Bühren, Christoph; Jung, Dominic

Working Paper

Performing without pressure? The effect of ghost games on effort- and skill-based tasks in the football Bundesliga

MAGKS Joint Discussion Paper Series in Economics, No. 27-2022

Provided in Cooperation with:
Faculty of Business Administration and Economics, University of Marburg

Suggested Citation: Bühren, Christoph; Jung, Dominic (2022) : Performing without pressure? The effect of ghost games on effort- and skill-based tasks in the football Bundesliga, MAGKS Joint Discussion Paper Series in Economics, No. 27-2022, Philipps-University Marburg, School of Business and Economics, Marburg

This Version is available at:
https://hdl.handle.net/10419/266025

Joint Discussion Paper Series in Economics

by the Universities of

Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 27-2022

Christoph Bühren and Dominic Jung

Performing without Pressure? The Effect of Ghost Games on Effort- and Skill-based Tasks in the Football Bundesliga

This paper can be downloaded from:

https://www.uni-marburg.de/en/fb02/research-groups/economics/macroeconomics/research/magks-joint-discussion-papers-in-economics

Coordination: Bernd Hayo • Philipps-University Marburg
School of Business and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

Performing without pressure? The effect of ghost games on effort- and skill-based tasks in the football Bundesliga

Christoph Bühren, Faculty of Sport Science, Ruhr-Universität Bochum,
christoph.buehren@rub.de

Dominic Jung, Department of Economics, Clausthal University of Technology,
dominic.jung@tu-clausthal.de

Abstract

We analyze the natural experiment of ghost games in the 2019/2020 season of the German football Bundesliga and confirm previous studies showing that the home advantage diminishes if the stadium is empty. However, our paper is the first that distinguishes between effort- and skill-based tasks in this setting. In line with behavioral economics, we observe that a supportive audience has a positive effect on effort-based performance but a negative effect on some offensive skill-based performance measures.

Keywords: Ghost games; home advantage; effort vs. skill, Covid-19

JEL: C93; Z20

Introduction

According to Amplifon (2020), the stadium of Borussia Dortmund is one of the loudest in the world. In the season before the pandemic (2018/2019), the team would have won the German Championship if only home matches would have been considered. Pollard (2008) lists several reasons for home advantages in football – for instance, crowd effects, referee bias, and psychological factors – and concludes that the phenomenon of home advantage is complex and open for future research. It is not even clear whether high (psychological) incentives to perform well in front of a supportive audience are always advantageous (see, e.g., Harb-Wu and Krumer, 2019).

To shed more light on home (dis-)advantages, we make use of the natural experiment of ghost games in the football Bundesliga in the second half of the 2019/2020 season. We compare these ghost games to the corresponding matches of the first half of the season, in which

the crowd was present. Furthermore, we compare the ghost games to the corresponding games in the same stadium during the 2018/2019 season.

Fischer and Haucap (2021) find that ghost games reduce the home advantage of teams in the first division (see Cueva, 2020, Ferraresi and Gucciardi, 2020, and Scoppa, 2021, for similar results), but not so much in the second and third division. They explain their findings with the occupancy rate in the stadiums, which is drastically reduced in the first but so much in the second and third divisions. Investigating potential channels through which the home advantage is reduced, Fischer and Haucap (2021) do not find strong support for a change of a potential referee bias or the teams' tactics (see Bryson et al., 2021, Cueva, 2020, and Scoppa, 2021, for evidence supporting the reduction of the referee bias). The authors argue that psychological reasons are more important and that future research is needed to analyze the psychological mechanisms that may drive their findings.

Our paper offers this analysis. We extend the literature on the natural experiment in football during the Covid-19-pandemic by distinguishing the effect of crowd support on effort-based performance measures vs. skill-based performance measures (see Ariely et al., 2009) using detailed team measures obtained from Opta-data.

Related Literature

A traditional key assumption in economics concerning performance-based and tournament incentives is that higher effort of individuals leads to better performance (see, e.g., Rosen, 1986). Baumeister and Showers (1986), however, challenge this assumption by reviewing the paradoxical effects of incentives on performance. One of the factors which induce incentives to perform especially well is the presence of an audience – particularly fans of the home team. Yet Baumeister and Steinhilber (1984) show that the support of the home audience may backfire. For instance, Dohmen (2008) observes that soccer players of the home team are more likely to miss important penalties than players of the away team.

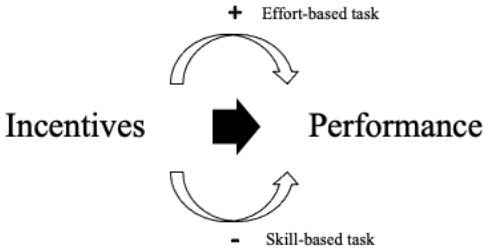
In psychology and behavioral economics, performance decrements despite high incentives are described as "choking under pressure". It is either explained by the distraction theory (Mullen et al., 2005) or by the self-focus theory (Baumeister, 1984, Masters, 1992, Mesagno et al., 1992). When the level of anxiety rises, e.g., during very important free throws in basketball (Cao et al., 2011) or penalty kicks in soccer (Jordet et al., 2007), performance decrements may either occur because players are distracted from their task or because they

focus too much on its execution – this conscious focus interferes with automatic processes and causes choking, i.e., players underperform compared to their typical level of skill. The latter theory finds more support in experimental settings, see e.g., Kent et al. (2018) for an overview.

Automatic processes are essential for sports, in which deliberate decisions making is typically too time-consuming (Gigerenzer and Todd, 1999). Baumeister (1984) finds that psychological pressure interferes with automatic processes, mediated by subjects' self-consciousness: Whereas he observes that high self-conscious subjects perform better than low self-conscious subjects in a skill-based task, he finds more evidence for choking under pressure if subjects have low self-consciousness. Cohen-Zada et al. (2017) find that the phenomenon of choking under pressure is more prevalent in competitions among men than in competitions among women.

Ariely et al. (2009) observe in a field experiment in India that very high incentives (compared to moderate incentives) improve performance in effort-based tasks but decrease performance in skill-based tasks. Complementing this finding, Harb-Wu and Krumer (2019) find evidence for choking under pressure in professional biathlon: Whereas home biathletes' skiing performance is better on average (effort-based task), their shooting performance is much worse than those of away biathletes (skill-based task). Harb-Wu and Krumer (2019) can rule out that these poor shooting results are explained by faster skiing. Home biathletes seem to perform worse because they perceive the pressure to perform especially well in front of a supportive audience (see also Wallace et al., 2005).

Figure 1
Forming the hypotheses.



In our paper, we try to deepen our understanding of the home (dis-)advantage in football by analyzing the natural experiment of ghost games during the pandemic. We go beyond the existing literature on ghost games in football by differentiating the influence of the home crowd on effort- vs. skill-based performance measures (see Figure 1). Furthermore, we distinguish

between defensive and offensive skill-based tasks, arguing that defensive skill-based tasks are closer to effort-based performance than offensive skill-based tasks. Based on the previous literature in behavioral economics, sports psychology, and sports economics, we hypothesize that

H1a: Playing at home has a positive influence on the performance in effort-based tasks of home teams in football Bundesliga.

H1b: Playing at home has a negative influence on the performance in skill-based tasks of home teams in football Bundesliga.

H2: The impact of an audience is greater for offensive skill-based tasks than for defensive skill-based tasks.

Data and Effort- vs. Skill-Based Measures

Open access to detailed football performance measures is generally limited. For our analysis, we were able to use the "F24-feed" of the seasons 2018/19 and 2019/20 for the German Bundesliga and German Bundesliga 2, provided by the sports analytics company Opta. The F24-feed contains on average 3.6 million positional data points and 1.600 event data points per match. Parsing the F24-feed with the Alteryx-software allows a unique in-depth analysis of key performance indicators in football matches with 74 action variables per team.

Comparing the ghost games in the second half of the 2019/2020 season to the corresponding matches in the first half of this season with spectators (same opponent, same season, different stadium) results in a dataset of 81 matches. We design a 2x2 treatment structure between home vs. away teams' performance in regular vs. ghost games (see Table 1). With this inner-season comparison we prevent potential between-season confounding trends in match outcomes, such as the introduction of video assistant referees, and league instructions on how to interpret the rules. However, the disadvantage of this kind of analysis is that corresponding games did not take place at the exact same location.

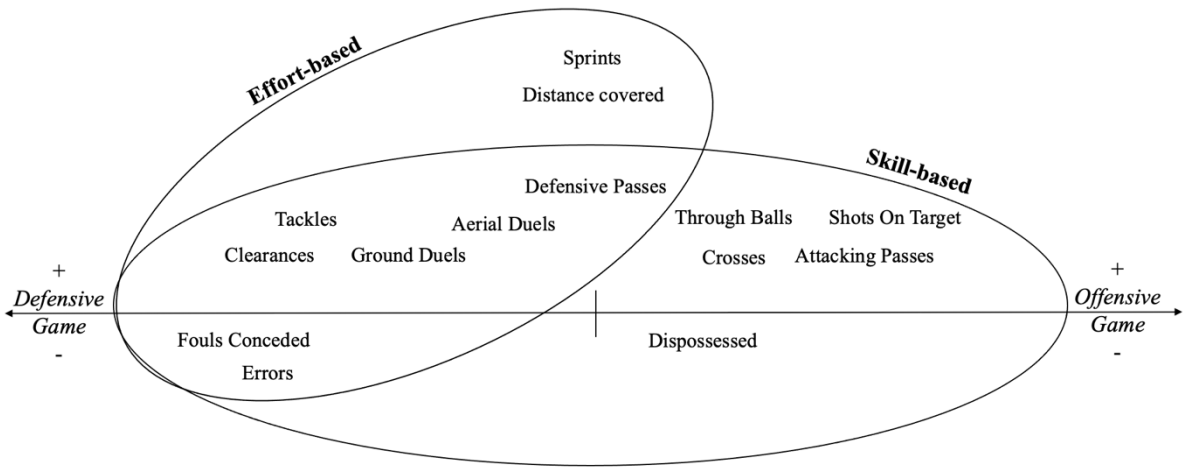
Table 1
Treatment structure.

Season 2019/20		AUDIENCE	
		Yes	**No**
VENUE	**Home**	*Home + Regular*	*Home + Ghost*
	Away	*Away + Regular*	*Away + Ghost*

Hughes & Barlett (2002) define a performance indicator (PI) as a selection, or combination, of action variables that relate to a successful outcome. To assign skill- and effort-based performance indicators in football, we follow Hughes et al. (2012), who provide the first framework of the relevant PIs in football classified into five categories: physiological, tactical, technical (defensive), technical (offensive), and psychological.

It is important to point out that the PIs in these categories have limitations. For instance, they depend on the question of how obviously non-self-serving, altruistic and cooperative behavior can be explained as part of the common good concerns not only in behavioral economics but also parts of the natural sciences. The parallels between sociobiology and behavioral economics in terms of content and methodology in relation to the explanation of altruistic and social preferences are remarkable. on the opponent (Zhou et al., 2018), the score (Wright et al., 2011; Clemente et al., 2012), the type of competition, the match location (Garcia-Rubio et al., 2015), and the game period (Pratas et al., 2012).

Figure 2
Categorization of skill- vs. effort-based variables based on Hughes et al. (2012).



In our study, we first group the 74 action variables contained in our dataset. For better interpretability, we use ratios for some of the variables. Afterwards, we assign the variables to (1) physiological and (2) technical actions after Hughes et al. (2012) (see Appendix 1). Psychological and tactical indicators are excluded. If it is unclear to which category the action variable predominantly belongs, we excluded it from further analysis. As a result, we identified eleven skill-based and two effort-based action variables out of the dataset (see Figure 1)

Whereas a clear distinction between these two categories can be made (see e.g., Rampinini et al, 2009), there are a few variables for which this categorization is more difficult. We thus follow Hughes et al. (2012) and divide skill measures by gameplay into defensive and offensive skill-based tasks. While defensive tasks (e.g., tackles) demand both effort and skill, offensive tasks in shooting and passing are based on individual skills.

We further distinguish between skill- and effort-based variables, which positively influence the team's results such as physical activity and higher accuracies in the defensive and offensive game (e.g., McGarry, 2009, Hossini et al., 2012, Carling, 2013), and variables such as errors leading to a goal or shot causing negative outcomes.

Results

In this section, we provide evidence on the performance of both home and away teams with and without an audience in the German Bundesliga. Table 2 displays the averages of team performance in effort-based, defensive skill-based, and offensive skill-based tasks with and without spectators by home vs. away teams in regular vs. ghost games. These measures are divided into action variables by panel and in the games played with or spectators by columns. The outcomes are further divided into outcomes for the home team and away team in rows. Due to the within-subject design, we used Wilcoxon signed-ranked tests. First, to identify a change in home effect we compare the home team's performances in regular games with ghost games. Table 2 shows some remarkable results:

In the effort-based tasks – distance covered and sprints – home teams generally outperform away teams in front of the crowd. They run 0.49 kilometers more than the opponent and sprint significantly more often ($p=0.0932$). Due to spectators, we see a home advantage that leads to higher performance in effort-based tasks. However, when the spectators disappear, the advantage also disappears. Both variables change their positive signs into negative signs. The away team is now stronger.

Whereas we see a home advantage for effort-based tasks in regular games, the home venue turns into a disadvantage for skill-based tasks. Home teams outperform away teams in just 3 out of 7 defensive skill-based tasks in front of the crowd. The away team has significantly more clearances ($p=0.0028$) and better defensive pass accuracy ($p=0.0225$). Without an audience, this effect changes. Home teams perform in 6 out of 7 action variables equally or even better without spectators, just fouls conceded represent an exception to this trend. The players might not feel social pressure. This is further significant for errors ($p=0.0325$) and ground duels ($p=0.0325$). For offensive skill-based tasks, we observe the same trend for all the 5 action variables with higher accuracies and lower dispossession rates confirming that the home effect disappears without spectators.

Table 2
The behavior of teams in games with and without spectators.

	Effort-based tasks			Skill-based tasks (defensive)			Skill-based tasks (offensive)		
	Regular (1)	Ghost (2)	Difference (2)-(1)	Regular (1)	Ghost (2)	Difference (2)-(1)	Regular (1)	Ghost (2)	Difference (2)-(1)
	Distance covered			**Fouls Conceded**			**Dispossessed**		
Home (a)	116.67 (4.38)	115.23 (4.68)	-1.44 (6.39)	12.41 (3.62)	12.79 (3.81)	0.37 (4.69)	9.83 (3.65)	8.88 (3.61)	-0.95 (5.46)
Away (b)	116.18 (5.10)	115.30 (4.39)	-0.88** (6.55)	12.76 (3.92)	12.44 (4.00)	-0.33 (5.18)	9.72 (3.64)	9.22 (3.76)	-0.49 (5.06)
Diff (a)-(b)	0.49 (3.54)	-0.07 (3.54)	-0.56 (5.17)	-0.35 (4.70)	0.35 (5.05)	0.70 (7.99)	0.11 (4.97)	-0.35 (4.60)	-0.46 (7.31)
	Sprints			**Errors Leading to a Shot or Goal**			**Through Balls Accuracy (%)**		
Home (a)	226.98 (30.76)	221.78 (27.40)	-5.20 (37.77)	0.28 (0.55)	0.15 (0.39)	-0.13*** (0.68)	0.24 (0.38)	0.22 (0.36)	-0.02 (0.57)
Away (b)	221.19 (32.92)	224.53 (31.85)	3.34 (43.98)	0.39 (0.61)	0.36 (0.75)	-0.03 (0.98)	0.27 (0.41)	0.21 (0.39)	-0.06 (0.55)
Diff (a)-(b)	5.76* (32.76)	-2.75 (30.48)	-8.54 (53.60)	-0.11 (0.76)	-0.21** (0.88)	-0.10 (1.18)	-0.03 (0.54)	0.01 (0.55)	0.04 (0.79)
				Clearances			**Crosses Accuracy (%)**		
Home (a)				17.01 (8.12)	17.37 (9.12)	0.36*** (11.99)	0.21 (0.13)	0.24 (0.15)	0.03 (0.18)
Away (b)				23.12 (10.14)	18.56 (8.83)	-4.56 (14.39)	0.24 (0.14)	0.21 (0.15)	-0.03 (0.21)
Diff (a)-(b)				-6.11*** (15.49)	-1.19 (14.85)	4.93 (22.79)	-0.30 (0.18)	0.30 (0.22)	0.06 (0.29)
				Tackles			**Attacking Passes Accuracy (%)**		
Home (a)				16.54 (5.13)	15.79 (4.85)	-0.75* (6.56)	0.64 (0.06)	0.67 (0.09)	0.02** (0.13)
Away (b)				17.05 (5.08)	15.11 (5.09)	-1.94** (6.72)	0.65 (0.08)	0.65 (0.09)	0.00 (0.22)
Diff (a)-(b)				-0.51 (6.47)	0.68 (6.03)	1.19 (9.35)	0.00 (0.11)	0.02 (0.26)	0.02 (0.20)
				Ground Duels Won (%)			**Shots on Target Accuracy (%)**		
Home (a)				0.50 (0.14)	0.56 (0.10)	0.06 (0.21)	0.59 (0.14)	0.61 (0.17)	0.02 (0.25)
Away (b)				0.52 (0.13)	0.52 (0.13)	0.00 (0.18)	0.58 (0.17)	0.60 (0.16)	-0.02 (0.22)
Diff (a)-(b)				-0.02 (0.22)	0.04** (0.17)	0.06 (0.27)	0.01 (0.24)	0.01 (0.22)	0.00 (0.34)
				Aerial Duels Won (%)					
Home (a)				0.51 (0.11)	0.50 (0.10)	-0.01 (0.15)			
Away (b)				0.49 (0.11)	0.50 (0.10)	0.01 (0.15)			
Diff (a)-(b)				0.01 (0.21)	0.01 (0.21)	0.00 (0.29)			
				Defensive Passes Accuracy (%)					
Home (a)				0.30 (0.18)	0.27 (0.13)	-0.02*** (0.26)			
Away (b)				0.38 (0.15)	0.29 (0.19)	-0.08 (0.22)			
Diff (a)-(b)				-0.08** (0.25)	-0.02 (0.24)	-0.06 (0.3)			

Notes: n=81; Standard error in parentheses; * p<0.1, ** p<0.05, *** p<0.01 based on two-sided Wilcoxon signed rank tests

Figures 3 and 4 analyze effort-based team performance measures and show that with spectators in the stadium home and away teams run more than without spectators, this trend is significant for away teams ($p=0.0362$). Whereas home teams also sprint more in front of a crowd, away teams sprint more in ghost games (225 to 221 sprints).

Figures 5 to 11 look at defensive skill-based performance measures. Home teams concede more and away teams fewer fouls in ghost games. Both teams reduce their errors leading to an opponent's shot or goal if the crowd is absent. Clearances of the away team decrease massively by around 20 percent, while home teams' clearances rise. However, both teams perform fewer tackles in front of a crowd (also significantly for the away team, $p=0.0436$). Home teams win ground duels slightly more often in ghost compared to regular games. Yet the audience does not influence the success rate of aerial duels. Whereas away teams' defensive pass accuracy is not affected by spectators, home teams' defensive passes are more precise with spectators ($p<0.01$).

Figures 12 to 16 compare performances in offensive skill-based tasks. Home and away teams lose the ball less often and are more successful with through balls in front of an audience. While home teams' crosses are more successful without spectators, away teams' crosses are more successful with spectators. Away teams' offensive pass accuracy is not influenced by spectators. However, home teams' offensive passes ($p=0.0394$) and shots on target are more precise in ghost games compared to regular games. In contrast, away teams' shots are better in regular games than in ghost games.

Figures 3-15

Performance by task of home vs. away teams in regular vs. ghost games

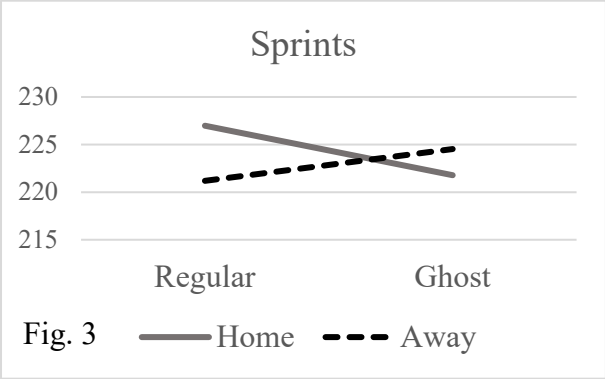


Fig. 3

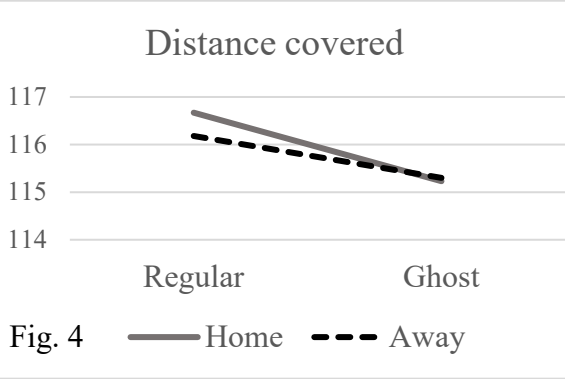


Fig. 4

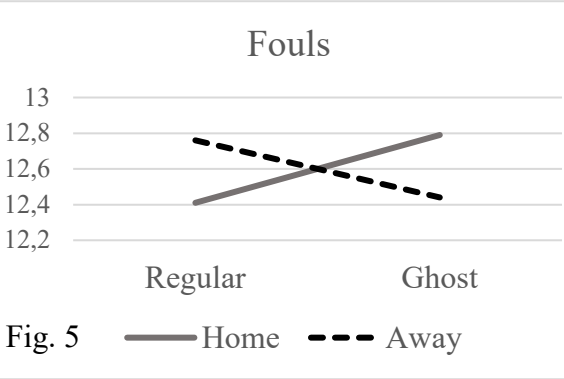


Fig. 5

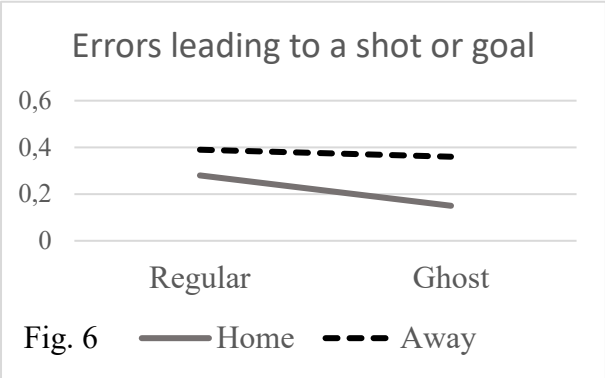


Fig. 6

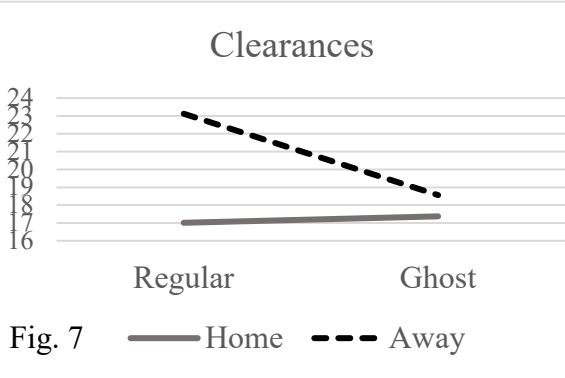


Fig. 7

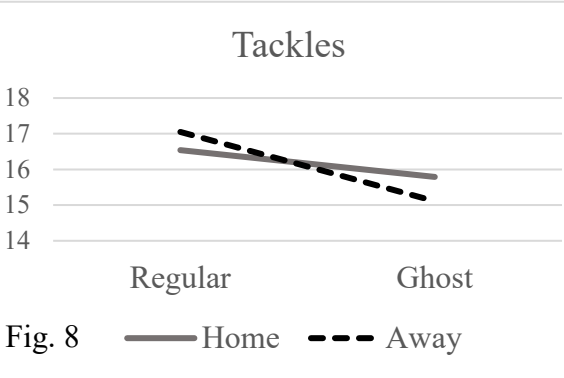


Fig. 8

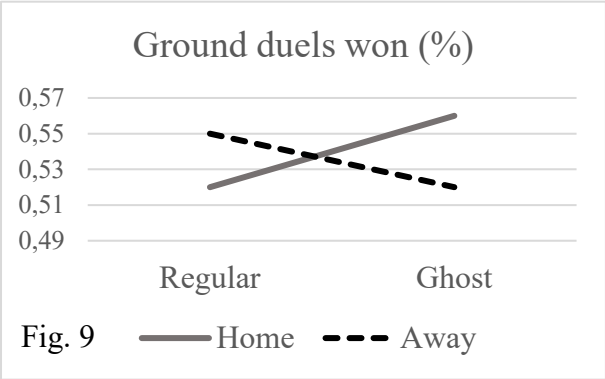


Fig. 9

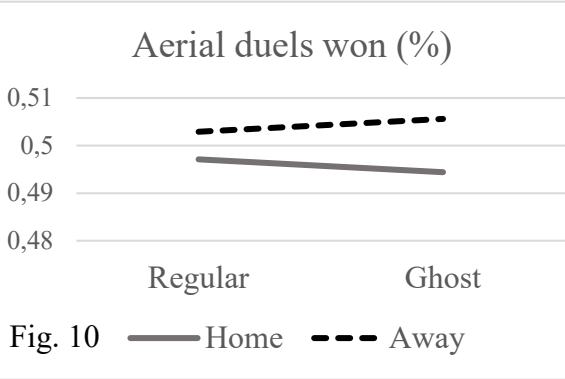


Fig. 10

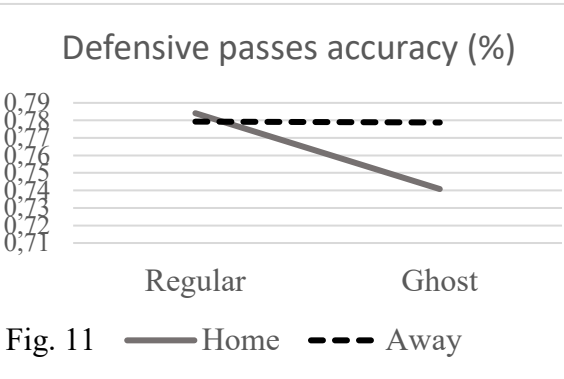


Fig. 11

Fig. 12

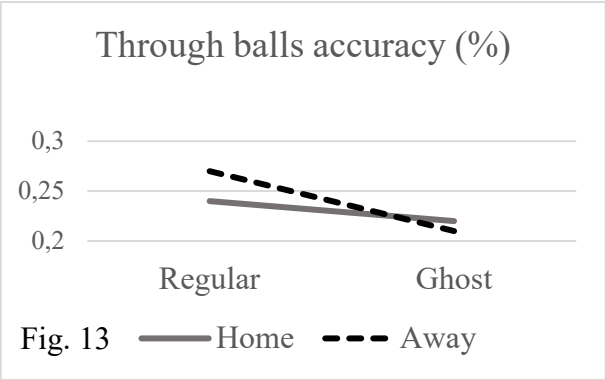


Fig. 13

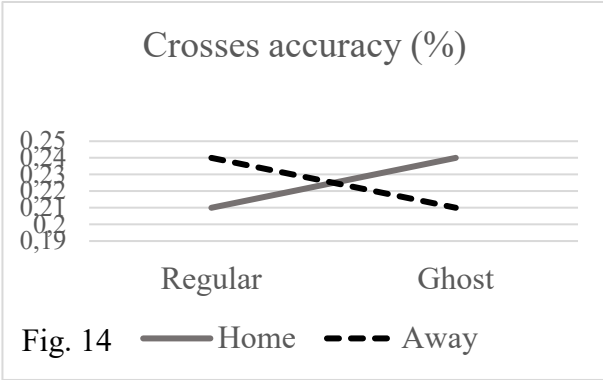


Fig. 14

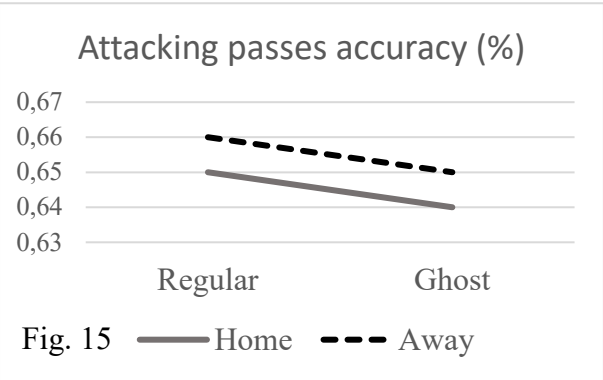


Fig. 15

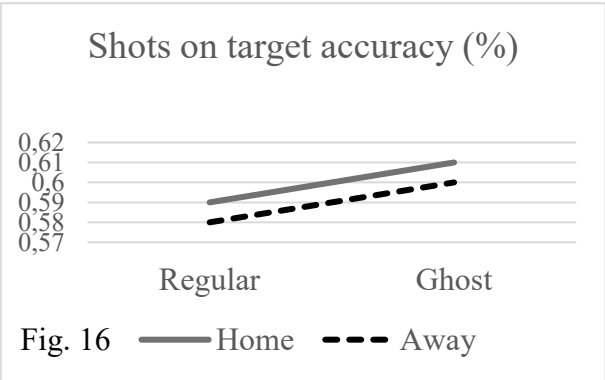


Fig. 16

As a robustness check, we calculated an OLS regression for each performance measure as the dependent variable and the dummies *Home* (1 for home team, 0 for away team) and *Ghost* (1 for ghost game, 0 for regular game) and the interaction term of *Home* and *Ghost* as the independent variables:

$$Performance\ measure = \alpha + \beta 1\ Home + \beta 2\ Ghost + \beta 3\ Home\ x\ Ghost$$

The results in Table 3 show significant positive interaction effects for clearances and ground duels and a significant negative interaction between *Home* and *Ghost* for defensive passes. The coefficient for *Home* is significantly negative for clearances, ground duels, and crosses. Similarly, the coefficient for *Ghost* is significantly negative for clearances and ground duels. Taken together, the regression results confirm our analyses in Table 2 and Figures 3-15.

Furthermore, we compared the ghost games not only to the corresponding regular games in the first half of the season 2019/2020 but, if possible, also to the identical games in 2018/2019. The advantage of this comparison is that these games are played in the same stadium. The disadvantage is that we cannot conduct this analysis for teams that managed to promote from the second division in 2018/2019. Furthermore, we do not have data on the two purely effort-based variables distance covered and sprints from 2018/2019. The results are displayed in Appendix 2 and confirm our main findings from Table 2.

Table 3: OLS regressions

	Sprints		Distance Covered		Fouls Conceded		Errors		Clearances		Tackles		Ground Duels		Aerial Duels		Defensive Passes		Dispossessed		Through Balls		Crosses		Attacking Passes		Shots on target	
	Coef.	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**	**Coef.**	**Std. err.**
Home	5.79	4.84	0.49	0.73	-0.35	0.60	-0.11	0.09	-6.11***	1.42	-1.25	0.78	-0.03*	0.02	-0.0093	0.01	-0.0050	0.01	0.11	0.58	0.04	0.10	-0.02*	0.02	-0.02	0.01	-0.01	0.02
Ghost	9.73	4.84	-0.88	0.73	-0.33	0.60	-0.03	0.09	-4.56***	1.42	0	0	-0.05**	0.02	0.0008	0.01	-0.01	0.01	-0.49	0.58	-0.06	0.09	-0.02	0.02	-0.01	0.01	-0.02	0.02
Home#Ghost	-8.54	6.84	-0.56	1.03	0.70	0.85	-0.09	0.13	4.92**	2.01	0	0	0.05**	0.02	-0.0017	0.02	-0.03*	0.01	-0.45	0.82	0.04	0.13	0.05	0.03	0.01	0.01	0.0038	0.03
Constant	221.18***	3.42	116.18***	0.51	12.77***	0.42	0.39***	8.85	23.12***	1.00	17.04***	0.55	0.55***	0.01	0.50***	0.01	0.79***	0.0097	9.71***	0.41	0.48***	0.07	0.23***	0.01	0.66***	0.0093	0.61***	0.01
N	324		324		324		324		324		162		324		324		324		324		160		323		324		324	
R^2	0.0057		0.017		0.0021		0.0254		0.0681		0.0160		0.0207		0.0024		0.0516		0.0107		0.0105		0.0093		0.0125		0.0051	
Adj. R^2	-0.0036		0.0078		-0.0072		0.0163		0.0594		0.0099		0.0115		-0.0070		0.0427		0.0014		-0.0085		-0.0001		0.0032		-0.0042	
F, Prob>F	0.61, p=0.6094		1.84, p=0.139		0.61, p=0.8773		2.78, p=0.0409		7.79, p<0.01		2.60, p=0.1087		2.25, p=0.0820		0.25, p=0.8583		5.80, p<0.01		1.15, p=0.3295		0.55, p=0.6465		0.99, p=0.3962		1.35, p=0.2585		0.55, p=0.6505	

Notes: Significance levels * p<0.1, ** p<0.05, *** p<0.01.

Conclusion & Discussion

We analyze the effect of spectators on the performance of home and away teams with the natural experiment of ghost games in the German football Bundesliga during the season 2019/2020. Our paper contributes to the literature on the weakening of home advantages in ghost games by distinguishing between effort vs. skill tasks and defensive vs. offensive skill tasks (see Leitner et al., 2022, for a review). We confirm the literature's findings concerning effort-based and some defensive skill-based tasks, but we find the opposite effect for offensive skill-based tasks. We argue that the performance in the latter tasks is dominated by skill and thus likely to be affected by choking under pressure in front of a supportive audience. Furthermore, we distinguish the effects of ghost games on home vs. away teams.

The incentive to perform well in front of a supportive audience seems to increase the performance in effort-based tasks, whereas away teams seem to be less intimidated and more active in effort-based tasks if the opposing fans are absent. This relationship is turned around when we look for instance at the offensive skill-based task crosses. The home teams' crosses accuracy is higher without spectators than with spectators. For away teams, however, the percentage of successful crosses is lower in ghost games than in regular games. This result indicates choking under the pressure to perform well in front of the home audience in skillful tasks. In these tasks, away teams seem to feel more pressure to perform well in ghost games, whereas the lower weight of expectations in regular away games seems to foster their performance. While offensive technical tasks are clearly skill-based, defensive technical tasks require not only skill but also some effort. For the defensive skill-based task tackles we see that the interaction between home vs. away teams' performance in regular vs. ghost games is in the same direction but much less pronounced.

Our results imply that home advantages or disadvantages are depending on the sport and the tasks within the sport – from purely effort-based to purely skill-based tasks. Considering these opposing effects could be important for players, coaches, managers, consultants, and the design of fair competitions.

Our study's limitations may encourage future research. For example, our results can now be compared with the season after the ghost game season, in which more and more visitors were allowed in the stadium. As a robustness check, we compared the ghost games to the same games (if possible) in the season before and did not find different results than those presented in the paper. Nevertheless, it would be interesting to analyze the effects with different capacities allowed in the stadiums.

References

Amplifon (2021): *The loudest football stadiums in the world.* https://www.amplifon.com/uk/audiology-magazine/loudest-football-stadiums-in-the-world (retrieved July 13th, 2022).

Ariely, D., Gneezy, U., Loewenstein, G., and Mazar, N. (2009). Large stakes and big mistakes. *The Review of Economic Studies*, 76(2), 451-469. https://doi.org/10.1111/j.1467-937X.2009.00534.x.

Baumeister, R. F. (1984). Choking under pressure: self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality and Social Psychology*, *46*(3), 610-620. https://doi.org/10.1037/0022-3514.46.3.610.

Baumeister, R. F., & Showers, C. J. (1986). A review of paradoxical performance effects: Choking under pressure in sports and mental tests. *European Journal of Social Psychology*, *16*(4), 361-383. https://doi.org/10.1002/ejsp.2420160405

Baumeister, R. F., and Steinhilber, A. (1984). Paradoxical effects of supportive audiences on performance under pressure: The home field disadvantage in sports championships. *Journal of Personality and Social Psychology, 47*(1), 85. https://doi.org/10.1037/0022-3514.47.1.85.

Bryson, A., Dolton, P., Reade, J. J., Schreyer, D., & Singleton, C. (2021). Causal effects of an absent crowd on performances and refereeing decisions during Covid-19. *Economics Letters*, *198*, https://doi.org/10.1016/j.econlet.2020.109664.

Cao, Z., Price, J., and Stone, D. F. (2011). Performance under pressure in the NBA. *Journal of Sports Economics, 12*(3), 231-252. https://doi.org/10.1177/1527002511404785.

Carling, C. (2013). Interpreting physical performance in professional soccer match-play: should we be more pragmatic in our approach?. *Sports Medicine*, *43*(8), 655-663. https://doi.org/10.1007/s40279-013-0055-8.

Clemente, F., Couceiro, M., Martins, F. M., & Mendes, R. (2012). Team's performance on FIFA U17 World Cup 2011: study based on notational analysis. *Journal of Physical Education and Sport*, *12*(1), 13. https://www.efsupit.ro/images/stories/vol_12_1__art_3.pdf.

Cohen-Zada, D., Krumer, A.; Rosenboim, M., and Shapir, O. M. (2017). Choking under pressure and gender: Evidence from professional tennis. *Journal of Economic Psychology, 61*, 176-190. https://doi.org/10.1016/j.joep.2017.04.005.

Cueva, C. (2020). *Animal Spirits in the Beautiful Game. Testing social pressure in professional football during the COVID-19 lockdown*. Mimeo. https://web.ua.es/va/actualidad-universitaria/documentos/2020/octubre2020/football-covid.pdf

Dohmen, T. J. (2008). Do professionals choke under pressure?. *Journal of Economic Behavior and Organization, 65*(3-4), 636-653. https://doi.org/10.1016/j.jebo.2005.12.004.

Ferraresi, M., & Gucciardi, G. (2020). *Team performance and audience: experimental evidence from the football sector*. Società Italiana di Economia Pubblica. https://www.researchgate.net/profile/Massimiliano-Ferraresi/publication/344106744_Team_performance_and_audience_experimental_evidence_from_the_football_sector/links/5f526a86299bf13a319f78ce/Team-performance-and-audience-experimental-evidence-from-the-football-sector.pdf

Fischer, K., & Haucap, J. (2021). Does Crowd Support Drive the Home Advantage in Professional Football? Evidence from German Ghost Games during the COVID-19 Pandemic. *Journal of Sports Economics*. https://doi.org/10.1177/15270025211026552.

Frencken, W., Poel, H. D., Visscher, C., & Lemmink, K. (2012). Variability of inter-team distances associated with match events in elite-standard soccer. *Journal of Sports Sciences*, *30*(12), 1207-1213. https://doi.org/10.1080/02640414.2012.703783.

García-Rubio, J., Gómez, M. Á., Lago-Peñas, C., & Ibáñez, J. S. (2015). Effect of match venue, scoring first and quality of opposition on match outcome in the UEFA Champions League. *International Journal of Performance Analysis in Sport*, *15*(2), 527-539. https://doi.org/10.1080/24748668.2015.11868811.

Gigerenzer, G., and Todd, P. M., and the ABC Research Group (1999). *Simple heuristics that make us smart*. New York: Oxford University Press.

Harb-Wu, K. and Krumer, A. (2019). Choking under pressure in front of a supportive audience: Evidence from professional biathlon. *Journal of Economic Behavior and Organization*, *166*, 246-262. https://doi.org/10.1016/j.jebo.2019.09.001.

Hossini, F., Rezae, S. R., & Masuodi, N. M. (2012). Effectiveness of types of individual defense performance in achieving success. *International Research Journal of Applied and Basic Science*, *3*, 891-895. https://irjabs.com/files_site/paperlist/r_390_121110141541.pdf.

Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*(10), 739-754. https://doi.org/10.1080/026404102320675602.

Hughes, M. D., Caudrelier, T., James, N., Redwood-Brown, A., Donnelly, I., Kirkbride, A., & Duschesne, C. (2012). Moneyball and soccer-an analysis of the key performance indicators of elite male soccer players by position, *Revistas – Journal of Human Sport and Exercise, 7*(2), 402-412. http://dx.doi.org/10.4100/jhse.2012.72.06.

Jordet, G., Hartman, E., Visscher, C., and Lemmink, K. A. (2007). Kicks from the penalty mark in soccer: The roles of stress, skill, and fatigue for kick outcomes. *Journal of Sports Sciences, 25*(2), 121-129. https://doi.org/10.1080/02640410600624020.

Kent, S., Devonport, T. J., Lane, A. M., Nicholls, W., and Friesen, A. P. (2018). The effects of coping interventions on ability to perform under pressure. *Journal of Sports Science and Medicine*, 17(1), 40-55. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5844208/.

Leitner, M. C., Daumann, F., Follert, F., & Richlan, F. (2022). The cauldron has cooled down: a systematic literature review on home advantage in football during the COVID-19 pandemic from a socio-economic and psychological perspective. *Management Review Quarterly*, 1-29. https://doi.org/10.1007/s11301-021-00254-5

Masters, R. S. (1992). Knowledge, knerves and know-how: The role of explicit versus implicit knowledge in the breakdown of a complex motor skill under pressure. *British Journal of Psychology, 83*(3), 343-358. https://doi.org/10.1111/j.2044-8295.1992.tb02446.x.

McGarry, T. (2009). Applied and theoretical perspectives of performance analysis in sport: Scientific issues and challenges. *International Journal of Performance Analysis in Sport*, *9*(1), 128-140. https://doi.org/10.1080/24748668.2009.11868469.

Mesagno, C., Marchant, D., and Morris, T. (2009). Alleviating choking: The sounds of distraction. *Journal of Applied Sport Psychology, 21*(2), 131-147. https://doi.org/10.1080/10413200902795091.

Mullen, R., Hardy, L., Tattersall, A., 2005. The effects of anxiety on motor performance: A test of the Conscious Processing Hypothesis. *Journal of Sport and Exercise Psychology*, *27*, 221–225. https://doi.org/10.1080/10413200902795091.

Pollard, R. (2008). Home advantage in football: A current review of an unsolved puzzle. *The Open Sports Sciences Journal*, 1(1), 12-14. https://doi.org/10.2174/1875399X00801010012.

Pratas, J., Volossovitch, A., & P Ferreira, A. (2012). The Effect of Situational Variables on Teams' Performance in Offensive Sequences Ending in a Shot on Goal. A Case Study. *The Open Sports Science Journal*, *5*(1). https://doi.org/10.2174/1875399X01205010193.

Rosen, S. (1986). Prizes and Incentives in Elimination Tournaments. *The American Economic Review*, *76*(4), 701-715. https://www.jstor.org/stable/1806068

Scoppa, V. (2021). Social pressure in the stadiums: Do agents change behavior without crowd support?. *Journal of Economic Psychology*, *82*, 102344, https://doi.org/10.1016/j.joep.2020.102344.

Wallace, H. M., Baumeister, R. F., and Vohs, K. D. (2005). Audience support and choking under pressure: A home disadvantage?. *Journal of Sports Sciences*, *23*(4), 429-438. https://doi.org/10.1080/02640410400021666.

Wright, C., Atkins, S., Polman, R., Jones, B., & Sargeson, L. (2011). Factors associated with goals and goal scoring opportunities in professional soccer. *International Journal of Performance Analysis in Sport*, *11*(3), 438-449. https://doi.org/10.1080/24748668.2011.11868563.

Zhou, C., Zhang, S., Lorenzo Calvo, A., & Cui, Y. (2018). Chinese soccer association super league, 2012–2017: key performance indicators in balance games. *International Journal of Performance Analysis in Sport*, *18*(4), 645-656. https://doi.org/10.1080/24748668.2018.1509254.

Appendix 1
Complete categorization catalog of skill- and effort-based variables

Action Variable	After Hughes	Description	Task	Game
Sprints	1	Number of Sprints	Effort	Both
Distance covered	1	Km per Team	Effort	Both
Fouls Conceded	-2	An illegal maneuver by a player that results in a free kick for the opposing team (does not include offsides)	Skill	Defense
Errors Leading To A Shot Or Goal	-2	When a player makes an error, which leads to a goal or shot conceded. Also used for spills and attempted claims or saves by a goalkeeper which directly leads to a second attempt to score.	Skill	Defense
Clearances	2	This is a defensive action where a player kicks the ball away from his own goal with no intended recipient of the ball.	Skill	Defense
Tackles	2	Dispossessing an opponent, whether the tackling player comes away with the ball or not	Skill	Defense
Ground Duels Won (%)	2	A duel is an 50-50 contest between two players of opposing sides in the match.	Skill	Defense
Aerial Duels Won (%)	2	Winning a header in a direct contest with an opponent	Skill	Defense
Defensive Passes Accuracy (%)	2	Successful passes divided by total attempted passes broken down to defensive third of the pitch	Skill	Defense
Dispossessed	-2	Being tackled by an opponent without attempting to dribble past them	Skill	Offense
Through Balls Accuracy (%)	2	An attempted/accurate pass between opposition players in their defensive line to find an onrushing teammate (running through on goal)	Skill	Offense
Crosses Accuracy (%)	2	An attempted/accurate pass from a wide position to a central attacking area	Skill	Offense
Attacking Passes Accuracy (%)	2	Successful passes divided by total attempted passes broken down to attacking third of the pitch	Skill	Offense
Shots On Target Accuracy (%)	2	An attempt to score a goal, made with any (legal) part of the body, either on or off target	Skill	Offense

Appendix 2: Robustness Check

The behavior of teams in identical games with spectator 18/19 and without spectators 19/20

	Skill-based tasks (defensive)			Skill-based tasks (offensive)		
	Regular 18/19 (1)	Ghost 19/20 (2)	Difference (2)-(1)	Regular 18/19 (1)	Ghost 19/20 (2)	Difference (2)-(1)
	Fouls Conceded			**Dispossessed**		
Home (a)	10.91 (3.73)	12.79 (3.81)	1.98** (5.30)	10.14 (3.81)	8.88 (3.61)	-0.82 (5.65)
Away (b)	12.30 (4.31)	12.44 (4.00)	0.07 (6.64)	10.98 (4.40)	9.22 (3.76)	-1.75** (5.07)
Diff (a)-(b)	-1.39 (4.70)	0.35 (5.05)	1.51 (5.61)	-0.83 (5.34)	-0.35 (4.60)	1.14 (6.64)
	Errors Leading to a Shot or Goal			**Through Balls Accuracy (%)**		
Home (a)	0.45 (0.66)	0.15 (0.39)	-0.36* (0.64)	0.27 (0.41)	0.22 (0.36)	-0.1 (0.49)
Away (b)	0.28 (0.49)	0.36 (0.75)	0.05 (0.90)	0.27 (0.43)	0.21 (0.39)	-0.06 (0.59)
Diff (a)-(b)	0.16 (0.86)	-0.21** (0.88)	-0.35 (1.43)	-0.00 (0.65)	0.01 (0.55)	0.02 (0.81)
	Clearances			**Crosses Accuracy (%)**		
Home (a)	20.21 (9.07)	17.37 (9.12)	-3,69** (13.32)	0.22 (0.13)	0.24 (0.15)	0.00 (0.16)
Away (b)	23.53 (9.04)	18.56 (8.83)	-3.83** (11.77)	0.21 (0.14)	0.21 (0.15)	-0.01 (0.23)
Diff (a)-(b)	-3.32* (15.95)	-1.19 (14.85)	-0.46 (23.22)	0.01 (0.19)	0.30 (0.22)	0.01 (0.28)
	Tackles			**Shots on Target Accuracy (%)**		
Home (a)	18.14 (5.59)	15.79 (4.85)	-1.95 (6.92)	0.59 (0.13)	0.61 (0.17)	0.04 (0.21)
Away (b)	17.28 (5.08)	15.11 (5.09)	-1.92** (8.06)	0.62 (0.15)	0.60 (0.16)	-0.01 (0.24)
Diff (a)-(b)	0.85 (6.76)	0.68 (6.03)	-0.39 (8.49)	-0.03 (0.19)	0.01 (0.22)	0.03 (0.28)
	Ground Duels Won (%)					
Home (a)	0.53 (0.13)	0.56 (0.10)	0.03 (0.17)			
Away (b)	0.54 (0.14)	0.52 (0.13)	-0.02 (0.18)			
Diff (a)-(b)	-0.01 (0.22)	0.04** (0.17)	0.04 (0.25)			
	Aerial Duels Won (%)					
Home (a)	0.50 (0.09)	0.50 (0.10)	0.00 (0.14)			
Away (b)	0.50 (0.09)	0.50 (0.10)	0.01 (0.13)			
Diff (a)-(b)	0.00 (0.19)	0.01 (0.21)	0.00 (0.30)			

Notes: n=58; Standard error in parentheses; * p<0.1, ** p<0.05, *** p<0.01 based on two-sided Wilcoxon signed rank tests