Under pressure: External influences and career concerns for refereeing activities in Brazilian football [£]

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Abstract
In many occupations, workers need to perform in environments that involve external pressure. Some authors have been using sports data to evaluate the performance of professionals under pressure. Based on information from the Brazilian Football Championship (Brasileirão Série A), this article studies the activity of football referees. It seeks to verify whether they systematically benefit home teams by applying more punishments (in the form of red or yellow cards) to visiting teams. Furthermore, the study investigates the influence of external pressure and monitoring factors on refereeing bias. The results corroborate the hypothesis of home bias in regard to the number of yellow and red cards awarded. Concerning the application of yellow cards, we found evidence that the home bias is negligible in games without attendance and in bigger games with less exposure.
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JEL Classification Codes: D03, D73, L83.

1. Introduction

> *"A smart referee does not whistle at what he sees. He whistles at what the stadium sees."*
> Romualdo Arppi Filho, former football referee; in 1986, he joined Arnaldo Cézar Coelho as one of the two Brazilian referees to supervise a FIFA Men's World Cup final, refereeing the match against Germany and Argentina

In certain occupations, external pressure can constitute an important element in the decision-making process. However, an empirical analysis of those choices may not always be feasible. For that reason, with growing frequency, economists and other social scientists have been using the situations that professionals in sports competitions are exposed to as laboratories to test models for individual behavior.

Notably, football refereeing behavior has been used to evaluate decision-making in pressure-filled environments. During their work duties, football referees are subject to several sources of pressure (such as the players, coaches and the crowd), making the task of keeping their technical integrity during the entire match a challenge.

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Currently, in Brazil, the occupation of the football referee is regulated by Law 12.867/2013, which guarantees the right for them to unite in professional associations and unions. However, unlike in many European countries (such as England, Germany and Spain), because of Law 9.615/1998, commonly known as Lei Pelé, it is stated that football referees are not allowed to have an employment relationship with any entities that they professionally evaluate as a referee. In practice, they can be regarded as autonomous workers, earning compensation for the tasks performed.

It is well-known that football has a "national sport" status in Brazil and is a source of passion for millions of people around the country. Those who choose to perform as football referees face an environment of uncertainty, because, without formal working relations, there is no guarantee of an available job position. They are supposed to prepare physically and psychologically to perform their professional duty when appointed to – many times, balancing their time with formal jobs they need to perform during the days when there are no matches. In this scenario, when selected, they still need to cope with pressure from the entities hiring their services to be at the peak of performance and to attempt perfection when commanding a football match. In this atmosphere, which is usually affected by external pressure and monitoring sources, errors when performing could harm the future of a football referee's career, meaning professional stagnation and, in some cases, early termination.

To be able to referee a professional football match, the referees enforce compliance with the rules as determined by the International Football Association Board (the responsible body for the regulation of the rules of football) as described in the *"Laws of The Game"* rule book, last modified in June 2018. In this code, for example, it is established that enforcive punishments such as yellow and red cards should be applied to sanction infractions. A yellow card is applied as a soft punishment, and a red card is applied as a more severe punishment, leading to the exclusion of the player from the game. Consistent with these dictates, it is expected that neutral refereeing should be passive to external pressure; however, some articles show evidence that other sources can wield some influence on refereeing decisions.

The existing literature addressing social pressure and refereeing bias aims to evaluate referees' decisions and the impact of external pressure and monitoring sources (such as attendance and refereeing experience) on these decisions. These studies indicate that, for example, referees typically add more time to the games in a way that benefits home teams (Sutter and Kocher, 2004; Garicano, Palacios-Huerta and Prendergast, 2005; Dohmen, 2008). In addition, home teams benefit from less punishment by either yellow cards or red cards (Carmichael and Thomas, 2005; Dawson, Dobson, Goddard and Wilson, 2007; Petterson-Lidbom and Pirks, 2010; Dawson, 2012).

In this context, the present study aims to evaluate refereeing activities regarding the enforcement of punishment by yellow and red cards in games played in the Brazilian Football Championship. This article employs a database that was built with data from 1,140 games played in the First Division of the Brazilian Football Championship (Brasileirão Série A)'s editions from 2015 to 2017. The study also investigates the influence of external pressure and monitoring sources on refereeing bias. The

econometric results support the hypothesis of a bias towards home teams when it concerns the application of yellow and red cards. Particularly concerning the use of yellow cards, it appears there is evidence that attendance is a relevant mechanism of pressure since the bias disappears in games without attendance. Furthermore, home bias is smaller in less-monitored matches.

Just a few studies cover the Brazilian case. Rocha, Sanches, Souza and Domingos da Silva (2003) look into the behavior of Brazilian referees in Brasileirão games from 2004 to 2008. The authors found evidence of home bias in the form of time addition. Furthermore, the bias presents itself in a more obvious way in less-monitored environments, such as when there is no television broadcast, and when both teams playing the game have low relevance in the national scene. We contribute to this literature, bringing new evidence related to the dimension of punishment assignments.

After this brief introduction, this article has three additional sections. In section 2, we present a more detailed analysis of the related literature, describing the main empirical findings regarding refereeing bias and the influence of external pressure and monitoring elements. In section 3, we describe the empirical approach, presenting the database and the strategy to estimate the econometric models. Last, in section 4, we present the main results.

2. Related Literature

Carmichael and Thomas (2005) are an important reference in the literature studying social pressure and home bias in football referees' activities. On a general basis, the authors analyze the hypothesis of home bias effect in the English Football Championship *(Premier League)* over the 1997-98 season, after noting that home teams won approximately 57% of the points in play. This effect presents itself under the influence of many elements, such as players' familiarity with the stadium where the match is played, potential traveling difficulties that may affect performance during the match (such as fatigue), and crowd distribution in the stands in such a way that it affects the teams in the form of a change of attitude. In stadiums with high attendance, for instance, the home team would be more inclined to search for an offensive style of play. In contrast, the visiting team would try to react with a more defensive, more aggressive style of play, implying tighter conduction of the game by the referee in the form of more interruptions and punishments. The study finds evidence that punishment by cards (yellow and red) is less costly to away teams because it is easier to adjust to a more defensive strategy during an away match. This piece of evidence could explain the larger number of cards typically assigned to away teams in the Premier League.

In a pioneer study, Sutter and Kocher (2004) aim to evaluate the thesis of home favoritism by referees empirically using extra time added and penalties assigned data from German Football Championship *(Bundesliga)* matches in the 2000/01 season. By analyzing the extra time added hypothesis, the study shows that referees tend to be more generous to the home team by increasing the time of play when the home team is losing by up to two goals. The extra time difference between situations where the visiting team is winning, and where it is losing by one goal, reaches an interval between 30 to 50 seconds

On the other hand, Garicano, Palacios-Huerta and Prendergast (2005) conducted their study in a broader context. Since the 1998 Féderation Internátionale de Football Association (FIFA) Men's World Cup, the FIFA has obligated referees to publicly announce how many minutes they are adding to regular play as extra time. In the Spanish Football Championship, the source for the study, the points system was also modified: moving from a 2-1-0 (two points for a win, one for a draw and none for a loss) system to one of 3-1-0 (three points for a win, one for a draw and none for a loss) after the 1994-1995 season. The authors compare the numbers from that season with the 1998-1999 season. Using a sample to highlight the added time hypothesis, the study measures situations where the home team is losing or winning by a one-goal difference. The conclusion points to the one Sutter and Kocher (2004) reached, with the referees showing a tendency to give more added time to the home team when it is losing and less added time when it is winning, with the difference between the two situations reaching 30% from the mean in the first case and 35% in the second.

Nevertheless, comparing the 1994-1995 and 1998-1999 seasons, Garicano, Palacios-Huerta and Prendergast (2005) also seek to investigate whether referee bias remained constant when favoring the home team. The interacting variables "goal difference" (assuming the value 1 when the home team is winning by a goal) and "year" (assuming the value 1 for the seasons after the changes) show the outcome is negative, indicating that the difference is significant. On average, there was an increase from 1.5 minute to 2 minutes in extra time added. Last, another important factor is included in the exercise: the crowd. The study considers the hypothesis that a fuller stadium influences the behavior of the referee and concludes that there is no evidence that the referees add more extra time in this environment.

Dawson, Dobson, Goddard and Wilson (2007) measure referee bias in their study covering the 1996/1997 to 2002/2003 seasons of the English Premier League. This paper, however, brings in a different element from the previous ones by adding an individual analysis of referees instead of looking at them as an entire group. It seeks to identify some patterns in their performances to determine the sources providing incentives for a bias towards the home team. Another unique point taken into account is the importance of the matches, based on the idea that in matches played towards the end of the season, the teams with aspirations of winning the league or qualifying for Continental play, or in avoiding relegation, play with extra incentives to win compared with teams situated in the middle of the rankings. In games in which the home team is playing for something, it is socially obligated by the crowd to show more effort on the field (which may, sometimes, manifest as excessive aggressiveness), producing a trend in the analyzed data that shows a significant difference concerning disciplinary punishment enforced by referees. The same effect would be found when analyzing managerial or playing scheme tactics during the same season.

When analyzing referees individually, Dawson, Dobson, Goddard and Wilson (2007) find a considerable variation in the application of disciplinary punishments, suggesting that there is some inconsistency in refereeing capacity to enforce the rules. The study also investigates the hypothesis that an increase in the importance of the match, using the crowd size and broadcasting type as indicators, affects the bias. They find that, unlike what common sense would suggest, as crowd size increases, referees do not favor the

home team by excessively punishing the visiting team, but the contrary. Last, the hypothesis that players and referees feel greater pressure when a match is broadcast on television, affecting their performances, does not hold.

Following Dawson, Dobson, Goddard and Wilson (2007), Boyko, Boyko and Boyko (2007) analyze the bias favoring the home team individually for each referee by using a group of variables that influence the matches – such as team ability, attendance, goal difference and difference of punishment by cards – in seasons from 1992/1993 to 2005/2006 in the English Premier League. The authors argue that, if refereeing bias is one of the main components of favoritism towards the home team, and if each referee responds differently to pressure sourced by the crowd, then the outcome of a match depends on the referee appointed to officiate it. The results support the hypothesis that psychological effects generated by social pressure – crowd noise, for example – result in effects favoring the home team. Since less experienced referees are more susceptible to these impacts than more experienced ones, the authors advocate that the more experienced referees should be the ones officiating matches with larger attendance or greater importance regarding a championship. There is also evidence indicating that the favoring bias towards the home teams changes from team to team, making it possible to infer that referees may be able to control how much favoritism they are allowing, generating a margin where the general public wonders about the honesty of the referees and the ones who are responsible for appointing the referees.

Buraimo, Forrest and Simmons (2009) evaluate the hypothesis of refereeing bias by analyzing the data regarding punishment by yellow and red cards through a new perspective. They consider other particular variables to each match – such as crowd proximity to the field, favoritism in betting houses, the rivalry between the teams involved and the number of goals scored - in the matches of the 2000/2001 to 2005/2006 seasons of the German *Bundesliga* and English Premier League. There is evidence that punishment by cards is made systematically in a group and in a small window of time, raising the question of this being a potential tradeoff for the referee being able to control the rhythm of the match. Similar to Carmichael and Thomas (2005), the authors find that the average number of cards applied to the visiting team is indeed more than that applied to the home team, but they argue this is more a consequence of a defensive style of play than a supposed refereeing bias.

The existence of athletic tracks between the field and the crowd is also analyzed by Buraimo, Forrest and Simmons (2009). The results indicate that home teams playing in stadiums without physical separation between the field and the crowd have a lesser probability of being punished with cards, indicating social pressure from the crowd is a determining factor in this situation. It does support the hypothesis that teams are already aware of this factor and motivated by it when rehabilitating their facilities, eliminating the physical separation with the crowd (in the Premier League, no stadium had this separation in the analyzed period, while in the *Bundesliga* only a small portion of the stadiums had it). When analyzing the hypothesis of favoritism in betting houses, Buraimo, Forrest and Simmons (2009) find evidence that when the home team is considered to be an underdog, the probability of being punished with cards is more prominent than when it is viewed as the favorite. The authors conclude that there is an indication of a biased treatment in this process.

Dohmen (2008) aims to complement the previous studies by analyzing the impact of crowd size on refereeing behavior. Examining data from twelve seasons of the German *Bundesliga*, the author considers certain specificities – such as the presence of opposing team fans and the existence of an athletic track in the stadium – to evaluate the theory that referees are affected by social pressures. However, that comes with the tradeoff of losing potential financial incentives from the local federation, incentivizing them to perform as impartially as they can. This study evaluates three situations: (i) if the home team is benefited by the addition of more extra time when it is losing the game; (ii) if the crowd composition affects the performance of the referee, and; (iii) if a larger presence of fans from the visiting team produces any effect in the referees' behavior. For (i), the conclusion is that the difference in extra time when the home team is behind in the score by one goal (compared to when it is ahead) is approximately 22 seconds, meaning a significant gap. For (ii), investigating the geographical distance between teams, the study concludes that the referee tends to favor the home team if the visiting team comes from a city located at least 150 km away, implying a decrease in size for the opposing team crowd. Finally, for (iii), the study infers that when there is no separation between the field and the crowd, the referee tends to award nearly 1 minute of extra time compared to the opposite situation.

Petterson-Lidbom and Priks (2010) study the refereeing behavior in exceptional situations when there is no crowd at all present in the stadiums. In the 2006/2007 season of the first two divisions of the Italian Football Championship, 21 matches (from a total of 842) were played with closed doors due to a punishment imposed by the local government (crowds were allowed in stadiums only with the necessary safety requirements). This measure was adopted after hooligan fans of Calcio Catania and Palermo Calcio were involved in fights in the city of Catania in February 2007. The authors incorporate into the discussion the punishments enforced by referees in red and yellow cards and fouls. The authors point out that the home team was punished less than the visiting team in the matches with crowds, while the contrary took place when the game was played behind closed doors.

Trying to understand the differences in refereeing behavior based on their job experience, Dawson (2012) evaluates the performance of European referees in the two main European club competitions - the UEFA Champions League and the UEFA Cup (today's UEFA Europa League) – in the editions 2002/2003 to 2006/2007. According to the results, there is no evidence that more experienced referees tend to officiate better when dealing with extra pressure coming from the home crowd, and the quantity of punishment grows for both home and away teams in these important competitions. The author infers, still, that referees tend to favor the home team due to the size of the home crowd present in the stadium.

Rocha, Sanches, Souza and Domingos da Silva (2013) bring this discussion to the Brazilian environment, employing data from the Brazilian Football Championship. The authors consider different levels of visibility (such as matches broadcasted on television) and pressure (such as matches with a higher level of importance) that may produce some career concerns regarding the referees favoring home teams. In their conclusion, the authors find evidence supporting that referees' home bias is more evident in games where the monitoring is weak (such as when there is no television coverage and the teams involved have little relevance in the national scenario).

Finally, the prior studies exemplify how the literature concerning the influence of pressure and monitoring exercise regarding the behavior of football referees is developed. In the Brazilian case, there are just a few articles available on this subject. This study aims to fill this gap, evaluating, in particular, how referees enforce punishment on the players involved in a match. In the next section, the aim is to econometrically review the hypothesis of favoritism raised by the literature. The main objective is to evaluate the existence of a systematic bias in referee behavior, after controlling for the typical determinants of punishments in the matches.

3. Empirical analysis

3.1 Data

The dataset is based on the data of 1,140 matches disputed in the seasons between 2015 and 2017 in the First Division (Série A) of the Brazilian Football Championship. For the extraction, the study used data available on the website of the Confederação Brasileira de Futebol (www.cbf.com.br), where the official referee and financial reports of each match are registered, and from ESPN Brazil's website (www.espn.com.br), where the data for fouls committed in each match are recorded. The dataset has a panel structure with information for each club by rounds and season played.

Table 1 presents the relevant characteristics of games in the Brazilian Football Championship. Punishment indicators for home and visiting teams are of direct interest to this paper. The average of yellow and red cards applied by referees appears to indicate that the visiting team tends to receive more punishments than the home team. In the case of yellow cards, the average difference reaches 0.5 cards per match.

Table 1: Descriptive Statistics

Variable	Mean	Standard deviation	Maximum	Minimum
Goals – home	1.4442	1.1622	6	0
Goals – visitor	0.9543	0.9829	6	0
Yellow cards – home	2.2019	1.4623	7	0
Yellow cards – visitor	2.6953	1.5435	9	0
Red cards – home	0.0834	0.2890	2	0
Red cards – visitor	0.1536	0.4065	3	0
Fouls – home	15.0026	4.6102	32	2
Fouls – visitor	15.5899	4.8146	34	4
Substitution – home	2.9534	0.2228	3	1
Substitution – visitor	2.9552	0.2385	3	0
Extra time (first half)	2.1202	1.1837	8	0
Extra time (second half)	3.9982	1.2421	11	0

Source: CBF, ESPN.

Table 1 also presents the mean quantity of fouls committed by the home and visiting teams. As we can see, visiting teams are usually credited with more fouls than the home teams. On average, the difference reaches 0.6 fouls per game. This fact suggests that the larger penalization against away teams may be related, to some extent, to more aggressive behavior and thus a larger number of infractions committed by the visiting teams.

3.2 Methodology

To evaluate the behavior of referees in Brazilian football matches, we use the number of yellow cards that a team received during a given match (*"Yellow card"*) as the dependent variable. The *dummy* variable *"Visitor"* which aims to indicate whether a team is playing as a visitor, is the variable of interest. The objective is to verify whether this favoring bias towards the home teams is significant when controlled for by match characteristics, monitoring elements and referees' experience.

The regression model below aims to identify the main determinants of the number of yellow cards applied to the teams in a given match.

$$\mathbf{Yellow\_card_{ij} = \beta_0 + \beta_1 Visitor_{ij} + \gamma X_{ij} + \alpha_i + \theta_t + \varepsilon_{ij}} \qquad \mathbf{(1)}$$

$Yellow\_card_{ij}$ refers to the number of yellow cards assigned to team i in game j; $Visitor_{ij}$ is a variable that assigns a value of 1 if team i is the visiting team in game j; α_i is a dummy variable for team i; θ_t is a dummy variable indicating the season in which game j is being played; and ε_{ij} is the error term. Other specifications include a set of control variables: X_{ij}, indicating other determinants of the quantity of cards assigned to team i in game j; the number of fouls committed by team i in game j; the number of goals scored and suffered by team i in game j; the number of substitutions executed by team i in game j; an indicator of which round that game j was played.

The main variable of interest is the indicator of the visiting team. If the null hypothesis of β_1 being equal to zero is rejected, there will be evidence that the visiting team receives, on average, more punishment by cards, even after controlling for the other variables that would explain this kind of punishment.

In the next steps, the aim is to incorporate the external elements of pressure and monitoring that can influence an eventual favorable bias towards the home team. These variables may be useful in the identification of the mechanisms that can increase or soften the biased behavior of refereeing. In equation (2), the "*External*" variable refers to the environmental component regarding match j that may affect the refereeing behavior. The external elements that can influence refereeing decisions are grouped by two sets of variables: (i) external pressure variables; and (ii) external monitoring variables.

$$\mathbf{Yellow\_card_{ij} = \beta_0 + \beta_1 Visitor_{ij} + \gamma X_{ij} + \beta_2 External_j + \beta_3 (Visitor_{ij} \times External_j) + \alpha_i + \theta_t + \varepsilon_{ij}} \qquad \mathbf{(2)}$$

The external pressure variables aim to introduce elements that can influence the referee's decision-making neutrality. The first factor indicates whether a referee belongs to the FIFA international referee list. One can expect that the *"Top referees"* are in a position of superiority in a hierarchy established by CBF and are believed to have better control of matches.[1] Subsequently, the research examines the effects of the presence of external

[1] The referees that belong to the FIFA (*Féderation Internationale de Football Association*) international list are able to referee international matches, having a superior position in the hierarchy established by CBF

sources of pressure coming from the stands in terms of referee performance, estimating the bias for matches played in stadiums that do not have athletic tracks or physical separation between the field and the crowd *("No athletic track")*.[2] Additionally, the models estimate the influence of external pressure from the stands through attendance, since more occupied stadiums may prove to be external sources of pressure; thus, a variable that relates to the absolute value of attendance in a match *("Attendance")* is included, as well as a relative measure relating to the percentage of stadium occupancy compared to its total capacity *("Attendance-to-capacity")*.[3] A fifth pressure variable identifies the matches played in stadiums that are not employed by the home teams on a regular basis *("Second home")*. In Brazil, for different reasons (for example, punishments, selling the rights to play at the main stadium, and the stadium being unavailable on the date assigned), it is common for clubs to play some games in a secondary stadium, creating a situation where the referee may have less pressure to deal with when performing. The last pressure variable identifies the games that, due to administrative punishment, were played without the presence of fans *("Punishment")*.[4]

External monitoring variables aim to incorporate matches' visibility elements that may affect refereeing decisions. Thus, the first variable indicates whether the match was broadcast on free-to-air television, which allows an evaluation of the visibility and monitoring in regard to refereeing *("Broadcast")*. During the seasons included in the database, all matches from the Brazilian Football Championship were broadcast by at least one network through pay-per-view, pay-TV or free-to-air, with the first two systems being the most restrictive. Therefore, matches broadcast by free-to-air TV networks that could be easily viewed by the public tended to generate more expectations, garnering more importance and monitoring from the standpoint of referee decision-making.

Another phenomenon studied in this paper pertains to the matches considered regional derbies, that is, played by two teams that share a historic rivalry *("Regional derby")*. These matches are notorious in football circles because they tend to generate more expectations from both fans and players, producing a situation more susceptible to media exposition and pressure for all those involved in the game, especially players, coaches, and referees.[5] Finally, the models include a variable that aims to capture the opacity of

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(Confederação Brasileira de Futebol). Appendix 1 presents more details about the construction of this variable.

[2] The existence of any kind of physical separation between the field and the crowd (such as an athletic track) tends to reduce the pressure imposed by the crowd present in the stadium towards the referees (Carmichael and Thomas, 2005; Dohmen, 2008). Appendix 1 presents more details about the construction of this variable.

[3] The information on the stadiums' capacity was obtained in the Cadastro Nacional de Estádios de Futebol, by CBF's Competitions Office in 2016 (DIRETORIA DE COMPETIÇÕES DA CONFEDERAÇÃO BRASILEIRA DE FUTEBOL. *CNEF – Cadastro Nacional de Estádios de Futebol*. 18 Jan. 2016. Available in <https://conteudo.cbf.com.br/cdn/201601/20160122182359_0.pdf>. Accessed on 6 Sep. 2018).

[4] These matches were played without crowd presence because of disturbances (for example, disorder, field invasion or throwing objects onto the field) caused by fans of the home team in prior games.

[5] Common sense dictates that these matches are more violent because rivalry brings an increase in stimulus to beat the rival team, requiring an increased role for the referee to control the rhythm of the match. Appendix 1 presents more details about the construction of this variable.

matches with less relevance, identifying the matches played by small teams *("Small matches").*[6]

4. Results

The main objective of the econometric exercise is to evaluate the existence of bias in the punishment by referees and to investigate whether the bias towards home teams is driven by pressure and monitoring elements. The models follow the specifications described in the previous section and are estimated by ordinary least squares (OLS).

The estimates for the parameters in the basic specification (1) are reported in table 1. In column (1), the basic control variables presented in the previous section are included. On the other hand, column (2) adds fixed effects for team, season and round in which each game is played. Finally, following the literature on this subject (Garicano, Palacios-Huerta and Prendergast, 2005; Rocha, Sanches, Souza and Domingos da Silva, 2013), column (3) reports the results for the *"close matches"* – a subsample of games in which the final score has a maximum goal difference of 1. In these matches, the outcome is under a more pronounced influence from the referee. As depicted, the observed results corroborate the hypothesis that the referee awards more yellow cards to the visiting team than to the home team. The estimates for the coefficient of the *"Visitor"* variable are positive and significant at 1% in all models, indicating the existence of a systematic bias in favor of the home team, even after controlling for other variables. The point estimates suggest that, on average, the visiting team is awarded an extra 0.4 yellow cards when compared with the home team.

[6] A team is considered large if it is part of the Big 13, the association that groups the great Brazilian football clubs.

Table 2: Number of yellow cards

Variables	(1)	(2)	(3)
Visitor	0.36390***	0.36560***	0.37693***
	(0.062)	(0.061)	(0.073)
Fouls	0.11466***	0.11851***	0.11342***
	(0.007)	(0.007)	(0.008)
Goals scored	-0.04013	-0.02893	0.07458
	(0.027)	(0.028)	(0.052)
Goals suffered	0.08687***	0.09028***	0.10948**
	(0.028)	(0.029)	(0.053)
Substitutions	-0.02451	-0.04538	-0.15467
	(0.120)	(0.119)	(0.152)
Extra time (1st half)	0.13164***	0.12287***	0.13878***
	(0.025)	(0.026)	(0.032)
Extra time (2nd half)	0.10106***	0.10974***	0.05007
	(0.024)	(0.025)	(0.033)
Constant	-0.15398	-0.75739*	0.65196
	(0.380)	(0.453)	(0.612)
Year, round and team fixed effects	No	Yes	Yes
Close games	No	No	Yes
Observations	2,278	2,278	1,560
R-squared	0.183	0.225	0.233

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Additionally, Table 2 shows that other variables have a statistically significant correlation with the quantity of yellow cards awarded by referees.[7] As one may expect, the quantity of fouls committed *("Fouls")* is positively correlated with the quantity of yellow cards awarded; on average, a team is awarded 1 yellow card for every 9 fouls committed in a match. Another statistically significant variable is the quantity of goals conceded by a team *("Goals suffered")*. The number of goals conceded may be seen as a proxy for pressure against the team; therefore, on average, the more goals a team concedes, the larger the incentive for a defensive, even reckless, attitude to contain the opponent. Regarding the extra time awarded by the referee *("Extra time – 1st half")*, the positive correlation may be related to the use of practices not permitted by the rules, such as reckless behavior and stalling for time, increasing punishments by yellow cards.

Table 3 reports results for external pressure variables that may affect the refereeing behavior. At each column from (4) to (9), a new external pressure variable is included. In the *"Pressure variable"* and *"Interaction"* lines, respectively, the isolated and the interacted effects generated by the correspondent pressure variable are reported. As mentioned, this exercise aims to evaluate how environmental characteristics for external pressure affect the identified pattern of favoritism in refereeing. The variable *"Punishment"* is the only variable to present a negative and statistically significant effect. This finding suggests that in matches played without fans (closed gates), there is a

[7] The econometric exercises with external pressure and monitoring factors are conducted only for the *"Close games"* subsample.

reduction effect of the bias favoring the home team. In effect, the joint significance test for *"Visitor"* and *"Interaction"* coefficients reveals that the bias in awarding yellow cards is null in games without crowd attendance.[8]

Table 3: Number of yellow cards in close matches – Pressure factors

Variables	(3) Basic results	(4) Top Referee	(5) No Athletic track	(6) Attendance	(7) Attendance-to-capacity	(8) Second home	(9) Punishment
Visitor	0.37693***	0.43087***	0.30854***	0.69228	0.23377*	0.38183***	0.38702***
	(0.073)	(0.094)	(0.104)	(0.961)	(0.130)	(0.080)	(0.073)
Fouls	0.11342***	0.11345***	0.11342***	0.10725***	0.11732***	0.11342***	0.11426***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)
Goals scored	0.07458	0.07462	0.07435	0.05758	-0.02754	0.07488	0.06822
	(0.052)	(0.052)	(0.052)	(0.055)	(0.029)	(0.052)	(0.052)
Goals suffered	0.10948**	0.11097**	0.10927**	0.09076*	0.08680***	0.11019**	0.11139**
	(0.053)	(0.053)	(0.053)	(0.055)	(0.029)	(0.053)	(0.053)
Substitutions	-0.15467	-0.15326	-0.15347	-0.15723	-0.03951	-0.15611	-0.14771
	(0.152)	(0.152)	(0.152)	(0.156)	(0.120)	(0.152)	(0.152)
Extra time (1st half)	0.13878***	0.13713***	0.13846***	0.15084***	0.11560***	0.13761***	0.13840***
	(0.032)	(0.032)	(0.032)	(0.035)	(0.027)	(0.032)	(0.032)
Extra time (2nd half)	0.05007	0.05021	0.04951	0.06065*	0.10387***	0.04967	0.04861
	(0.033)	(0.033)	(0.033)	(0.035)	(0.025)	(0.033)	(0.033)
Pressure variable		0.12806	-0.08423	0.10715	0.21827	-0.08435	0.33587
		(0.097)	(0.119)	(0.080)	(0.190)	(0.126)	(0.482)
Interaction		-0.12314	0.14420	-0.02967	0.30940	-0.03675	-1.47775**
		(0.140)	(0.155)	(0.102)	(0.265)	(0.185)	(0.669)
Constant	0.65196	0.59409	0.50475	-0.08656	-0.08525	0.66964	0.62016
	(0.612)	(0.616)	(0.618)	(0.998)	(0.482)	(0.615)	(0.613)
Year, round and team fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Close games	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,560	1,560	1,560	1,428	2,232	1,560	1,560
R-squared	0.233	0.234	0.234	0.234	0.227	0.234	0.236

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4 reports the estimates for match visibility and external monitoring variables affecting refereeing activity. At each column from (10) to (12), a new external monitoring variable is included. In the *"Monitoring variable"* and *"Interaction"* lines, respectively, the isolated and the differential effect coming from the correspondent visibility variable are reported. The external monitoring variables capture elements that increase visibility and the importance of matches and thus impact refereeing behavior. *"Broadcast"* and *"Regional derby"* variables have significant coefficients in regard to card enforcement. Matches broadcast on free-to-air TV *("Broadcast")* appear to show a decrease in the enforcement of yellow cards (on average, a reduction of 0.2 cards); on the other hand, as expected, matches involving regional rivals *("Regional derby")* are characterized by an increase in the enforcement of yellow cards (on average, an increase of 0.5 cards). These

[8] Statistic F(1,1486) = 2.67 (p-value = 0.1027).

two dimensions, however, seem not to influence refereeing with a pattern that favors the home team. The only external monitoring variable that presents a significant interaction term is *"Small matches"*; in matches involving two small teams, referees tend to perform under less external monitoring as a result of the reduced visibility towards the dispute. In a less-monitored environment, the bias towards awarding yellow cards to the visiting team is twofold higher than the average (0.64 cards in small matches versus 0.3 on average).[9]

Table 4: Number of yellow cards in close matches – Monitoring factors

Variables	(3) Basic results	(10) Broadcast	(11) Regional derby	(12) Small matches
Visitor	0.37693***	0.38438***	0.39630***	0.31234***
	(0.073)	(0.085)	(0.074)	(0.080)
Fouls	0.11342***	0.11426***	0.11088***	0.11316***
	(0.008)	(0.008)	(0.008)	(0.008)
Goals scored	0.07458	0.07100	0.07821	0.07301
	(0.052)	(0.052)	(0.052)	(0.052)
Goals suffered	0.10948**	0.11165**	0.10411**	0.11213**
	(0.053)	(0.053)	(0.053)	(0.053)
Substitutions	-0.15467	-0.15520	-0.16319	-0.15538
	(0.152)	(0.151)	(0.151)	(0.151)
Extra time (1st half)	0.13878***	0.13751***	0.13714***	0.13761***
	(0.032)	(0.032)	(0.032)	(0.032)
Extra time (2nd half)	0.05007	0.04689	0.04439	0.05082
	(0.033)	(0.033)	(0.033)	(0.033)
Monitoring variable		-0.18052*	0.51398***	-0.06374
		(0.104)	(0.195)	(0.133)
Interaction		-0.03907	-0.18485	0.32994*
		(0.164)	(0.269)	(0.172)
Constant	0.65196	0.69981	0.67421	0.63882
	(0.612)	(0.613)	(0.606)	(0.612)
Year, round and team fixed effects	Yes	Yes	Yes	Yes
Close games	Yes	Yes	Yes	Yes
Observations	1,560	1,560	1,560	1,560
R-squared	0.233	0.236	0.238	0.235

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.1 Red Cards

The same procedures used in the prior section are applied to determine the quantity of red cards. The results are reported in tables 8, 9 and 10 of Appendix 2.

Unlike the yellow card (enforced as a warning), the red card is enforced to prevent reckless and undisciplined behavior by the players, being less recurrent than the yellow

[9] The statistic for the sum of effects is F(1,1486) = 16.98 (p-value = 0.0000)

card. On average, the occurrence of red cards per game equals 0.12, compared to 2.3 for yellow cards. Table 1 reports that, on average, the punishment by red cards is greater for visiting teams (0.15 card per game) than for home teams (0.08 card per game).

Table 5 reports the basic results for the main determinants of red card enforcement. The results show that, even after controlling for other related variables, there is a bias that makes the referee award more red cards to the visiting team, similar to the findings on the yellow card case. On average, the visiting team is punished with 0.05 more red cards per game than the home team, a bias equivalent to an increase of 45% in the average quantity of red cards awarded.

As in the previous section, the research also finds significant results for variables regarding the quantities of goals scored, goals conceded, and minutes added for extra time in the second half. It should be noted that the quantity of fouls committed does not have a significant correlation with punishment by a red card, which is related to sporadic and extreme acts of indiscipline.

Tables 9 and 10 report results for external pressure and monitoring variables for the matches. Among pressure variables (Table 9), it can be noted that, on average, FIFA referees *("Top referee")*, which are regarded as more experienced, enforce a smaller quantity of red cards. In a similar form, referees also enforced a relatively lower quantity of red cards in matches played with closed doors *("Punishment")*. Regarding the effects of external pressure and monitoring variables towards a favoring bias for the home team, the research does not find significant results. The interaction between these variables and the visiting dummy variable is not robust at the usual levels of statistical significance.

5. Concluding Remarks

Despite the growing international literature on this subject, there are few studies in Brazil using sports data to analyze the decisions of professionals in occupations under high levels of pressure. This study aims to fill this gap, employing data from the First Division of the Brazilian Football Championship (*Brasileirão Série A*). The aim is to evaluate whether football referees systematically benefit the home teams by awarding relatively more punishments (yellow or red cards) to the visiting team.

Comparable to the international literature, our findings support the hypothesis of bias towards home teams in the enforcement of yellow and red cards. Furthermore, in the yellow card case, pressure and monitoring factors particular to each match seem to affect the magnitude of the favoring bias. In particular, the results suggest that the bias towards the home team is nonexistent in matches played behind closed doors and is larger in games with small visibility. Therefore, external control elements matter in refereeing decisions.

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Appendix 1: Definition of variables

In this appendix, we present a short description of the variables we have used in the econometric models.

Regional derbies

For the *"Regional derby"* variable, we highlight the matches that involve two rival teams, employing the procedure used by Buraimo, Forrest and Simmons (2009) to study the behavior of referees in this environment. The criteria used for this division are mainly regional, taking the matches involving teams based in the same city (with Santos being an exception, since, even though it is a team based in the city of Santos, their greatest rivalries are with the Corinthians, Palmeiras and São Paulo, teams from the city of São Paulo).

Table 5: List of matches considered regional derbies

State	Derbies
Bahia	Bahia x Vitória
Minas Gerais	Atlético MG x Cruzeiro
Pernambuco	Santa Cruz x Sport
Paraná	Athletico x Coritiba
Rio de Janeiro	Botafogo x Flamengo, Botafogo x Fluminense, Botafogo x Vasco, Flamengo x Fluminense, Flamengo x Vasco, Fluminense x Vasco
Rio Grande do Sul	Grêmio x Internacional
Santa Catarina	Avaí x Figueirense
São Paulo	Corinthians x Palmeiras, Corinthians x Santos, Corinthians x São Paulo, Palmeiras x Santos, Palmeiras x São Paulo, Santos x São Paulo

Athletic Track and Hostile Stadiums

Following the hypothesis proposed by Buraimo, Forrest and Simmons (2009) and Dohmen (2008), the variable *"No Athletic Track"* was included in determining the effects of seating stands' proximity to the field as a source of external pressure for the referee. The analysis of the stadiums in the database is challenging, since a large number of these facilities recently went through a series of renovations, promoted by the realization of the 2014 FIFA Men's World Cup and the 2016 Summer Olympics in Brazil. For this exercise, we follow the definition used by Rocha, Sanches, Souza and Domingos da Silva (2013), filling a value of 1 for the stadiums where the stands' proximity to the field reflects pressure on the referee and a value of 0 for those that do not.

Table 6: List of stadiums, grouped by *"No Athletic Track"* effect

Stadiums with "*No Athletic Track*"	Alfredo Jaconi, Arena Condá, Arena Joinville, Barradão, Couto Pereira, Fonte Luminosa, Giulite Coutinho, Ilha do Retiro, Independência, Luso-Brasileiro, Mário Helênio, Moisés Lucarelli, Orlando Scarpelli, Raulino de Oliveira, Ressacada, São Januário, Vila Belmiro e Vila Capanema
Stadiums with "*Athletic Track*"	Allianz Parque, Arena Corinthians, Arena da Baixada, Arena das Dunas, Arena do Grêmio, Arena Fonte Nova, Arruda, Beira-Rio, Estádio do Café, Jóia da Princesa, Kléber Andrade, Mané Garrincha, Maracanã, Mineirão, Morumbi, Nilton Santos, Olímpico Pedro Ludovico, Pacaembu, Pituaçu e Serra Dourada

FIFA referees

The *"FIFA"* variable was included to group the referees belonging to the FIFA international referee list. Following this logic, those who have the right to use the FIFA badge are more experienced and prepared to deal with external pressure.

Table 7: List of referees, grouped by "FIFA" effect

Referees with FIFA badge	Anderson Daronco, Dewson Fernando Freitas da Silva, Luiz Flávio de Oliveira, Raphael Claus, Ricardo Marques Ribeiro, Sandro Meira Ricci e Wilton Pereira Sampaio
Referees without FIFA badge	Alisson Sidnei Furtado, André Luiz de Freitas Castro, Antônio Dib Moraes de Souza, Avelar Rodrigo da Silva, Braulio da Silva Machado, Bruno Arleu de Araújo, Caio Max Augusto Vieira, Claudio Francisco Lima e Silva, Cleisson Veloso Pereira, Diego Almeida Real, Dyorgines José Padovani de Andrade, Eduardo Tomaz de Aquino Valadão, Elmo Alves Rezende Cunha, Emerson de Almeida Ferreira, Emerson Luiz Sobral, Felipe Gomes da Silva, Flávio Rodrigues de Souza, Flávio Rodrigues Guerra, Francisco Carlos do Nascimento, Francisco de Paula dos Santos Silva Neto, Gilberto Rodrigues Castro Junior, Grazianni Maciel Rocha, Guilherme Ceretta de Lima, Igor Junio Benevenuto, Ítalo Medeiros de Azevedo, Jailson Macedo Freitas, Jean Pierre Gonçalves Lima, João Batista de Arruda, José Cláudio Rocha Filho, Leandro Bizzio Marinho, Leonardo Garcia Cavaleiro, Luis Teixeira Rocha, Luiz César de Oliveira Magalhães, Marcelo Aparecido Rodrigues de Souza, Marcelo de Lima Henrique, Marcos André Gomes da Penha, Marcos Mateus Pereira, Marielson Alves Silva, Nielson Nogueira Dias, Pablo dos Santos Alves, Paulo Henrique Schleich Vollkopf, Paulo Roberto Alves Junior, Rafael Traci, Rodrigo Batista Raposo, Rodrigo D'Alonso Ferreira, Rodrigo Nunes de Sá, Sávio Pereira Sampaio, Thiago Duarte Peixoto, Vinícius Furlan e Vinícius Gonçalves Dias Araújo
Special cases	Héber Roberto Lopes, Leandro Pedro Vuaden, Péricles Bassols Pegado Cortez, Rodolpho Toski Marques, Wagner do Nascimento Magalhães e Wagner Reway

Six referees were classified in the "Special cases" category due to changes in the list of Brazilian referees with a FIFA badge in January 2017[10]. In this update, referees Héber Roberto Lopes, Leandro Pedro Vuaden and Péricles Bassols Pegado Cortez were withdrawn from the list. They were replaced with Rodolpho Toski Marques, Wagner do Nascimento Magalhães and Wagner Reway, who earned the right to use the FIFA badge starting with the 2017 season. Each one of the referees had their values assigned with the value corresponding to their status in the moment of any given match they worked.

[10] ESTADÃO CONTEÚDO. *Héber, Vuaden e Bassols deixam relação de árbitros brasileiros da FIFA*. **Estadão**, 1 Jan. 2017. Available in <https://esportes.estadao.com.br/noticias/futebol,heber-vuaden-e-bassols-deixam-relacao-de-arbitros-brasileiros-da-fifa,10000097534>. Access in 2018/11/10.

Appendix 2: Results for red cards

Table 8: Number of red cards

Variables	(1)	(2)	(3)
Visitor	0.05142***	0.05212***	0.05344***
	(0.016)	(0.016)	(0.019)
Fouls	0.00091	0.00124	0.00259
	(0.001)	(0.002)	(0.002)
Goals scored	-0.01013	-0.00803	-0.03291**
	(0.007)	(0.007)	(0.015)
Goals suffered	0.02711***	0.02749***	0.07059***
	(0.007)	(0.007)	(0.014)
Substitutions	0.01835	0.01860	0.03093
	(0.029)	(0.030)	(0.033)
Extra time (1st half)	0.00980	0.01018	0.01150
	(0.006)	(0.007)	(0.009)
Extra time (2nd half)	0.03043***	0.03445***	0.03936***
	(0.009)	(0.009)	(0.013)
Constant	-0.13817	-0.30085***	-0.08554
	(0.093)	(0.113)	(0.158)
Year, round and team fixed effects	No	Yes	Yes
Close games	No	No	Yes
Observations	2,278	2,278	1,560
R-squared	0.031	0.067	0.099

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Number of red cards in close matches – Pressure factors

Variables	(3) Basic results	(4) Top Referee	(5) No Athletic track	(6) Attendance	(7) Attendance-to-capacity	(8) Second home	(9) Punishment
Visitor	0.05344***	0.04582*	0.06275**	0.03622	0.07585**	0.05783***	0.05147***
	(0.019)	(0.026)	(0.026)	(0.259)	(0.033)	(0.021)	(0.019)
Fouls	0.00259	0.00251	0.00251	0.00118	0.00131	0.00259	0.00245
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Goals scored	-0.03291**	-0.03326**	-0.03280**	-0.04052***	-0.00955	-0.03267**	-0.03193**
	(0.015)	(0.015)	(0.015)	(0.014)	(0.007)	(0.015)	(0.015)
Goals suffered	0.07059***	0.07021***	0.07064***	0.06930***	0.02628***	0.07090***	0.07005***
	(0.014)	(0.014)	(0.014)	(0.015)	(0.007)	(0.014)	(0.014)
Substitutions	0.03093	0.02939	0.03070	0.02520	0.02195	0.03044	0.02991
	(0.033)	(0.033)	(0.033)	(0.034)	(0.029)	(0.033)	(0.033)
Extra time (1st half)	0.01150	0.01232	0.01128	0.01122	0.01004	0.01090	0.01152
	(0.009)	(0.009)	(0.009)	(0.010)	(0.007)	(0.009)	(0.009)
Extra time (2nd half)	0.03936***	0.03927***	0.03980***	0.04520***	0.03065***	0.03917***	0.03951***
	(0.013)	(0.013)	(0.013)	(0.014)	(0.009)	(0.013)	(0.013)
Pressure variable		-0.04098*	0.02497	-0.00038	0.05884	-0.03716	-0.10614*
		(0.022)	(0.029)	(0.021)	(0.049)	(0.031)	(0.054)
Interaction		0.01737	-0.01989	0.00080	-0.05468	-0.03222	0.28287
		(0.037)	(0.041)	(0.028)	(0.068)	(0.047)	(0.185)
Constant	-0.08554	-0.06045	-0.10120	-0.10026	-0.12600	-0.07838	-0.07999
	(0.158)	(0.159)	(0.170)	(0.251)	(0.122)	(0.158)	(0.158)
Year, round and team fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Close games	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,560	1,560	1,560	1,428	2,232	1,560	1,560
R-squared	0.099	0.101	0.099	0.107	0.064	0.101	0.100

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Number of red cards in close matches – Monitoring factors

Variables	(3) Basic results	(10) Broadcast	(11) Regional derby	(12) Small matches
Visitor	0.05344***	0.05928**	0.04662**	0.05993***
	(0.019)	(0.023)	(0.019)	(0.021)
Fouls	0.00259	0.00271	0.00239	0.00262
	(0.002)	(0.002)	(0.002)	(0.002)
Goals scored	-0.03291**	-0.03353**	-0.03274**	-0.03277**
	(0.015)	(0.015)	(0.015)	(0.015)
Goals suffered	0.07059***	0.07084***	0.07031***	0.07035***
	(0.014)	(0.014)	(0.014)	(0.014)
Substitutions	0.03093	0.03094	0.02930	0.03098
	(0.033)	(0.033)	(0.033)	(0.033)
Extra time (1st half)	0.01150	0.01127	0.01138	0.01161
	(0.009)	(0.009)	(0.009)	(0.009)
Extra time (2nd half)	0.03936***	0.03874***	0.03896***	0.03929***
	(0.013)	(0.013)	(0.013)	(0.013)
Monitoring variable		-0.02903	-0.01667	0.00724
		(0.026)	(0.043)	(0.033)
Interaction		-0.02433	0.09472	-0.03326
		(0.041)	(0.084)	(0.047)
Constant	-0.08554	-0.07824	-0.07643	-0.08448
	(0.158)	(0.159)	(0.158)	(0.159)
Year, round and team fixed effects	Yes	Yes	Yes	Yes
Close games	Yes	Yes	Yes	Yes
Observations	1,560	1,560	1,560	1,560
R-squared	0.099	0.101	0.100	0.099

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.