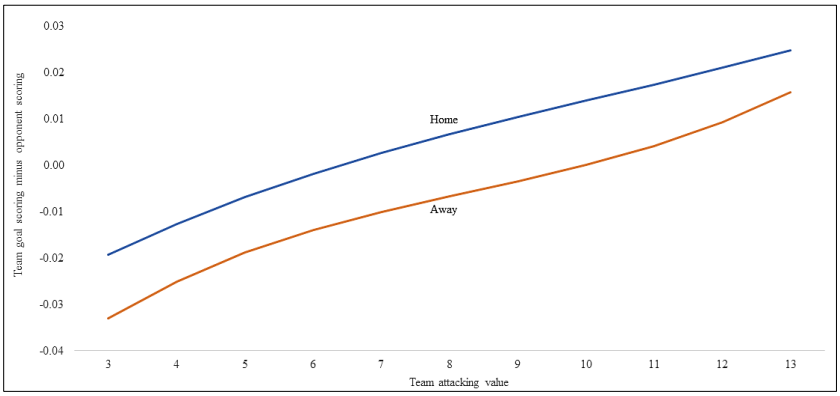
Table 1 presents the results of fixed effect regressions estimating the determinants of goal scoring probabilities per minute. In the first column, the dependent variable is equal to the number of goals scored by the home team in a particular minute of the game. The second column examines scoring by the away team, while column three examines net goal scoring (home goals minus away goals in the minute). The coefficient on each variable in the third column is equal to the coefficient in the first column minus that in the second column.

Table 1. Determinants of goal scoring rates per minute.

Variable	Home goals		Away goals		Net goals	
Minute	0.03925	***	0.02917	***	0.01007	**
Minute squared	-0.02943	***	-0.02051	***	-0.00892	*
Minute*Ln(attend)	0.00058	***	-0.00012		0.0007	***
Minute 45	0.0307	***	0.02518	***	0.00552	
Minute 90	0.07953	***	0.07222	***	0.00731	
Home ahead 3+	-0.10829	***	0.01928	***	-0.12757	***
Home ahead 2	-0.07923	***	0.01008	***	-0.08931	***
Home ahead 1	-0.03974	***	0.00764	***	-0.04739	***
Away ahead 1	0.01022	***	-0.03719	***	0.04741	***
Away ahead 2	0.01359	***	-0.08049	***	0.09409	***
Away ahead 3+	0.01285	**	-0.11818	***	0.13103	***
Home red cards	-0.01214	***	0.01483	***	-0.02696	***
Away red cards	0.01495	***	-0.00663	***	0.02158	***
Home subs	0.0013	***	-0.00048		0.00179	***
Away subs	-0.00113	***	0.00023		-0.00135	***
Attack value home	0.00427		-0.02656		0.03083	

Attack value home squared	-0.00004		0.00131		-0.00134	
Attack value home cubed	-0.0000002		-0.00002		0.00002	
Attack value away	-0.11213	**	-0.04285		-0.06928	
Attack value away squared	0.00609	**	0.0025		0.00359	
Attack value away cubed	-0.00011	**	-0.00005		-0.00007	
Power index diff * home attack	0.00011	***	0.00002		0.00009	**
Power index diff * away attack	0.00012	***	-0.00005	**	0.00017	***
Minute * Home ahead 3+	0.04906	***	-0.01051	*	0.05957	***
Minute * Home ahead 2	0.05165	***	0.00023		0.05142	***
Minute * Home ahead 1	0.02753	***	-0.00051		0.02803	***
Minute * Away ahead 1	-0.00407	*	0.02519	***	-0.02926	***
Minute * Away ahead 2	-0.00154		0.05611	***	-0.05765	***
Minute * Away ahead 3+	0.00009		0.05892	***	-0.05883	***
F-statistic, home attack	19.74	***	3.85	***	18.07	***
F-statistic, away attack	4.86	***	17.26	***	14.96	***
Observations	648.180		648.180		648.180	

*Note. *, **, *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% levels. Standard errors allow correlation between observations from within the same game. The models include fixed effects for each match.*

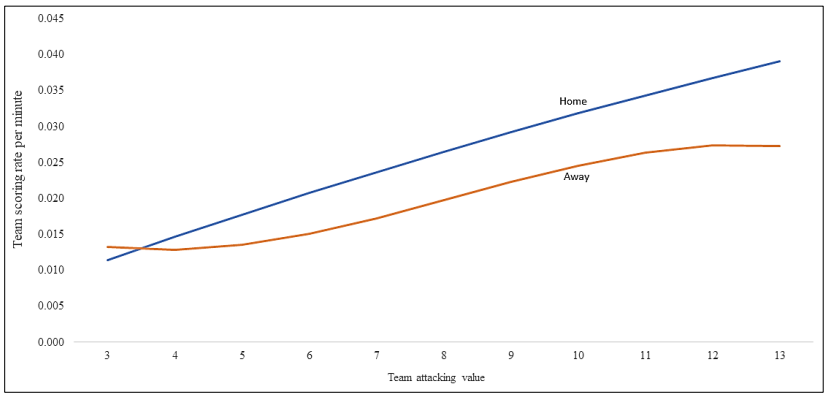


Note. Team attacking value is the stun of attack value for each player on the field where defender = 0, midfielder = 1, forward = 2. The vertical axis shows the probability of the team scoring in the next minute minus the probability of the opposing team scoring in the next minute in a tie game between two evenly matched teams with no red cards and no substitutes. The opposing team's attacking value is set to 8, and the average values are assumed for minutes and attendance. Based on Column 3 from Table 1.

Figure 1. Net goal scoring per minute by team attacking value.

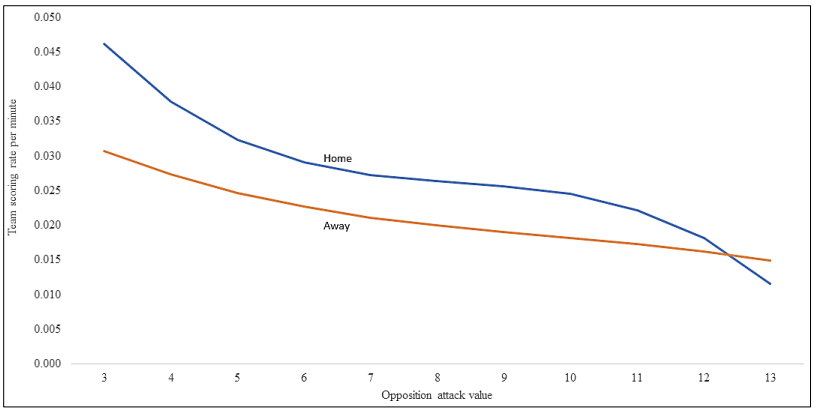
The regressions in Table 1 include variables measuring the attacking value of the home and away lineups, the squares of those values, and the cubes of those values. The F-statistics for the three home team attack value variables and for the three away team attack variables are listed near the bottom of the table. The home attack value variables have a jointly significant impact on both home scoring and away scoring rates, and the same is true for the away team attack variables. The home lineup has a more significant impact on home scoring than on away scoring, while the away lineup has a more significant impact on away scoring. Figure 1 illustrates the effect of the team's lineup on the net scoring rate (team scoring minus opponent scoring) in the average minute of a tie game between two evenly matched teams. Both home and away teams do very poorly when they have heavily defensive lineups, but each does much better when they introduce more attacking players onto the field. The estimation suggests that teams have better net scoring rates the more attacking their lineups are. In the data there is very little evidence that a lineup can be too attack-oriented if the two teams are even in terms of quality.

How big is the effect on net goal scoring of increasing the number of attacking players on the field? Based on the estimates in column 3 of Table 1, the home team's net scoring (home expected goals minus away expected goals) rises by 0.0037 per minute if it raises the attack value of its lineup from eight to nine while the away team lineup's attacking value remains at eight. That change in net scoring would project to a 0.34 increase in the home team's net goal advantage for the game if it were sustained over 90 minutes. For the away team, raising the attack value of its lineup from eight to nine while holding the home team value constant would improve the away team's net scoring by 0.0032 per minute, or by 0.29 net goals over a full game. These are large effects. In the data set, the home team outscores the away team on average by 0.34 goals per game when there are fans in the stadium. Thus, replacing one defender with a midfielder (or a midfielder with a forward) for all 90 minutes has about the same impact on the game outcome as does having home field advantage.



Note. Team attacking value is the sum of attack value for each player on the field where defender = 0, midfielder = 1, forward = 2. The vertical axis shows the probability of the team scoring in the next minute in a tie game between two evenly matched teams with no red cards and no substitutes. The opposing team's attacking value is set to 8, and the average values are assumed for minutes and attendance. Based on Columns 1 and 2 from Table 1.

Figure 2. Team scoring rates by team attacking value.

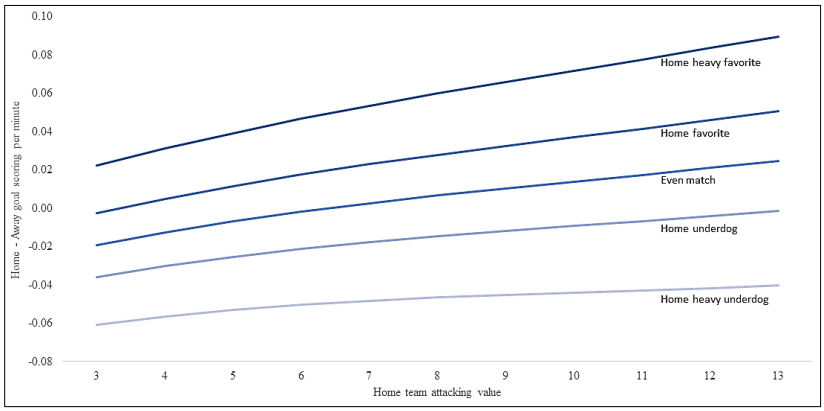


Note. Opposition attacking value is the sum of attack value for each of the opposing team's players on the field where defender = 0, midfielder = 1, forward = 2. The vertical axis shows the probability of the team scoring in the next minute in a tie game between two evenly matched teams with no red cards and no substitutes. The scoring team's attacking value is set to 8, and the average values are assumed for minutes and attendance. Based on Columns 1 and 2 from Table 1.

Figure 3. Team scoring by opposition lineup attacking value.

We can use columns 1 and 2 in Table 1 to determine how the attacking value of a lineup affects the team's own scoring and how it affects the scoring of the opposition. Figure 2 shows how the home and away team lineups affect their own scoring rates per minute. The effect is slightly larger for the home team, but for both home and away teams, having more attacking players on the field means that the team will score at a higher rate.

Figure 3 presents evidence that (in addition to raising the team's own scoring rate) having more attacking players on the field also reduces scoring by the opposition. Again, the effect is larger for the home team, but for both home and away teams, the opposing team scores fewer goals per minute if a team puts more attacking players on the field than if it plays primarily defenders.



Note. Team attacking value is the sum of attack value for each player on the field where defender = 0, midfielder = 1, forward =2. The figure shows a tie game with no red cards and no substitutes. The opposing team's attacking value is set to 8 (the median), and the average values are assumed for minutes and attendance. Heavy team favourites mean the team is at the 95th percentile in the difference between values for the team power indexes. Favourites mean that the team is at the 75thpercentile in the difference between values for the team power indexes.

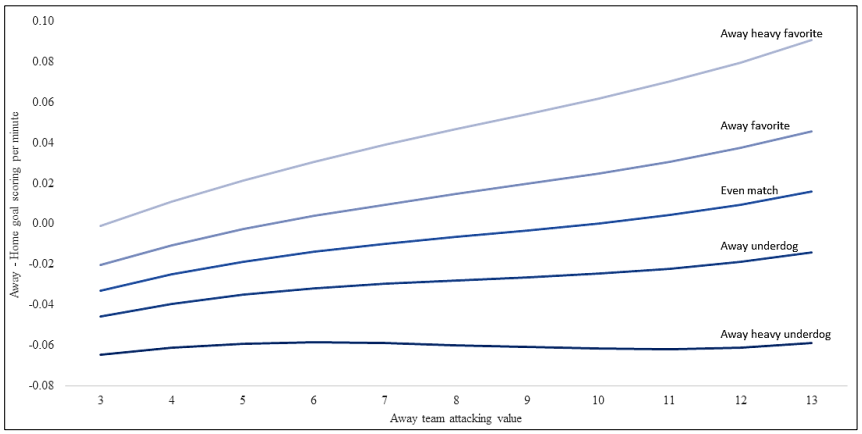
Figure 4. Net goals per minute, home attack value, and relative team strength.

The model investigates this possibility by including interaction terms between the attacking values of each team and a measure of their relative strength. The significant positive coefficient on the home attack – power index interaction term in Column 1 means that the more the home team is the favourite, the bigger the positive impact on home scoring an attacking home lineup has. When the home team is an underdog, putting an attacking lineup on the field has a smaller but still positive impact on home scoring. Figure 4 illustrates how home attack values are related to net goal scoring for five different types of matches: the home team as a heavy favourite, home team as a favourite, an even matchup, away team as a favourite, and away team as a heavy favourite. A heavy favourite is the favoured team when the difference between the two teams' power indexes is at the 95th percentile while a favourite indicates that the difference is at the 75th percentile. An underdog or heavy underdog is the weaker team in those games. As the figure shows, even when the home team is a heavy underdog, it still does better when it plays a more attacking lineup, though the advantage of playing an attacking lineup is largest when the home team is a heavy favourite.

In a game in which the away team is a favourite and both home and away teams have an attacking lineup value of eight, the home team is expected to lose the game by 1.31 goals. If the home team raises the attacking value of its lineup value to nine, it is expected to lose only by 1.06 goals. Thus, raising the attacking value of the lineup leads to an improvement of 0.25 net goals for the home underdog. If the home team is the favourite, however, and it raises the attacking value of its lineup from eight to nine (while the away team

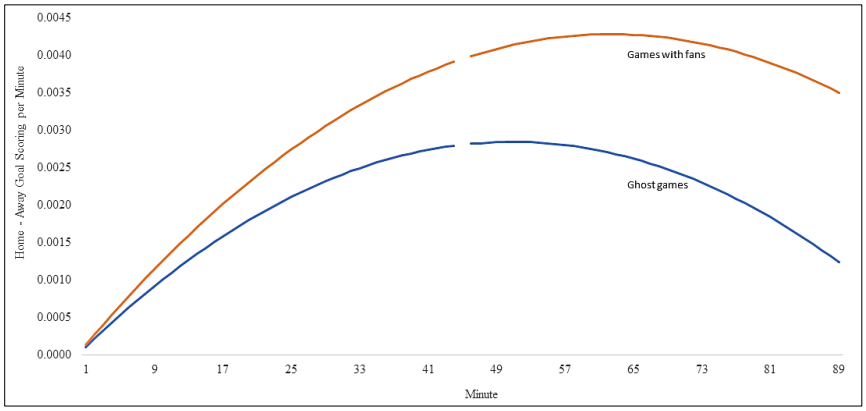
remains at eight), the home team's expected winning margin rises from 2.52 goals to 2.94 goals. The gain in expected winning margin from an increase in the home team lineup's attacking value is thus larger when the home team is the favourite (0.42 goals) than when it is the underdog (0.25 goals).

There are also significant coefficients on the power difference – away team attack value interaction terms in both the home and away scoring regressions. The positive coefficient on this interaction term in the home scoring regression means that if the home team is a heavy enough favourite, having more attacking players on the field for the away team can lead to more goals by the home team. The negative coefficient on this interaction term in the away scoring regressions means that when the home team is a heavy favourite, the away team having more attacking players on the field has a smaller positive impact on away scoring. These results suggest that the away team may want to put out a more defensive lineup if it is a heavy enough underdog.



Note. Team attacking value is the sum of attack value for each player on the field where defender = 0, midfielder = 1, forward = 2. The figure shows a tie game with no red cards and no substitutes. The opposing team's attacking value is set to 8, and the average values are assumed for minutes, attendance. Heavy team favourites mean the team is at roughly the 95111 percentiles in the difference between values for the team power indexes. Favourites mean that the team is at roughly the 75111 percentiles in the difference between values for the team power indexes.

Figure 5. Net goals per minute, away attack value, and relative team strength.



Note. Net goal scoring is the probability of the home team scoring in the next minute minus the probability of the away team scoring in the next minute in a tie game with no red cards and no substitutes. Both teams' attacking values are set to 8. Attendance for games with fans is set to the median value for non-ghost games (25,365). Based on column 3 from Table 1.

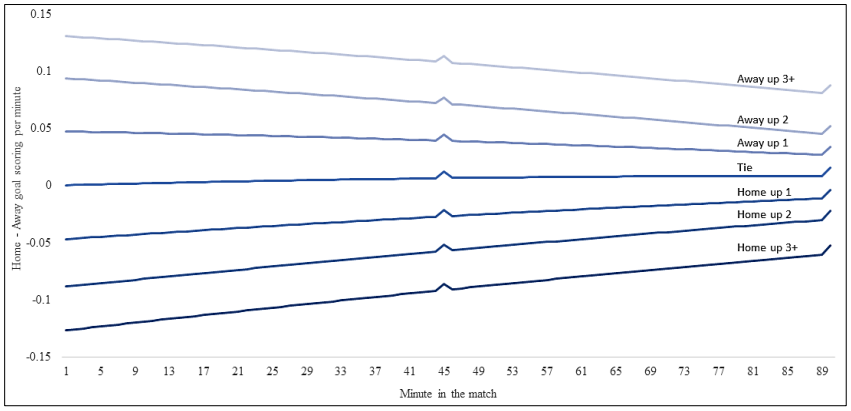
Figure 6. Home — away net goal scoring rate per minute, ghost and fan games.

Figure 5 illustrates the impact of the away team lineup on the away team's net scoring (away goals minus home goals per minute). If the away team is the stronger team, or if it is even close to the home team in quality, the away team should play more attacking players, and the more attacking lineup the better. If the away team is a very heavy underdog, on the other hand, it may be better off sending out a defensive lineup or making defensive substitutions. When the game is at the 95th percentile in terms of the home team's power index advantage over the away team, the away team maximizes its net scoring rate when it has a lineup with an attacking value of six. The most common lineup with this attacking value has five defenders, four midfielders, and one forward.

The results for the control variables are intuitive. As the positive coefficient on minutes and the negative coefficient on minutes squared in the first two columns indicate, both teams' goal scoring rates increase until near the middle of the second half, at which point scoring rates begin to fall. Home goal scoring rises faster over the course of the game if there is a large crowd in the stadium. This result suggests that the size of the crowd has an increasing positive influence on home team scoring as the game approaches its end. The crowd does not significantly affect away scoring rates. Both home and away teams are estimated to be more likely to score in minutes 45 and 90, though the greater stoppage time added at the end of the game means the effect for minute 90 is more than twice as large as the effect for minute 45.

The net goal scoring regression in column 3 shows that in games with many fans in the stadium, the home team has an increasingly large advantage in scoring over the away team as the game progresses. Figure 6 shows the effect of crowds by comparing net goal scoring during each minute of the match during games played during the pandemic when fans were excluded from the stadium (ghost games) to games played with the median attendance level prior to the pandemic. During ghost games, the home team's advantage in scoring rates peaks during minute 51 of the game, at which point the home team is expected to score 0.0028 more goals in a minute than the away team. In the median game with fans, on the other hand, the home team's scoring advantage peaks in minute 62, at which point the home team is expected to score 0.0043 more goals per minute than the away team. The estimates predict that the home team will score 0.19 more goals during the game than the away team if there are no fans in the stadium and 0.29 more goals in a game with the median number of fans. In the average game in the data set, the home team scored 0.34 more goals when there were fans in the stadium. Together, these estimates suggest that about 30% of the scoring advantage received by the home team in a typical game is due to the fans. This estimate falls in between that of two previous studies. Van de Ven (2011) and Ponzo and Scoppa (2018) examined matches between two teams that shared the same stadium but where the designated home team had more fans in the stadium. Van de Ven (2011) concluded that having more fans did not lead to a home advantage in these games. Ponzo and Scoppa (2018), on the other hand, found that the home team retained 60% of the normal home advantage even when the two teams shared the same home stadium, suggesting that most of home advantage is due to crowd support.

Table 1 shows that the score in the match has a large impact on scoring rates, with the team that is behind more likely to score than the team that is ahead (all else equal). Compared to being tied, the home team's expected goal scoring in a minute early in the match falls by 0.04 if it is ahead by 1 goal, falls by 0.08 if it is ahead by two goals, and falls by 0.11 if it is ahead by three goals. Home scoring rises by 0.01, on the other hand, if it is behind. For the away team, scoring early in the match falls by 0.04, 0.08, and 0.12 respectively if it is ahead by one, two, and three or more goals. Away team scoring rises by 0.01, 0.01, or 0.02 if it is behind by one, two, or three or more goals rather than being tied. Interestingly, for both teams there is a much larger drop in scoring when the team takes a lead than there is a rise in scoring when it falls behind.



Note. Net goal scoring is the probability of the home team scoring in the next minute minus the probability of the away team scoring in the next minute. The values are estimated based on column 3 from Table 1 assuming a game with no red cards, no substitutes, and with both teams' attacking values set to 8. Attendance for games with fans is set to the median value for non-ghost games (25,365). Homel, Home2, and Home3 (Away, Away2 and Away3) indicate that the home team (away team) is ahead by 1 goal, two goals, three or more goals respectively.

Figure 7. Net goal scoring rates, game score, and minute.

The effect of the game score on the home team's net advantage in scoring rates depends on the minute of the match. The models include interaction terms between minute and the game score dummy variables, and the coefficients on these interaction terms are significant in Column three at the 1% level, both individually and collectively. Figure 7 shows how the model's predicted net scoring rates during each minute depend on the game score. The game score has a very large impact on scoring rates early in the match, but as the match approaches the end, the effect of the game score diminishes. At all points in the game, the team that is behind has a net scoring advantage over the team that is ahead.

In games that are tied, the home team and the away team begin the game with almost exactly equal chances of scoring in a typical game between equally matched teams. By the end of the game, however, the home team's scoring advantage is considerable. If the home team's scoring advantage in minute one was maintained over the full 90 minutes, the home team would win on average by 0.02 goals. The home team's scoring advantage in minute 89, if extended over the full game, would mean a home win of 0.74 goals.

Column one in Table 1 shows that each extra substitution made by the home team significantly raises home scoring rates while away team substitutions reduce home scoring. Neither home nor away substitutions significantly affect scoring by the away team, as column two shows, though the signs of the coefficients are consistent with a rise in away scoring when the away team makes substitutions and a fall in away scoring with home team substitutions[3].

Column three shows that home substitutions have a significant positive impact on the home team's net scoring rate while away team substitutions significantly reduce the home team's scoring advantage. The result that home scoring rises with home team substitutions and falls with away team scoring is similar to the conclusion of Amez et al (2021), who found that substitutions reduce scoring by the opposing team and the first two substitutions raise the team's own scoring. Unlike this paper, however, Amez et al. (2021) also found that away team scoring rises with the first two away substitutions and falls with all home substitutions.

[3]*Later substitutions do not have a significantly different impact on scoring rates than earlier substitutions do in the data set.*

DISCUSSION

The results described above provide clear evidence on each of the three hypotheses tested in this paper. As Figure 2 shows, there is strong evidence in support of Hypothesis 1. Having more attacking players on the field means that the team will score at a higher rate. While this result is hardly surprising, it supports what coaches expect about their substitutions. In the survey by Wittkugel (2022), 93% of coaches responded that bringing on more attacking players would result in a higher scoring probability.

The more interesting results relate to Hypothesis 2, that the likelihood of conceding a goal would be higher with more attacking players on the field. Professional coaches have somewhat mixed views on this question. In the survey by Wittkugel (2022), only 41% of managers responded that an offensive substitution would increase the chance of conceding but 71% of managers felt that a defensive substitution would reduce the chance of conceding. The estimates strongly refute the idea that bringing on more attacking players and substituting out defensive players will increase a team's rate of conceding goals. As Figure 3 shows, when the two teams on the field are relatively equal, having more attacking players on the field actually reduces scoring by the opposition. The strategy of "*parking the bus*," or playing many defensive players to stop the other team from scoring, is not only not successful but is actively harmful. Teams are more successful at preventing the other team from scoring during the minutes that they have more attacking players on the field than they are during minutes when they primarily have defenders on the field. One potential explanation could be that attacking players force the opposing team to keep their players in more defensive positions on the field, which reduces their goal scoring. Another explanation might be that teams with more attacking players can control the ball better than teams that are playing more defenders. Managers in recent years have begun increasingly prioritizing possession of the ball, not only because it raises the chance of scoring, but also because it reduces the chance of conceding. The estimates in this paper show that playing an attacking lineup can be an effective way of defending, either through ball possession or by posing a threat to the opponent's goal.

With more attacking players raising the probability of scoring and reducing the probability of conceding, teams clearly have better net scoring rates with more attacking players in evenly matched games. Perhaps, however, the advantages of attacking players are asymmetrical, and weaker teams should be more defensive in their lineups, as Hypothesis 3 proposes. Managers seem to believe this hypothesis, as they play more defensive lineups on average when they are the underdogs. The estimates in this paper provide evidence that stronger teams get a larger benefit from including attacking players than weaker teams do. Even the weaker team in a matchup, however, is better off playing more attacking players in the vast majority of situations. The estimates from Table 1 show that the away team's net scoring improves if it changes its lineup to become slightly more attacking in over 91% of the minutes played between 2017 and 2021. The away team is better off making substitutions to become more defensive in only 9% of the minutes. Magee (2025) shows that managers become more defensive in their substitutions when they are playing an away game in a stadium with a large crowd. The estimates in this paper suggest that shifting the lineup to be more defensive is a mistake over 90% of the time.

How should we evaluate Hypothesis 3, then? It is true, consistent with the hypothesis, that teams who are favourites get more of an advantage (than underdogs do) from playing an attacking lineup. Even underdogs, however, benefit from playing a more attacking lineup in the vast majority of cases. Only away teams who are far inferior to their opponents should consider shifting their lineups to be more defensive. Hypothesis 3 would thus be a more accurate reflection of reality in professional football leagues if it was revised to say that

favoured teams are better off playing more attacking players while heavy underdogs away from home are occasionally better off playing more defenders.

CONCLUSIONS

This paper estimates how the number of attacking players on the field affects scoring rates for teams in the top five European football leagues. The paper evaluates three hypotheses. Not surprisingly, there is strong evidence in favour of the hypothesis that having more attacking players on the field increases the likelihood that a team scores a goal. Perhaps somewhat surprisingly, however, teams also concede fewer goals in the vast majority of matches if they have a more attacking lineup. Thus, teams almost always do better when they shift their lineups to become more attacking. The only exception to this conclusion is for teams that are playing away from home and that are at a huge disadvantage relative to their opponent in terms of team quality. In those cases, a relatively defensive lineup of five defenders, four midfielders, and one forward minimizes the expected loss in the match. Such cases are rare, however. Based on the estimates in this paper, the away manager is better off replacing a defensive player with a more attacking one over 91% of the time.

Are managers being overly defensive in their lineups, then? The estimates in this paper suggest that they have been. It would not be the first time that conservative decisions by coaches reduced their team's chances of winning. Analytics long suggested that coaches in American football should go for it on fourth down much more often than they did in games. Yam and Lopez (2019) estimate that a better fourth down strategy would have gained teams an average of 0.4 extra wins per year in the National Football League between 2004 and 2016. Only in the last few years have coaches in American football shifted their decision making to be more attack-minded on fourth downs. This paper argues that a similar revolution toward attacking play should happen among managers in European football leagues.

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