I Z A Institute
of Labor Economics
Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 11722

Player Dismissal and Full Time Results in the UEFA Champions League and Europa League

Arne De Meyere
Ward Vanruymbeke
Stijn Baert

AUGUST 2018

I Z A Institute
of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 11722

Player Dismissal and Full Time Results in the UEFA Champions League and Europa League

Arne De Meyere
Ghent University

Ward Vanruymbeke
Ghent University

Stijn Baert
Ghent University, Research Foundation – Flanders, University of Antwerp, Université catholique de Louvain, IZA, and IMISCOE

AUGUST 2018

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Player Dismissal and Full Time Results in the UEFA Champions League and Europa League

This study is the first to estimate the effects of the sending-off of a player on the full time results in international club soccer. To this end, we analyse data of more than 2,000 recent games in the UEFA Champions League and UEFA Europa League. We find that when home teams receive a red card, it harms their goal scoring and victory probabilities. By contrast, a red card for away teams can have a positive, negative, or neutral effect for them, depending on the timing of the player dismissal.

JEL Classification: L83, J44, Z00

Keywords: soccer, red card, player dismissal, performance, fixed effects regressions

Corresponding author:
Stijn Baert
Ghent University
Sint-Pietersplein 6
B-9000 Ghent
Belgium
E-mail: Stijn.Baert@UGent.be

1 Introduction

In the summer of 2017, Neymar Jr. left his soccer club Barcelona FC for Paris Saint-Germain, which paid 222 million euro for the young Brazilian winger (Lowe, 2017). Rumours are circulating that this transfer record will not last long. Clearly, soccer has become more than a sport game—it has become big business (Baert & Amez, 2018; Lowe, 2017). Therefore, not surprisingly, the investigation of determinants of soccer game outcomes has received increasing attention, including in peer-reviewed literature. More concretely, some factors found to be accountable for soccer game outcomes are referee bias (Buraimo, Forrest, & Simmons, 2010; Dohmen, 2008; Reilly & Witt, 2013), shirt colour (Attril, Gresty, Hill, & Barton, 2008; Garcia-Rubio, Picazo-Tadeo, & Gonzalez-Gomez, 2011), playing as home or away team (Carron, Loughead, & Bray, 2005; Garicano, Palacios-Huerta, & Pendergast, 2005; Torgler, 2004; Van Damme & Baert, 2018), and whether a red card is issued (Bar-Eli, Tenenbaum, & Geister, 2006; Caliendo & Radic, 2006; Červený, van Ours, & van Tuijl, 2016; Chowdhury, 2015; Mechtel, Stribeck, Brändle, & Vetter, 2011; Ridder, Cramer, & Hopstaken, 1994). This study contributes to the literature on the latter determinant of soccer game outcomes.

To ensure fair play, referees of soccer games have the power to hand out yellow and red cards (Dunmore, 2011; FIFA, 2017). An unfair act by a player is called a foul, and as punishment, a free kick is given to the opposing team. A misconduct is a more serious foul, punished by a disciplinary sanction; a card is issued. The referee has the choice between giving the player a caution (yellow card) and dismissing him from

the field (red card). Giving two yellow cards to the same player also results in a red card. A player who gets a red card cannot be replaced; hence, red cards are potential game changers.

Although several studies evaluated the effect of a red card on the final result of a soccer game, they did not converge to a single conclusion. On the one hand, based on data for the Dutch, German, and English national competitions, Ridder et al. (1994), Bar-Eli et al. (2006), and Chowdhury (2015) reported that, on average, a red card harms the full time results for both home and away teams. The same pattern was found based on World Cup data by Caliendo and Radic (2006) and Červený et al. (2016). Thus, all these studies contrast with the famous 'ten do it better' soccer myth (Caliendo & Radic, 2006). On the other hand, Mechtel et al. (2011) found no overall effect of a red card for away teams in their large dataset comprised of games from the German national league.

In this article, we are the first to estimate the effects of the sending-off of a player on the full time results in international club soccer. To this end, we analyse data of more than 2,000 recent games in the Union of European Football Associations (UEFA) Champions League and UEFA Europa League. Since we allow the effects of a red card to be heterogeneous by the home or away status of the team and by the moment of receiving the red card, we are able to answer the following research questions.

R1a. What is the effect of the issuing of a red card for the home team on full time results in European international club soccer?

R1b. What is the effect of the issuing of a red card for the away team on full time results in European international club soccer?

R2a. Is the effect of a red card for the home team on full time results in European international club soccer heterogeneous by the timing of this red card?

R2b. Is the effect of a red card for the away team on full time results in European international club soccer heterogeneous by the timing of this red card?

In addition to its aforementioned substantive contribution, this study is innovative based on two methodological aspects. First, our dataset is substantially larger than those analysed in most former studies in this literature, so we have more statistical power to distinguish between zero and significantly positive or negative effects. Second, the effects presented in former contributions might be biased because they do not control for the fact that when a team gets a red card, this event goes often hand-in-hand with a penalty for its opponent. We account for this in one of our several robustness checks.

2 Methods

2.1 Data

We analysed data on recent soccer games in the two most prestigious international club soccer competitions worldwide—measured by the prize and television money at stake (UEFA, 2017)—i.e. the UEFA Champions League and the UEFA Europa League. These two competitions are contested by top-division European club teams.

The number of teams from each country that enters these competitions is based on the performance of the clubs from this country in previous editions of both leagues. The teams that finished in the highest positions in the previous season of each country's (domestic) highest division league are eligible for the (qualification rounds of the) UEFA Champions League. The teams that finished next in line are eligible for the (qualification rounds of the) UEFA Europa League. Both the UEFA Champions League and the UEFA Europa League are comprised of two phases: the group phase (contested from September until December) and the knockout phase (from February until May). The group phase is played by 32 teams in the UEFA Champions League and 48 teams in the UEFA Europa League. All groups comprise four teams. Each team meets the other teams of its group twice, once as a home team and once as an away team. The group winners and runners-up proceed to the knockout phase of the competition. In addition, the third place team in the group phase of the UEFA Champions League participates in the knockout phase of the UEFA Europa League. During the latter phase, teams meet each other in one home and one away game, after which the team with the positive goal difference over these two games advances to the following round. This phase ends with a final game that is played at a neutral ground. To obtain additional insight into the complete structure of these championships, we refer to the official UEFA website (http://www.uefa.com).

Game reports of both competitions are publicly available on the official website of the UEFA (http://www.uefa.com). In one edition of the UEFA Champions League and UEFA Europa League, 125 and 205 official soccer games, respectively, are played

in the two phases of these competitions. Our analyses are based on the game reports for all 1,000 games in the UEFA Champions League from season 2008–2009 until season 2015–2016 and 1,023 of the 1,025 games in the UEFA Europa League from season 2011–2012 until season 2015–2016. For two games in the UEFA Europa League, the game reports were not available at the moment of our data processing. The game reports of the UEFA Europa League before soccer season 2011–2012 were not considered because the UEFA Europa League employed a different tournament structure before that season.

Table 1 describes the game characteristics used in our analyses conducted to answer R1a, R1b, R2a, and R2b. The dependent variables used in these analyses are presented in Panel A, the independent variables in Panel B, and the control variables in Panel C. We present summary statistics both at the level of the full dataset and at the level of two subsets of games (i.e. games with a red card for the home team and games with a red card for the away team).

<Table 1 about here>

Our independent variables all relate to the issuing of red cards for the home and away teams. In 375 (i.e. 18.5%) of the included 2,023 games at least one red card is issued. In line with the literature, we consider the first red card only. So, in what follows, when we refer to 'a red card', we actually refer to 'a first red card'. However, as a sensitivity analysis discussed in Section 3.3, we test the robustness of our results after excluding the 47 games in which more than one player is dismissed.

A (first) red card is issued to the home team in 132 (i.e. 6.5%) of the analysed games and to the away team in 243 (i.e. 12.0%) of these games. To answer R2a and R2b, we also included interactions between the issuing of a red card and the remaining time at that moment. First, an interaction with a continuous indicator is included. This continuous indicator is the number of minutes of remaining regular time, ranging from 0 (when the red card is issued in minute 90 or later) to 89 (when the red card is issued in minute 1). When a home team receives a red card, on average, the home team has to play 25.848 minutes while one man down. Similarly, when an away team gets a red card, on average, the away team has to play 25.584 minutes while missing one player. Second, because the overall median remaining time at the issuing of a red card is approximately 20 minutes, we include interactions with indicator variables capturing whether a team has to play more than 20 minutes while one man down (versus 20 minutes or less). For the home team (away team), this occurs in 55.3% (47.3%) of the cases with a red card for this team. Third, also interactions with three (instead of two) different time intervals with respect to the remaining time at the issuing of a red card were added: (i) less than or equal to 10 minutes, (ii) between 10 and 30 minutes, and (iii) more than 30 minutes—as can be seen from Table 1, the issuing of red cards is quite equally divided between these three time windows.

In line with Mechtel et al. (2011), Červený et al. (2016), and Baert and Amez (2018), we used the goal difference at full time as our benchmark dependent variable. This variable is defined as the difference at full time between the number

of goals scored by the home team and the number of goals scored by the away team. The average value of this goal difference found in the full dataset is 0.406. This substantially positive number is consistent with the home advantage in soccer established in Carron et al. (2005), Garicano et al. (2005), Torgler (2004), and Van Damme and Baert (2018). The summary statistics for the other four dependent variables point in the same direction: the probability of victory for the home team equals 47.1%, whereas the probability of victory for the away team equals 28.8%. The final number of goals by the home team is on average 1.549, which is, again, substantially higher than the average number of goals by the away team at 1.142.

For the subdataset that contains only soccer games in which the home team received a red card, we find a negative average goal difference at full time (-0.333). In addition, the probability of a victory by the home (away) team and the final number of goals by the home (away) team are substantially lower (higher) within this subdataset compared to the numbers for the total dataset. By contrast, for the subdataset containing only games in which the away team got a red card, more favourable (adverse) outcomes for the home (away) team are found. These numbers are in line with the majority of former contributions to the literature on the effects of red cards in soccer that found a negative impact for both home and away teams. However, this descriptive analysis does not consider the endogeneity of receiving a red card with respect to full time results. That is, receiving a red card may correlate with other determinants of performance in soccer (e.g., relative ranking). The regression approach we discuss in the next subsection addresses this problem by

controlling for a large set of game characteristics.

The majority of our control variables are predetermined before the start of the game. Most importantly, to be able to control for the relative strength of the home and away teams, we merged, by analogy with Baert and Amez (2018), the available game reports with information on the UEFA coefficient of the home and away teams (for our time window of seasons). The UEFA coefficient of a team is based on its participation and results in the five previous editions of the UEFA Champions League and the UEFA Europa League. The concrete proxy of the relative strength used in the present study was calculated by taking the natural logarithm of the quotient of the UEFA coefficient of the home team plus 1 and the UEFA coefficient of the away team plus 1 for the relevant season—1 is added to the coefficients in the numerator and denominator to avoid division by 0. In addition, we created variables capturing the sort of game played: (i) an indicator of games in the UEFA Europa League and (ii) four indicators of whether the soccer game was a game in the group phase, a first leg game in the knockout phase, a second leg game in the knockout phase, or a final game. The first of these four variables is used as a reference category in our regressions. A last control variable that is predetermined at the start of the game is the goal difference after the first leg knockout game in case the analysed game is a second leg knockout game (and 0 otherwise).

The other variables in Panel C of Table 1 were added to our data to control for a particular concern with respect to the endogeneity of our independent variables. When a team is underperforming, this may, due to frustration or the need to commit

a misconduct to brake the opponent's offensive actions, result in a red card for this team as well as in an unfavourable goal difference at the moment of that red card. Thus, it is important to control for this goal difference at the issuing of a red card. However, as mentioned in Mechtel et al. (2011), including this standing as one continuous number is not advisable because it would impose the assumption that the goal difference at the issuing of a dismissal has the same impact on the game's outcomes at full time irrespective of whether this dismissal happened early or late in the game. Therefore, in line with Mechtel et al. (2011), we included five additional interaction variables to our dataset that equal 0 in case there was no red card (for the team under review) in the time interval and equal the goal difference in case the team got a red card in this interval: (i) goal difference at issuing of red card between minute 1 and minute 30, (ii) goal difference at issuing of red card between minute 31 and half time, (iii) goal difference at issuing of red card between half time and minute 60, (iv) goal difference at issuing of red card between minute 61 and minute 75, and (v) goal difference at issuing of red card between minute 76 and full time.

2.2 The econometric model

To answer R1a, R1b, R2a, and R2b, the data presented in Section 2.1 were analysed by fixed effects regression models that can, by analogy with Baert and Amez (2018), be abstracted by using the following general equation:

$$Y_{ijn} = \alpha + \boldsymbol{\beta X_{ijn}} + \boldsymbol{\gamma Z_{ijn}} + \mu_i + \nu_j + \varepsilon_{ijn}$$

In this equation, Y_{ijn} represents the dependent variable: one of the full time

outcomes mentioned in Panel A of Table 1, with respect to the *n*th game between home team *i* and away team *j*. $\boldsymbol{X_{ijn}}$ is a vector of two or more independent variables, related to red cards for the home and away teams (as included in Panel B of Table 1), of which we want to know the impact with respect to the dependent variable. $\boldsymbol{Z_{ijn}}$ is a subset of the control variables mentioned in Panel C of Table 1. $\boldsymbol{\alpha}$ is the intercept of the model, $\boldsymbol{\beta}$ is a vector of coefficients related to $\boldsymbol{X_{ijn}}$, and $\boldsymbol{\gamma}$ is a vector of coefficients associated with $\boldsymbol{Z_{ijn}}$. ε_{ijn} is the error term, which was White-corrected given the discrete distributions of our dependent variables.

Finally, μ_i (ν_j) is a home (away) team fixed effect. By introducing these fixed effects, we estimate the effect of receiving a red card on the results at full time within teams. As a result, all dimensions of unobserved, time-constant team heterogeneity that may determine the final outcomes of the analysed soccer games and that may correlate with receiving a red card are controlled. Nevertheless, the effect of a red card in these fixed effects models is exclusively identified based on the observation that in at least one game, this team or its competitor received a red card and one game in which this was not the case. This results in a lower statistical power.

3 Results

In this section, we present our regression results. R1a and R1b are answered in Section 3.1, which discusses Tables 2 and 3. R2a and R2b are answered in Section 3.2, which discusses Table 4. Finally, in Section 3.3, we elaborate on further

robustness checks we conducted.

3.1 Benchmark model

Table 2 presents the results of regressing the goal difference at full time on indicators of receiving a red card as home or away team and various sets of control variables. In model (1), no control variables are included. Starting from model (2), all game characteristics mentioned in Section 2.1 are added except the relative strength of the teams, which is included from model (3) onward. Starting from model (4), the fixed effects for the home and away teams discussed in Section 2.2 are introduced. In model (5), which is our benchmark model, we include the variables capturing the goal difference at the issuing of a red card at different time windows (as defined in Section 2.1).

<Table 2 about here>

We notice a highly significantly negative effect of receiving a red card by the home team on the goal difference at full time in model (1) to model (5). The magnitude of this effect is fairly stable across these models. The coefficient estimated in model (5) is -0.696 (p = 0.000), indicating that when a home team receives a red card during the game, the goal difference at full time is about seven tenths of a goal lower. We return to the heterogeneity in this effect by the timing of the issuing of a red card in Section 3.2.

By contrast, the effect of the away team receiving a red card on the same dependent variable is significantly positive—which implies an adverse effect from

the perspective of the away team given the definition of the goal difference at full time—only for models (1) to (4). In model (4), the related coefficient is 0.370 (p = 0.002). Thus, without controlling for the goal difference at the issuing of a red card, our coefficient estimate is in line with the aforementioned studies finding that, overall, red cards also harm for away teams. However, when adding the controls for the standing at the issuing of a red card, this coefficient becomes insignificant both in economic and statistical terms, i.e. it decreases to 0.107 (p = 0.288). So, adding these controls turns out to be important.

As a first robustness check, in model (6) we re-estimate model (5) after exclusion of the games in which the red card is immediately followed by a penalty. As mentioned in Section 1, this is done to rule out that the estimated effects of player dismissal are driven by red cards often going hand-in-hand with a penalty for the opponent. Indeed, in 46 of the 375 games with a red card, the player dismissal is followed directly by a penalty. Excluding these games from the sample results in a small decrease of the (magnitude of the) effect of a red card for the home team on the goal difference at full time (i.e. from -0.696 to -0.660). Still, however, this negative impact is highly significant (p = 0.000). In addition, after excluding these games, the effect of a red card for the away team is virtually zero (i.e. 0.023; p = 0.820).

Table 3 presents the results of regression analyses in which the alternative dependent variables discussed in Section 2.1 are used. For all the models in Table 3, the independent and control variables are the same as those included in model (5)

of Table 2. The results confirm to a large extent the findings reported for our benchmark model. First, the harming effect of a red card for home teams is found for all models in Table 3. A red card for home teams decreases their probability to win the game by 18.8 percentage points (p = 0.000) and increases the corresponding probability for their opponents by 15.0 percentage points (p = 0.000). In addition, home teams that receive a red card score, on average, 0.298 goals less (p = 0.002) and concede, on average, 0.399 goals more (p = 0.000) than similar teams not being issued a red card. Second, in line with model (5) of Table 2, the effects of receiving a red card for the away team are insignificant in three of the four models of which the results are presented in Table 3. Model (1) of Table 3 is an exception in this respect. Indeed, it is found that a red card for the away team has a weakly significantly positive impact on the probability of a victory by the home team (p = 0.075). However, as this exception to the overall pattern of overall insignificant effects of a red card for away teams does not remain when games in which a red card is followed by a penalty are excluded—the corresponding coefficient is then 0.037 (p = 0.300)—we tend to interpret this finding as a statistical artefact.

<Table 3 about here>

In sum, we conclude with respect to R1a and R1b that red cards are seriously harming full time results for home teams whereas we do not find evidence for substantial effects of red cards received by away teams.

3.2 Heterogeneity by the timing of a red card

To answer R2a and R2b, we extend our benchmark model by adopting interactions between receiving a red card and the remaining regular time. More concretely, in model (1) of Table 4, interactions with the continuous indicator of remaining time are added. This indicator, when interacted with a red card for the home and away teams, is normalised by subtracting its mean value in the subdatasets of games with a red card for home and away teams, respectively. This is done to ensure comparability of the overall effect of receiving a red card between model (1) of Table 4 and the results in Table 2. In models (2) and (3) the overall effect of a red card for home and away teams is broken down by the time interval in which it is received.

<Table 4 about here>

The results of model (1) of Table 4 show that red cards are more harming full time results when they are issued earlier in the game. The goal difference at full time decreases by 0.017 goals (p = 0.002) for each additional minute of regular time after a red card is issued to the home team and it increases by 0.013 goals (p = 0.002) for each additional minute after a player of the away team is dismissed.

In addition, the results of model (2) and model (3) indicate that irrespective of the time window in which a home team receives a red card, it always has a disadvantage in terms of the goal difference at full time for them. According to model (2), a red card for the home team decreases the goal difference at full time by 0.967 goals (p = 0.000) when this card is received before minute 71 and by 0.352

goals (p = 0.030) when it is received in minute 71 or later. As can be seen from the p-values mentioned in the lower rows of Table 4, these two coefficients are highly significantly different.

By contrast, a red card for the away team does not seem to harm this team's full time results when this card is issued after minute 60. We even find a weakly significantly negative effect of a late red card issued to them on the goal difference. More concretely, when an away team receives a red card later than minute 80, the goal difference is 0.235 goals more to the advantage of this team (p = 0.055). On the other hand, when a red card is issued to the away team before minute 61, the goal difference is 0.466 goals more to their disadvantage (p = 0.009).

In sum, we conclude with respect to R2a and R2b that the effect of a red card in European international club soccer is, indeed, heterogeneous by the timing of this red card. For both home and away teams, player dismissal is less harming their full time results when it occurs later in the game. However, whereas a red card for home teams has a detrimental impact on their full time results no matter in which period of the game the card is received, a red card for away teams can have a positive, negative, or neutral effect for them, depending on the timing of the player dismissal.

3.3 Further robustness checks

To further test the robustness of the results in the previous subsections, we conducted additional analyses, the results of which are available on request. First, we redid the analyses reported in Table 4 using the alternative dependent variables.

This did not yield different answers with respect to R2a and R2b than those reported in Section 3.2.

Second, not all of the 2,023 games in our data had a substantial competitive value. Following Baert and Amez (2018), games in the group phase have no substantial competitive value if for one of the teams it is mathematically impossible to change its qualification status for the next round. This is the case if a team is sure it will finish within the group phase (i) as winner or runner-up (in the UEFA Champions League or UEFA Europa League), (ii) in third place in its group in the UEFA Champions League, (iii) in fourth place in its group in the UEFA Champions League, or (iv) in third or lower place in its group in the UEFA Europa League. After removing the games without a substantial competitive value, we ended up with a dataset consisting of 1,727 European soccer games with a substantial competitive value. However, our answers to R1a, R1b, R2a, and R2b based on this restricted dataset were the same as those based on the full dataset. The same is true when we excluded the 47 games in which more than one red card was issued (see Section 2.1).

Third, for all analyses discussed in this article, we also ran the corresponding (ordered) logistic regressions, yielding similar conclusions as those based on linear (probability) models. However, in the end, we opted to present linear models, given that (i) four of our five dependent variables are continuous, (ii) the good performance of the linear probability model with White-corrected standard errors for binary dependent variables (Angrist & Pischke, 2008; Baert & Amez, 2018), and

(iii) the potential incidental parameters problem when combining logistic regression models with fixed effects (Greene, 2004).

4 Conclusion

We analysed the effects of receiving a red card on full time results in 2,023 recent games in the UEFA Champions League and UEFA Europa League. We found that when a home team receives a red card, the goal difference at full time (in favour of this team) decreases by approximately 0.660 goals. In addition, receiving a red card for the home team lowers its probability of a victory by 18.8 percentage points. In contrast, as soon as we control for the goal difference at the issuing of a red card, the average effect of receiving a red card for away teams is close to zero. For both home and away teams, the effect of receiving a red card is more adverse when it is received early in the game. For an away team, the impact of receiving a red card can even be beneficial when it is received at the end of the game.

The heterogeneity in the effects of a red card by the timing of receiving the card is consistent with what Caliendo and Radic (2006) and Červený et al. (2016) reported based on World Cup data, in which there are no genuine home and away teams. Therefore, it is not surprising that they found a neutral effect of late red cards for teams at the World Cup, holding the middle between the adverse effect of receiving a late red card for home teams and its beneficial impact for away teams reported in our study.

Overall, our results are particularly in line with Mechtel et al. (2011) in the sense that theirs was the only study to date providing evidence for larger effects of receiving a red card for home teams (compared to away teams). This similarity in results might be explained by the fact that our sample size and statistical framework are more akin to each other than to the other studies not reporting evidence for this dimension of heterogeneity. The explanation for this greater adverse effect of receiving a red card for home teams in Mechtel et al. (2011) is that the tasks of home teams are more complex than those of away teams given their usually more offensive playing style—this might be related to the expectations of their home audience as discussed in Baert and Amez (2018). Due to this higher task complexity, the adjustment of the play to a player dismissal might be greater for home teams. In contrast, for away teams, a motivational aspect might be dominant. That is, in line with the aforementioned soccer myth that 'ten do it better', higher effort levels and better team spirit might be induced after receiving a red card (Caliendo & Radic, 2006; Mechtel et al., 2011). Whether these are indeed the mechanisms driving the estimated effects of receiving a red card in the UEFA Champions League and UEFA Europa League could be the subject of future qualitative research.

We end this study by acknowledging its main limitation. In several aspects, we took a step forward in measuring the unbiased effect of player dismissal on full time results in European international club soccer. In particular, we had greater statistical power to reject zero effects than most former studies on the effects of red cards given the size of our dataset. Moreover, we showed that the presented effects of

player dismissal are not driven by red cards being correlated with a penalty for the team of the dismissed player's opponent. Yet, the coefficient estimates in this article can only be given a causal interpretation under the assumption that the endogeneity problem discussed in this article is solved by our regression strategy. If receiving a red card is (i) correlated with game characteristics up to the issuing of the red card not being captured by the goal difference at the moment of the red card that (ii) affect the results at full time, this assumption does not hold. Therefore, we are in favour of future empirical work that exploits other statistical frameworks (e.g., the one presented in Caliendo (2006) or that used by Červený et al. (2016)) to further investigate how the effects of receiving a red card are heterogeneous by the home status of the team and by the remaining time at the issuing of the red card.

References

Angrist, J. D., & Pischke, J. S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton: Princeton University Press.

Attril, M. J., Gresty, K. A., Hill, R. A., & Barton, R. A. (2008). Red shirt colour is associated with long-term team success in English football. *Journal of Sports Sciences*, *26*, 577–582.

Baert, S., & Amez, S. (2018). No better moment to score a goal than just before half time? A soccer myth statistically tested. *PLOS ONE, 13*, e0194255.

Bar-Eli, M., Tenenbaum, G., & Geister, S. (2006). Consequences of players' dismissal

in professional soccer: A crisis-related analysis of group-size effects. *Journal of Sports Sciences*, *24*, 1083–1094.

Buraimo, B., Forrest, D., Simmons, R. (2010). The 12th man? Refereeing bias in English and German soccer. *Journal of the Royal Statistical Society: Series A*, *173*, 279–468.

Caliendo, M., & Radic, D. (2006). *Ten do it better, do they? An empirical analysis of an old football myth.* IZA Discussion Papers, 2158.

Carron, A. V., Loughead, T. M., & Bray, S. R. (2005). The home advantage in sport competitions: Courneya and Carron's (1992) conceptual framework a decade later. *Journal of Sports Sciences*, *23*, 395–407.

Červený, J., van Ours, J., & van Tuijl, M. (2016). *Effects of a red card on goal-scoring in World Cup football matches*. CentER Discussion Papers, 2016-031.

Chowdhury, A. (2015). *Can ten do it better? Impact of red card in the English Premier League*. Marquette University Department of Economics Working Paper Series, 2015-01.

Dohmen, T. J. (2008). The influence of social forces: Evidence from the behaviour of football referees. *Journal of Economic Inquiry*, *46*, 411–424.

Dunmore, T. (2011). *Historical Dictionary of Soccer*. Lanham: Scarecrow Press.

FIFA (2017). *Laws of the game 2016/2017*. Zurich: FIFA.

Garcia-Rubio, M. A., Picazo-Tadeo, A. J., & Gonzalez-Gomez, F. (2011). Does a red shirt improve sporting performance? Evidence from Spanish football. *Applied Economics Letters*, *18*, 1001–1004.

Garicano, L., Palacios-Huerta, I. I., & Prendergast, C. (2005). Favoritism under social pressure. *Review of Economics and Statistics*, *87*, 208–216.

Greene, W. (2004). The behaviour of the maximum likelihood estimator of limited dependent variable models in the presence of fixed effects. *Econometrics Journal*, *7*, 98–119.

Lowe, S. (2017). Neymar to PSG: How money and Lionel Messi led to the sale of the century. Retrieved from https://www.theguardian.com/football/blog/2017/aug/02/neymar-psg-barcelona-lionel-messi.

Mechtel, M., Brändle, T., Bäker, A., & Vetter, K. (2011). Red cards: Not such bad news for penalized guest teams. *Journal of Sports Economics*, *12*, 621–646.

Reilly, B., & Witt, R. (2013). Red cards, referee home bias and social pressure: Evidence from English Premiership Soccer. *Applied Economics Letters*, *20*, 710–714.

Ridder, G., Cramer, J. S., & Hopstaken, P. (1994). Down to ten: Estimating the effect of a red card in soccer. *Journal of the American Statistical Association*, *89*, 1124–1127.

Torgler, B. (2004). The economics of the FIFA football World Cup. *Kyklos*, *57*, 287–

300.

UEFA (2017). 2017/18 UEFA Champions League revenue distribution. Retrieved from https://www.uefa.com/uefachampionsleague/news/newsid=2493261.html.

Van Damme, N., & Baert, S. (2018). *Home advantage in European international soccer: Which dimension of distance matters?* Mimeo.

Table 1. Data: Summary Statistics

	All games (N = 2,023)		Games with red card for home team (N = 132)		Games with red card for away team (N = 243)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
A. Dependent variables						
Goal difference at full time	0.406	1.867	-0.333	1.790	0.869	1.732
Victory by home team	0.471	-	0.280	-	0.605	-
Victory by away team	0.288	-	0.462	-	0.181	-
Final number of goals by home team	1.549	1.326	1.201	1.215	1.790	1.366
Final number of goals by away team	1.142	1.147	1.538	1.201	0.922	0.991
B. Independent variables						
Red card home team	0.065	-	1.000	-	0.000	-
Red card home team × #minutes remaining	1.687	8.350	25.848	21.137	0.000	-
Red card home team × remaining time less than or equal to 20 minutes	0.029	-	0.447	-	0.000	-
Red card home team × remaining time more than 20 minutes	0.036	-	0.553	-	0.000	-
Red card home team × remaining time less than or equal to 10 minutes	0.018	-	0.280	-	0.000	-
Red card home team × remaining time between 10 and 30 minutes	0.023	-	0.348	-	0.000	-
Red card home team × remaining time more than 30 minutes	0.024	-	0.371	-	0.000	-
Red card away team	0.120	-	0.000	-	1.000	-
Red card away team × #minutes remaining	3.073	11.632	0.000	-	25.584	23.501
Red card away team × remaining time less than or equal to 20 minutes	0.063	-	0.000	-	0.527	-
Red card away team × remaining time more than 20 minutes	0.057	-	0.000	-	0.473	-
Red card away team × remaining time less than or equal to 10 minutes	0.043	-	0.000	-	0.358	-
Red card away team × remaining time between 10 and 30 minutes	0.034	-	0.000	-	0.280	-
Red card away team × remaining time more than 30 minutes	0.043	-	0.000	-	0.362	-
C. Control variables						
Game in UEFA Europa League	0.506	-	0.545	-	0.560	-
Game in group phase	0.735	-	0.742	-	0.667	-

Game in knockout phase: first leg	0.130	-	0.106	-	0.136	-
Game in knockout phase: second leg	0.130	-	0.152	-	0.198	-
Final game	0.006	-	0.000	-	0.000	-
Goal difference after first leg	-0.027	0.601	-0.129	0.452	-0.066	0.599
Relative strength home team	0.000	1.716	0.043	1.628	-0.006	1.719
Goal difference at issuing of red card between minute 1 and minute 30	0.000	0.070	-0.008	0.087	0.004	0.193
Goal difference at issuing of red card between minute 31 and half time	0.007	0.163	0.030	0.301	0.041	0.415
Goal difference at issuing of red card between half time and minute 60	0.012	0.237	0.091	0.647	0.049	0.487
Goal difference at issuing of red card between minute 61 and minute 75	-0.002	0.278	-0.061	0.639	0.016	0.649
Goal difference at issuing of red card between minute 76 and full time	0.023	0.412	-0.015	0.847	0.198	0.997

Notes: A definition of these variables can be found in Section 2.1. No standard deviations are reported for binary variables. Source: Own data processing based on publicly available information on the official UEFA website (http://www.UEFA.com).

Table 2. Results: Benchmark Analysis

	(1)	(2)	(3)	(4)	(5)	(6)
Red card home team	**-0.731*** (0.162)**	**-0.728*** (0.163)**	**-0.742*** (0.156)**	**-0.637*** (0.154)**	**-0.696*** (0.125)**	**-0.660*** (0.135)**
Red card away team	**0.471*** (0.120)**	**0.449*** (0.119)**	**0.453*** (0.116)**	**0.370*** (0.121)**	**0.107 (0.100)**	**0.023 (0.102)**
Game in UEFA Europa League	-	-0.038 (0.082)	-0.039 (0.079)	0.035 (0.134)	0.026 (0.128)	0.029 (0.129)
Game in knockout phase: first leg	-	-0.182 (0.113)	-0.116 (0.112)	-0.019 (0.124)	0.048 (0.119)	0.077 (0.122)
Game in knockout phase: second leg	-	0.417*** (0.123)	0.345*** (0.122)	0.146 (0.136)	0.109 (0.130)	0.108 (0.131)
Final game	-	-0.304 (0.495)	0.245 (0.463)	-0.708 (0.501)	-0.717 (0.494)	-0.711 (0.492)
Goal difference after first leg	-	0.187** (0.073)	0.151** (0.072)	0.058 (0.074)	0.063 (0.072)	0.065 (0.073)
Relative strength home team	-	-	0.303*** (0.024)	-0.026 (0.056)	-0.035 (0.053)	-0.053 (0.055)
Goal difference at issuing of red card between minute 1 and minute 30	-	-	-	-	1.203* (0.466)	0.974* (0.563)
Goal difference at issuing of red card between minute 31 and half time	-	-	-	-	1.205*** (0.206)	1.152*** (0.221)
Goal difference at issuing of red card between half time and minute 60	-	-	-	-	0.864*** (0.104)	0.882*** (0.107)
Goal difference at issuing of red card between minute 61 and minute 75	-	-	-	-	0.694*** (0.104)	0.656*** (0.119)
Goal difference at issuing of red card between minute 76 and full time	-	-	-	-	0.744*** (0.066)	0.767*** (0.070)
Constant	0.397*** (0.046)	0.396*** (0.069)	0.396*** (0.065)	0.749* (0.397)	0.764* (0.395)	0.723* (0.400)
Fixed effects home team	No	No	No	Yes	Yes	Yes
Fixed effects away team	No	No	No	Yes	Yes	Yes
Exclusion of games in which red card is followed by penalty	No	No	No	No	No	Yes
Dependent variable: goal difference at full time	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.018	0.028	0.105	0.380	0.450	0.448
N	2,023	2,023	2,023	2,023	2,023	1,977

Notes: A definition of the included variables can be found in Section 2.1. The presented statistics are linear regression model estimates with White-corrected standard errors in parentheses. The results for the independent variables are in bold. *** (**) ((*)) indicate significance at the 1% (5%) ((10%)) significance level.

Table 3. Results: Alternative Outcome Variables

	(1)	(2)	(3)	(4)
Red card home team	**-0.188*** (0.038)**	**0.150*** (0.040)**	**-0.298*** (0.098)**	**0.399*** (0.109)**
Red card away team	**0.058* (0.032)**	**-0.042 (0.028)**	**0.046 (0.084)**	**-0.060 (0.074)**
Game in UEFA Europa League	0.024 (0.039)	-0.002 (0.036)	0.132 (0.102)	0.106 (0.090)
Game in knockout phase: first leg	0.014 (0.036)	-0.039 (0.035)	-0.165* (0.085)	-0.213** (0.089)
Game in knockout phase: second leg	0.026 (0.038)	0.013 (0.032)	0.065 (0.102)	-0.043 (0.084)
Final game	-0.292** (0.135)	0.211 (0.147)	-0.321 (0.370)	0.396 (0.295)
Goal difference after first leg	0.017 (0.019)	-0.017 (0.016)	0.078 (0.059)	0.016 (0.042)
Relative strength home team	0.003 (0.017)	-0.013 (0.016)	-0.011 (0.042)	0.024 (0.038)
Goal difference at issuing of red card between minute 1 and minute 30	0.318*** (0.118)	-0.162 (0.140)	1.115*** (0.330)	-0.089 (0.379)
Goal difference at issuing of red card between minute 31 and half time	0.290*** (0.056)	-0.207*** (0.053)	0.655*** (0.179)	-0.550*** (0.131)
Goal difference at issuing of red card between half time and minute 60	0.157*** (0.048)	-0.127*** (0.040)	0.555*** (0.085)	-0.308*** (0.099)
Goal difference at issuing of red card between minute 61 and minute 75	0.147*** (0.025)	-0.144*** (0.030)	0.351*** (0.108)	-0.343*** (0.110)
Goal difference at issuing of red card between minute 76 and full time	0.196*** (0.022)	-0.177*** (0.022)	0.427*** (0.060)	-0.317*** (0.057)
Constant	0.529*** (0.093)	0.370*** (0.095)	2.206*** (0.292)	1.442*** (0.291)
Fixed effects home team	Yes	Yes	Yes	Yes
Fixed effects away team	Yes	Yes	Yes	Yes
Exclusion of games in which red card is followed by penalty	No	No	No	No
Dependent variable: victory by home team	Yes	No	No	No
Dependent variable: victory by away team	No	Yes	No	No
Dependent variable: number of goals by home team at full time	No	No	Yes	No
Dependent variable: number of goals by away team at full time	No	No	No	Yes
R^2	0.358	0.327	0.380	0.301
N	2,023	2,023	2,023	2,023

Notes: A definition of the included variables can be found in Section 2.1. The presented statistics are linear regression model estimates with White-corrected standard errors in parentheses. The results for the independent variables are in bold. *** (**) ((*)) indicate significance at the 1% (5%) ((10%)) significance level.

Table 4. Results: Extended Models

	(1)	(2)	(3)
Red card home team	-0.690*** (0.122)	-	-
Red card home team × #minutes remaining (normalised)	-0.017** (0.007)	-	-
Red card home team × remaining time less than or equal to 20 minutes	-	-0.352** (0.162)	-
Red card home team × remaining time more than 20 minutes	-	-0.967*** (0.173)	-
Red card home team × remaining time less than or equal to 10 minutes	-	-	-0.426** (0.189)
Red card home team × remaining time between 10 and 30 minutes	-	-	-0.516*** (0.201)
Red card home team × remaining time more than 30 minutes	-	-	-1.054*** (0.217)
Red card away team	0.106 (0.097)	-	-
Red card away team × #minutes remaining (normalised)	0.013*** (0.004)	-	-
Red card away team × remaining time less than or equal to 20 minutes	-	-0.128 (0.111)	-
Red card away team × remaining time more than 20 minutes	-	0.366** (0.156)	-
Red card away team × remaining time less than or equal to 10 minutes	-	-	-0.235* (0.123)
Red card away team × remaining time between 10 and 30 minutes	-	-	0.068 (0.171)
Red card away team × remaining time more than 30 minutes	-	-	0.466*** (0.178)
Game in UEFA Europa League	0.017 (0.128)	0.021 (0.128)	0.018 (0.128)
Game in knockout phase: first leg	0.041 (0.118)	0.042 (0.118)	0.041 (0.118)
Game in knockout phase: second leg	0.092 (0.129)	0.101 (0.129)	0.103 (0.130)
Final game	-0.724 (0.496)	-0.725 (0.496)	-0.718 (0.498)
Goal difference after first leg	0.066 (0.072)	0.062 (0.072)	0.064 (0.073)
Relative strength home team	-0.042 (0.053)	-0.045 (0.053)	-0.042 (0.053)
Goal difference at issuing of red card between minute 1 and minute 30	1.048** (0.447)	1.158*** (0.447)	1.146*** (0.444)
Goal difference at issuing of red card between minute 31 and half time	1.156*** (0.194)	1.161*** (0.198)	1.139*** (0.197)
Goal difference at issuing of red card between half time and minute 60	0.868*** (0.107)	0.860*** (0.110)	0.859*** (0.112)
Goal difference at issuing of red card between minute 61 and minute 75	0.696*** (0.103)	0.687*** (0.105)	0.702*** (0.107)
Goal difference at issuing of red card between minute 76 and full time	0.785*** (0.064)	0.777*** (0.064)	0.786*** (0.064)
Constant	0.773* (0.396)	0.766* (0.397)	0.767* (0.397)

F-test for equality of 'Red card home team × remaining time less than or equal to 20 minutes' and 'Red card home team × remaining time more than 20 minutes' (p-value)	-	0.008	-
F-test for equality of 'Red card home team × remaining time less than or equal to 10 minutes' and 'Red card home team × remaining time between 10 and 30 minutes' (p-value)	-	-	0.738
F-test for equality of 'Red card home team × remaining time less than or equal to 10 minutes' and 'Red card home team × remaining time more than 30 minutes' (p-value)	-	-	0.026
F-test for equality of 'Red card home team × remaining time between 10 and 30 minutes' and 'Red card home team × remaining time more than 30 minutes' (p-value)	-	-	0.067
F-test for equality of 'Red card away team × remaining time less than or equal to 20 minutes' and 'Red card away team × remaining time more than 20 minutes' (p-value)	-	0.007	-
F-test for equality of 'Red card away team × remaining time less than or equal to 10 minutes' and 'Red card away team × remaining time between 10 and 30 minutes' (p-value)	-	-	0.123
F-test for equality of 'Red card away team × remaining time less than or equal to 10 minutes' and 'Red card away team × remaining time more than 30 minutes' (p-value)	-	-	0.001
F-test for equality of 'Red card away team × remaining time between 10 and 30 minutes' and 'Red card away team × remaining time more than 30 minutes' (p-value)	-	-	0.099
Fixed effects home team	Yes	Yes	Yes
Fixed effects away team	Yes	Yes	Yes
Exclusion of games in which red card is followed by penalty	No	No	No
Dependent variable: goal difference at full time	Yes	Yes	Yes
R^2	0.454	0.453	0.453
N	2,023	2,023	2,023

Notes: A definition of the included variables can be found in Section 2.1. The variable '#minutes remaining' is normalised by subtracting its mean value in the relevant subdataset of games with a red card. The presented statistics are linear regression model estimates with White-corrected standard errors in parentheses. The results for the independent variables are in bold. *** (**) ((*)) indicate significance at the 1% (5%) ((10%)) significance level.