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ABSTRACT

Fatigue and Team Performance in Soccer: Evidence from the FIFA World Cup and the UEFA European Championship*

We investigate the role of fatigue in soccer (football). Although this issue is important for the "productivity" of players and the optimal organization of national and international championships, empirical evidence is lacking. We use data on all the matches played by national teams in all the tournaments of the FIFA Soccer World Cup (from 1930 to 2010) and the UEFA European Football Championship (from 1960 to 2012). We relate team performance (in terms of points gained and goals scored and conceded) to the respective days of rests that teams have had after their previous match, controlling for several measures of teams' abilities. Using different estimators we show that, under the current structure of major international tournaments, there are no relevant effects of enjoying different days of rest on team performance. However, we find that before Nineties days of rest had a positive impact on performance, presumably because athletic preparation of players was less effective. Furthermore, we show that the advantage of additional rest is quite relevant, when rest time of one of the opposing teams is three days or less.

JEL Classification: L83, J4, J22, L25, C29

Keywords: sports economics, soccer, fatigue, team performance, World Cup, European Football Championship

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1. Introduction

During the latest soccer European Championship held in June 2012, the Spain's coach Vicente del Bosque told the press before the semi-final against Portugal "We have two fewer days to rest than them. It is a small handicap". "Three days' rest is more than enough. The Spaniards claimed having two days is a disadvantage but, as a professional, I believe it is not an important factor," replied Portugal's captain Cristiano Ronaldo. Eventually, Spain defeated Portugal. In the same tournament, after the defeat of Italy in the Final against Spain, Italy's coach Cesare Prandelli said: "Really the only regret is that we didn't have a few extra days to recuperate. You could tell right away that they were fresher physically". The statements of Prandelli and del Bosque echoed coach Vince Lombardi's famous quote: ''Fatigue makes cowards of us all''.

Soccer is a physically and psychologically very demanding sport. In a match, each player on average covers a total distance of 9-12 km (Bangsbo, 1994) and performs approximately 1,350 activities, including about 220 runs at high speed (Mohr et al., 2003). Besides running, other game-related and energy-demanding activities, such as dribbling, tackling and heading, contribute to the overall demands on the player (Bangsbo, 1994; Reilly, 1997).

In major European Leagues, such as Spain, England, Italy, Germany, top club teams play about fifty matches each year, adding up matches for the national League, the national Cup, Champions League or Europa League.[1] Furthermore, many top players are also employed in matches played by their national teams. In the most important international tournaments, such as the World Cup or the European Championship, national teams play a match every three or four days in a short period of time.

Given the high number of matches played in modern soccer, a crucial question for the "productivity" of players and the optimal organization of national leagues and international championships is whether players are allowed the necessary rest between consecutive matches. Players' fatigue could have relevant economic effects. Mostly important, if soccer players are tired because of insufficient time to recuperate, their performance might be less than optimal: the speed, the acceleration, the ability to dribble, to change direction, to score, are seriously impaired when players are not in optimal physical conditions. Rottenberg (2000, p.11) vividly illustrates this aspect "The quality of a game is higher, the more grace and skills with which it is produced, the larger the number of instances of extraordinary physical achievement the appear in it".

The fact that fatigue might affect players' physical conditions could have direct implications on the spectators' and fans' expected quality of performance, lowering match attendance and the number of TV spectators (Borland and MacDonald, 2003, García and Rodríguez, 2002, and Feddersen and Rott, 2011, among others, provide strong evidence that the expected quality of a match affects attendance and demand of

[1] In Italy, for example, top teams play matches for the Italian League ("Serie A") – usually on week-ends – and in the interval between league matches – on Tuesday, Wednesday or Thursday – these teams play international matches for the Champions League or for the Europa League.

sport on TV).[2] Furthermore, insufficient time to recuperate from small injuries could cause the missing of established star players from important matches with further negative effects on demand.

Secondly, it is worthwhile to investigate if fatigue affects team performance because when days of rest are not equal among competing teams (as it is often the case in international tournaments), the balance between teams – beyond the traditional factor of the distribution of talents – might be altered. The outcome of a match could be determined more by the scheduling of matches than by the respective abilities of players. As it is well known (see, among others, Schmidt and Berri, 2001; Zimbalist, 2002), the uncertainty of outcome for matches and competitive balance are important determinants of demand of sports.

Considering the amount of revenues that teams and tournament obtain from attendance and TV broadcast rights, and the related sponsor and advertising activities, these issues have important implications for the optimal organization of international tournaments (but also for national league championships), since in principle there might be a trade-off between staggered matches in different dates to increase TV audience and the possible negative effects on the interest of spectators due to lower expected quality or alterations of teams' chances of winning (see Szymanski, 2003).

Only few papers analyze the role of fatigue in sports from an economist's point of view, and to the best of our knowledge, no empirical study investigates the impact of fatigue on team performance in soccer.[3]

Some studies analyze the role of fatigue in the National Basketball Association (NBA). Entine and Small (2008), using data from two recent NBA seasons and exploiting the fact that visiting teams in the NBA typically enjoy fewer days of rest, show that the lack of rest is a factor contributing to explain the home court advantage, although the effect is quantitatively small. Ashman, Bowman and Lambrinos (2010) using NBA data for 19 seasons show that the home team performed poorly when playing in consecutive days while the visiting team had a few days of rest. Moreover, the home team performed particularly bad when it traveled from west to east between consecutive games. They also show that the betting market was unable to take into account the home team's fatigue, systematically mispricing these kind of games.

Some other papers analyze whether differences in rest or in travelling times between opposing teams can contribute to explain the home field advantage (Carmichael and Thomas, 2005; Courneya and Carron, 1992; Nevill and Holder, 1999).

Oberhofer, Philippovich and Winner (2010), looking at German Football Premier League, show that team performance in soccer decreases with the distance from the home location and the away playing venue. In the same vein, Nichols (2012) studies US National Football League matches and finds that visiting teams traveling from longer distance (and in particular from west to east, crossing at least one time zone) are more

[2] For recent works analysing productivity in sport, see Fried and Simmons (2011).

[3] Most of the research in sports medicine (see Bangsbo, 1994; Mohr et al., 2003) analyzes the effects of players' fatigue within a match rather than between matches (Odetoyinbo, Wooster, and Lane, 2008). Among the few studies on the latter topic, the findings are not unambiguous. Odetoyinbo, Wooster, and Lane (2008) – analyzing soccer players from Premiership League playing 3 matches within 5 days – show that high intensity activities of players were negatively influenced by the short recovery period between matches. On the other hand, Carling and Dupont (2011) report that neither physical nor skill-related performance is affected across three consecutive games.

likely to lose. Goossens and Spieksma (2012) find no effect of the quality of opposing teams in previous matches on teams' current performance ("carryover effect"). Picazo-Tadeo, and González-Gómez (2010) using the Data Envelopment Analysis show that the performance of soccer teams in Spain is negatively influenced by the extra games they play in Champions League, UEFA Cup and National Cup, probably because of fatigue and more frequent players' injuries.[4]

Our paper is also related to a bunch of papers analyzing if fatigue has an impact on labor productivity in non-sporting activities, mostly regarding the effects of overtime working. Hart (2004, p. 55) summarizing other works (see, in particular, Feldstein (1976); Booth and Schiantarelli, 1987), proposes a discontinuous function in which the marginal productivity of hours worked is initially increasing and then becomes negative "towards the end of the working day, because of 'winding-down' activities, perhaps aided and abetted by fatigue or boredom". Yanif (1995) proposes a theoretical model in which overtime might be a cause of absenteeism, since excessive use of overtime burns out the worker's emotional and mental resources. He also discusses of the possibility of deterioration of the quality of service provided by staff suffering from burnout. Halbesleben and Buckley (2004) offer a review of studies examining the impact of burnout on performance. Dragone (2009) and Ryvkin (2011) present two models in dynamic contexts in which agents choose the optimal amount of effort considering the impact of fatigue over time (the latter papers contain many references to a growing literature analyzing the relationship between fatigue and productivity). Mainly because of the well-known problem of the unavailability of micro data on labor productivity in non-sport fields, there is a lack of empirical evidence on the relationship between fatigue and performance in standard economic activities. Similarly to other issues related to labor market outcomes, the availability of detailed and reliable measures of performance in sports might be particularly useful for this topic.

In this paper we investigate the role of fatigue in soccer (football) using data on all the matches played by national teams in the most important international championships: the FIFA World Cup and the UEFA European Football Championship.[5] These competitions – aimed at selecting, respectively, the best team in the World and in Europe – last about a month and during this period teams play a match every three or four days. Mainly to the aim of increasing TV audience, matches in these tournaments are typically staggered in different dates and, as a consequence, opposing teams in knock-out rounds often enjoy different days of rest. Exploiting these variations in teams' days of rest, we relate team performance in a match – measured both in terms of points gained and goal scored and conceded – to the respective days of rests that teams enjoyed before the current match, controlling for several measures of teams' abilities and strength (number of matches played in international tournaments, points gained in these matches, positions in the FIFA World Ranking, being the hosting country of the tournament). We estimate several specifications with Ordered Probit estimators and, as robustness checks, we also apply Poisson and OLS estimators.

[4] Kern and Sussmuth (2005) analyse German "Bundesliga" teams' sporting success explicitly taking into account participation in international competitions of teams to the aim of not "penalizing" in terms of efficiency participating clubs.

[5] FIFA (Fédération Internationale de Football Association) is the football's world governing body. UEFA is the Union of European Football Associations.

Whereas we find that team performance is correlated to past outcomes in international tournaments and to the World Ranking and that the hosting country enjoys a considerable advantage, our findings show that currently there are no relevant effects of having different days of rest on team performance. On the other hand, we find that differences in days of rest had a positive impact on performance in the past (approximately, before Nineties). Furthermore, we find a non-linear impact of rest: it turns out to be important if rest time is equal or below three days between consecutive matches, whereas it becomes irrelevant when teams are allowed with at least four days of rest. Therefore, the current organization of major soccer international tournaments, giving at least four days of rest, is sufficient to preserve the productivity of players and the balance between teams.

The paper is organized in the following way. In Section 2 we describe the data and the Championships analyzed, providing also some preliminary evidence. In Section 3 we conduct several econometric analyses to estimate the impact of days of rest on team performance. In Section 4 we analyze the possible existence of non-linear effects. Section 5 concludes.

2. Data and Descriptive Statistics

The data we use come from the matches of all the tournaments of the FIFA World Cup and the UEFA European Championship.

The FIFA soccer World Cup is an international competition among national teams to determine the best team in the world. The World Cup is the world's most widely viewed sporting event.[6] The final tournament is held every four years since 1930 (except in 1942 and 1946 because of World War II). The latest editions were held in Japan and South Korea in 2002, in Germany in 2006 and in South Africa in 2010.

Currently, the final tournament involves 32 competing teams, playing at venues in a hosting country over a period of about a month (see Monks and Husch, 2009, for a detailed description).[7] The tournament consists of several rounds of play. In the group stage, participating teams are divided into groups of four teams.[8] Each team plays once against the other teams in its group. The standard points system is used (three points are awarded for a win, one point for a draw, zero points for a loss). The winner and runner-up of each group progresses to the eighth-finals, where a knockout system is used: two teams play each other once,[9] the winner progresses to the next round while the loser is eliminated. This system is used in all subsequent rounds as well: the winners of the quarter-finals matches progress to the semifinals, and the winners of

[6] According to the FIFA official website: "Based on viewers watching a minimum of 20 consecutive minutes of coverage, the 2010 tournament reached nearly a third of the world population with 2.2 billion viewers [..]. The average in-home global audience for each match was 188.4 million, while the highest average audience measured was for the final at 530.9 million" (http://www.fifa.com/worldcup/archive/southafrica2010).

[7] Prior to entering the final tournament, more than 200 national teams (other than the host nation that qualifies automatically) compete in a series of qualifying tournaments over a period of about 18 months.

[8] The allocation of teams to groups is in part the result of seeding (8 seeded teams based on the results obtained in the previous World Cup tournaments and on being the hosting nation) and in part the result of random draws.

[9] The pairings of teams depend on the group stage and on the ranking of teams in each group.

semifinals play in the final. The knock-out round requires a winner: if the match is a tie after 90 minutes, extra time of 30 minutes is played (in case of further tie, penalty kicks are used).

The UEFA European Football Championship is the main competition of national teams in Europe aimed to determine the best European soccer team. It is played every four years since 1960 in the even-numbered year between World Cup tournaments. The latest editions were held in Portugal in 2004, in Austria and Switzerland in 2008 and in Poland and Ukraine in 2012. The format of the European Football Championship is analogous to the World Cup, although the number of teams participating to the final tournament is typically lower (16 in the current format).

The data are available on the official sites of FIFA and UEFA.[10] For each tournament (19 tournaments played for the World Cup and 14 for the European Championship) we know the year and the host country. For each match we observe the two opposing teams, the date in which it is played, the round stage, the goals scored, if extra time is played (or penalty kicks are necessary). Instead of using the standard definition of "home" and "away" team, we define the first team indicated in the official reports of FIFA or UEFA as "Team A" and the second team as "Team B".

We consider all the matches played in these championships except the opening match of each team in each tournament for whom there is no meaningful difference in days of rest between teams. As a result, we have available 739 observations, 572 from the World Cup and 167 from the European Championship. Descriptive statistics are reported in Table 1.

For organizational purposes, and in particular for increasing TV audience for important matches, matches in the World Cup and the European Championship typically are not played contemporaneously after the group stage. Therefore, frequently teams face each other in knock-out rounds having played their latest match at different dates. For example, in the 2012 European Championship, Germany and Italy played against each other in the semi-final on the 28th of June 2012. However, Germany had played its quarter-final on the 22th June, while Italy had played its quarter-final on the 24th June. As a consequence, before the semi-final match, Germany had 6 days of rest while Italy had only 4 days.

For each match we calculate the days of rest of each team since its latest match, taking the simple difference between the date of the current match and the date of the previous match. On average, teams have 4.27 days of rest between two consecutive matches. Whereas in about half of the matches (53%) the two opposing teams have the same days of rest, in 36% of the matches one of the teams had one more day of rest than its opponent, and in about 11% one of the teams had two or more days of rest. Our main explanatory variable is the *Difference in Days of Rest*, equal to *Days of Rest Team A* minus *Days of Rest Team B*.

[10] Respectively, http://www.fifa.com/worldcup/archive/index.html and http://www.uefa.com/uefaeuro/index.html.

Table 1. Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Days of Rest Team A	739	4.271	1.058	1	8
Days of Rest Team B	739	4.260	1.221	1	10
Difference in Days of Rest	739	0.010	1.072	-6	4
Goals Team A	739	1.731	1.524	0	9
Goals Team B	739	1.070	1.048	0	7
Goal Difference	739	0.660	1.843	-7	9
Points	739	1.835	1.304	0	3
Average Points Team A[(a)]	739	1.526	0.646	0	3
Average Points Team B[(a)]	739	1.387	0.661	0	3
Average Points Difference[(a)]	739	0.139	0.815	-3	3
# Matches Team A[(a)]	739	22.88	21.520	1	97
# Matches Team B[(a)]	739	18.22	17.430	1	98
# Matches Difference[(a)]	739	4.655	24.40	-88	92
Team A Host Country	739	0.112	0.316	0	1
Team B Host Country	739	0.060	0.239	0	1
Host Country Difference	739	0.051	0.413	-1	1
Extra Time Team A	739	0.055	0.229	0	1
Extra Time Team B	739	0.061	0.239	0	1
Extra Time Difference	739	-0.005	0.265	-1	1
European Championship	739	0.226	0.418	0	1
Final Phase	739	0.376	0.485	0	1
After 1993	739	0.469	0.499	0	1
Min Rest<=3	739	0.337	0.473	0	1
Fifa Ranking Team A	347	17.98	16.35	1	105
Fifa Ranking Team B	347	19.55	15.46	1	105
Fifa Ranking Difference	347	-1.571	22.53	-102	96
Fifa Points Team A	347	573.3	407.0	35	1611
Fifa Points Team B	347	568.4	408.4	35	1611
Fifa Points Difference	347	4.963	201.6	-936	964

Notes: The data are from all the matches (except the opening match of each team in the tournament) of World Cup (1930-2010) (572 matches) and European Championship (1960-2012) (167 matches).
(a) Calculated considering all the past matches (excluding the current match) played in the championship considered.

A second measure of fatigue that we consider is related to the occurrence for a team of playing extra time in the previous match. We build the dummy variable *Extra Time Team A* equal to 1 if in the previous match Team A played extra time and zero otherwise. Similarly, we build *Extra Time Team B*. We then take the difference between these dummies, building the variable *Extra Time Difference*.

We measure team performance in a match in two different ways: the number of *Points* gained (by Team A) and *Goal Scored (Team A)* and *Goal Conceded (Team A)* (that is, the goals scored by Team B).[11] In the former case, we attribute three points if a team wins a game, one point in case of draw and zero points for a loss, even in knock-out matches in which points are not formally assigned. We consider the final result at the end of 90 minutes or at the end of 120 minutes in case of extra time (regardless of penalty kicks outcome). All our variables of performance are defined as the difference between *Team A* and *Team B*.

[11] We also build *Goal Difference*, calculated as *Goals Team A* minus *Goals Team B* (used with OLS estimators).

To control for the respective abilities or strengths of national teams, we build the variable *Average Points* gained by a team in all the past matches of, respectively, the World Cup and the European Championship before the current match. Then, we determine the *Average Points Difference* (between Team A and Team B) taking the difference between the *Average Points Team A* minus the *Average Points Team B.*

Moreover, we determine the *Number of Matches* played in past in each championship (before the current match). Playing a higher number of matches in a championship implies that a team has qualified for the final tournament more times and/or that it has progressed in the tournament for a higher number of rounds. As above, we calculate the *Number of Matches Difference*.

As a further measure of quality of a team, we calculate the number of points gained in each tournament prior to the current match and calculate the difference between the two opposing teams, building the variable *Difference in Points in the Tournament.*

We also control for the fact that one of two teams is the host country. We build a variable *Host Country Difference* equal to zero if neither team is the host country, equal to +1 if the Team A is the host country and equal to –1 if the Team B is the host country.

Finally, as an alternative measure of abilities of teams, we use the FIFA-Coca Cola World Ranking, which is a very accurate ranking system for national teams.[12] The national teams are awarded points on the basis of the results obtained in international matches played in the latest four years; more recent results and more important matches are more heavily weighted. The ranking is updated approximately on a monthly basis. To avoid problems of reverse causality, we attach to each team for each tournament the respective most recent FIFA World ranking dating about a month before the event considered. For example, for the matches of the World Cup played in South Africa in June 2010, we attach to each team the FIFA ranking of May 2010. The top team has a ranking of 1, the second best team has a ranking of 2 and so on. We use, alternatively, both the points accumulated by teams and their rankings.

Unfortunately, the FIFA World Ranking has been introduced only in 1993 and therefore when we control for this variable we can only use the observations starting since 1994 (leaving us with 347 observations). However, we find that the FIFA World Ranking is highly correlated to our alternative measures of strengths of national teams (for example, the correlation with *Average Points Difference* is ρ=–0.48, *p*-value=0.000), reassuring us that the latter are good proxies of teams' quality.

3. Difference in Days of Rest and Performance of Teams

In this Section we carry out an econometric analysis of the impact of days of rest on team performance.

We start with a very simple assumption about the expected impact of recovery on player performance. Performance of team *k,* Y_k , can be modeled as:

[1] $$Y_k = F_1(R_k) + F_2(X_k)$$

[12] The official site for the FIFA world ranking is: http://www.fifa.com/worldranking/rankingtable/index.html

where F_1 and F_2 are two distinct functions, R_k is rest time of team *k*, X_k are all the other possible factors affecting performance (players' and coach's abilities, home advantage, and so on). We simply suppose that F_1 is increasing in rest time *R*, and, as a consequence, that the difference in performance of opposing teams is a function of their difference in rest time. In Section 4 we modify this simple assumption proposing a particular "kinked" function relating rest time to performance.

In the econometric analysis we first consider *Points* (Team A) as dependent variable. We deal with the ordinal nature of the dependent variable originated from win, draw, or loss as the final result of the game, estimating several specifications with an Ordered Probit estimator. Results of estimates are reported in Table 2. Since Ordered Probit coefficients are not easy to interpret, we also report in Table 3 the marginal effects for the outcome Win (Three points). Therefore, the coefficients in Table 3 show the effects of the explanatory variables on the probability of winning a match for Team A.

In column (1) we estimate a simple model for *Points* using as explanatory variable only the *Difference in Days of Rest*. For the interpretation of results, it should be noticed that *Difference in Days of Rest* is positive if Team A had more rest than Team B. We find that the difference in rest has a small positive impact on team performance, significant at the 10 percent level. However, these estimates could be biased since any difference in rest between teams could be correlated to teams' abilities or to other factors affecting team performance.

To this aim, in an auxiliary regression (not reported) we investigate if the days of rest of a team are independent from other observable variables: we find that the days of rest of a team tend to be positively correlated to the variables measuring team's quality and to the dummy *Host Country*, implying that – probably as a result of seeding and of the final rankings in group stage – stronger teams and the home team have a higher probability of enjoying of more rest between matches.

Therefore, to avoid any bias in the estimations because of omitted variables, we need to control for a number of variables that could determine team performance and could be possibly related to our variable of interest, *Difference in Days of Rest*.

Table 2. Team Performance and Rest. Ordered Probit Estimates. Dependent Variable: Points Team A

	(1)	(2)	(3)	(4)	(5)	(6)
Difference in Days of Rest	0.0701*	0.0320	0.0263	0.0429	0.0582	0.0261
	(0.0402)	(0.0406)	(0.0406)	(0.0424)	(0.0463)	(0.0462)
Average Points Difference		0.1497**	0.1689***	0.1544**	0.1527**	0.0950
		(0.0617)	(0.0624)	(0.0667)	(0.0667)	(0.0770)
# Matches Difference		0.0120***	0.0119***	0.0135***	0.0133***	0.0151***
		(0.0024)	(0.0024)	(0.0024)	(0.0024)	(0.0031)
Host Country Difference			0.4308***	0.3639***	0.3671***	0.4092***
			(0.1133)	(0.1172)	(0.1170)	(0.1249)
Extra Time Difference				-0.2563	-0.2583	-0.2834
				(0.1716)	(0.1714)	(0.1804)
European Championship					-0.0477	
					(0.1155)	
(Difference in Days of Rest)*Euro Cup					-0.0700	
					(0.1127)	
Time Fixed Effects	NO	NO	NO	YES	YES	YES
Team Fixed Effects	NO	NO	NO	NO	NO	YES
Cut-off 1	-0.7003***	-0.6614***	-0.6470***	-2.1931***	-2.1992***	-1.7170*
	(0.0505)	(0.0513)	(0.0516)	(0.3510)	(0.3528)	(0.9898)
Cut-off 2	-0.0963**	-0.0193	0.0046	-1.4458***	-1.4513***	-0.9269
	(0.0463)	(0.0486)	(0.0494)	(0.3502)	(0.3520)	(0.9901)
Observations	739	739	739	739	739	739
Pseudo R-squared	0.002	0.044	0.055	0.144	0.144	0.181

Notes: The Table reports Ordered Probit estimates. The dependent variable is Points gained by Team A. All the differences are defined as the outcome of Team A minus the outcome of Team B. Standard errors (reported in parentheses) are corrected for heteroskedasticity using the estimator of variance proposed by Huber (1967) and White (1980). The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 3. Marginal Effects of Ordered Probit Estimates. Outcome=Win.

	(1)	(2)	(3)	(4)	(5)	(6)
Difference in Days of Rest	0.0278*	0.0127	0.0105	0.0170	0.0231	0.0104
	(0.0160)	(0.0161)	(0.0161)	(0.0168)	(0.0184)	(0.0184)
Average Points Difference		0.0595**	0.0671***	0.0612**	0.0605**	0.0378
		(0.0245)	(0.0248)	(0.0264)	(0.0264)	(0.0306)
# Matches Difference		0.0048***	0.0047***	0.0054***	0.0053***	0.0060***
		(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0012)
Host Country Difference			0.1711***	0.1442***	0.1454***	0.1627***
			(0.0450)	(0.0464)	(0.0463)	(0.0497)
Extra Time Difference				-0.1015	-0.1023	-0.1127
				(0.0680)	(0.0679)	(0.0718)
European Championship					-0.0189	
					(0.0459)	
(Difference in Days of Rest)*(European Champ.)					-0.0277	
					(0.0447)	
Observations	739	739	739	739	739	739
Pseudo R-squared	0.002	0.044	0.055	0.144	0.144	0.181

Notes: The Table reports Marginal Effects for the outcome of Win of Ordered Probit estimates of Table 2.

In column (2) we control for two variables aimed to capture any difference in the quality of opposing teams: number of matches played in the past tournaments in the World Cup or in the European Championship (respectively, according to the tournament considered) (*Number of Matches Difference*) and the average points (*Average Points Difference*) realized in these championships. The *Average Points Difference* has a positive and strong impact on team performance: from Table 3 (column 2), if Team A has

obtained on average one point more than Team B in past matches in a championship, then the probability of winning the match for Team A increases of 5.9 percentage points. Similarly, teams with a higher number of matches played in past international championships reach better outcomes: 10 more matches increase of 4.8 percentage points the probability of winning. Both these variables are highly statistically significant (at the 1 percent level). Crucially, once we control for teams' quality, we find that *Difference in Days of Rest* has no impact whatsoever on team performance (*p*-value=0.43).

In column (3) we control for the variable *Host Country Difference* to take into account the fact that one of the teams is the host country. This variable should control for the well-known "home advantage", which, as shown in many studies, is strong in many sports and in soccer in particular, due to psychological reasons, social pressure by the crowd, possible favouritism of referees and so on (see Carmichael and Thomas, 2005, and Scoppa, 2008). *Host Country Difference* has a strong impact on team performance: our estimates show that the probability of winning for a team is 17 percentage points higher if the match is played in its own country. Again, the *Difference in Days of Rest* has no effect on team performance.

To take into account that soccer could be changed during time along many dimensions (the rules, the organization, the athletic preparation of players, medical assistance, and so on), we build a dummy for each decade (7 in total) and include six time dummies in our regressions, starting from column (4).

Furthermore, in column (4) we control for another variable that proxies for the fatigue of players: *Extra Time Difference*, which is equal to one if Team A has played extra time in the previous match (or -1 if Team B has played extra time). As expected, playing *Extra Time* has a negative effect on team performance (the probability of winning reduces of about 10 percentage points if in the latest match a team has played extra time), although the effect is not statistically significant at conventional levels (*p*-value=0.13). *The coefficient on rest time is only slightly changed (and remains not significant) when we include time dummies and the variable* Extra Time Difference.[13]

To investigate if days of rest have a different impact in the World Cup with respect to the European Championship – given that in the World Cup more rounds are typically played – in column (5) of Table 2 we control for a dummy *European Championship* (equal to one for European Championship matches and 0 for World Cup matches) and an interaction variable *(Difference in Days of Rest)*(European Championship)*. Results show that the days of rest have a little impact on performance in the World Cup (2 percentage points more as probability of winning for each day of rest), but the effect is not very significant (the p-value is 0.21). No effect at all is found for the European Championship (the p-value is 0.90).

Finally, in column (6) of Tables 2 and 3 we report a specification that includes team fixed effects (76 teams are present). Controlling for team fixed effects, the estimator uses the time variation (from a match to another) in rest within each team, relating it to the variation (among matches) in performance for the same team. In this way we are avoiding any possible bias arising by the fact that some teams (for example, more or less influential teams) might obtain more or less rest than others. Nonetheless, from the results of column (6)

[13] Including a dummy for each year consumes many degrees of freedom (22). However, the results remain almost identical when we include all time dummies.

we conclude that also in this case *Difference in Day of Rest* has no significant effect on the performance of the teams.[14]

3.1. The Impact of Rest in the Initial and Final Phase

In Table 4 we examine if rest is more important in the final phase of the tournaments with respect to the initial stage. We build a variable *Final Phase* equal to one for the matches after the group stage (that is, eighth-finals, quarter finals, semi-finals, finals).

We firstly examine separately for the initial stage (column 1) and for the final phase (column 2) the impact of rest, controlling for the variables used in the specification (4) of Table 2. We find that the coefficient on *Rest* is almost the same in columns (1) and (2) and is not statistically significant. In column (3) we estimate on the whole sample, including the dummy *Final Phase* and an interaction term between *Final Phase* and *Difference in Days of Rest*. The interaction term is null, confirming that there is no difference in the impact of rest between the initial stage and the final phase.

Table 4. Ordered Probit Estimates. Heterogeneous impact for group stage and final phase?

	(1)	(2)	(3)
	Initial Stage	Final Phase	Whole sample
Difference in Days of Rest	0.0499	0.0489	0.0442
	(0.0674)	(0.0564)	(0.0645)
Average Points Difference	0.1451*	0.2692	0.1553**
	(0.0743)	(0.1715)	(0.0667)
# Matches Difference	0.0135***	0.0139***	0.0135***
	(0.0031)	(0.0042)	(0.0024)
Host Country Difference	0.4695**	0.3097*	0.3628***
	(0.1846)	(0.1595)	(0.1178)
Extra Time Difference	0.5110	-0.2593	-0.2554
	(0.6842)	(0.1811)	(0.1722)
(Difference in Rest)* Final Phase			-0.0028
			(0.0857)
Final Phase			0.0312
			(0.0957)
Observations	461	278	739
Pseudo R-squared	0.132	0.183	0.144

Notes: The Table reports Ordered Probit estimates. The dependent variable is Points gained by Team A. All the differences are defined as the outcome of Team A minus the outcome of Team B. In all specifications, we control for 7 time dummies. Standard errors (reported in parentheses) are corrected for heteroskedasticity. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

3.2. Controlling for FIFA rankings

A possible concern with previous estimates is that the measures of teams' abilities used might be rather imperfect, since they take into account performance of teams in the past tournaments, while teams' current strength could be quite different. To consider this aspect, we take advantage of the FIFA World Ranking,

[14] Furthermore, we also control for the points that teams obtained in the past matches in the current tournaments, disregarding the outcomes they obtained in previous tournaments, *Difference in Points in the Tournament*. We find very similar results (regression not reported for brevity).

reflecting teams' quality as evaluated about one month before each tournament. As this ranking is available only since 1993, we only use tournaments starting since 1994 and we end up with 347 observations.

We replicate specifications (2), (4) and (6) of Table 2, simply substituting the two variables of teams' abilities firstly with *FIFA Ranking Difference* (reporting results in columns 1-3 of Table 5) and then with *FIFA Points Difference* (columns 4-6 of Table 5).

In all the specifications we find that the *Difference in Days of Rest* has no impact on team performance. As expected, the ranking difference has a strong negative impact on *Points*: if the ranking difference is positive (that is, if team A is ranked lower than team B), this implies that the performance of team A is predicted to be worse than the performance of team B. In columns (4), (5) and (6) in which we use, instead of teams' ranks, simply the number of points accumulated in the FIFA World Ranking (which has a positive impact on *Points*) the qualitative results are the same.[15]

Table 5. Ordered Probit Estimates. Controlling for teams' FIFA World rankings

	(1)	(2)	(3)	(4)	(5)	(6)
Difference in Days of Rest	-0.0109	-0.0357	-0.0958	0.0044	-0.0154	-0.1044
	(0.0765)	(0.0768)	(0.0861)	(0.0757)	(0.0759)	(0.0868)
FIFA Ranking Difference	-0.0153***	-0.0187***	-0.0186***			
	(0.0030)	(0.0031)	(0.0045)			
FIFA Points Difference				0.0018***	0.0021***	0.0020***
				(0.0004)	(0.0004)	(0.0005)
Host Country Difference		0.6408***	0.8759***		0.5593***	0.7683***
		(0.1893)	(0.2240)		(0.1849)	(0.2148)
Extra Time Difference		-0.2613	-0.3378		-0.2840	-0.3498
		(0.2369)	(0.2654)		(0.2335)	(0.2722)
Observations	347	347	347	347	347	347
Pseudo R-squared	0.038	0.058	0.132	0.039	0.056	0.136

Notes: The Table reports Ordered Probit estimates. The dependent variable is Points gained by Team A. All the differences are defined as the outcome of Team A minus the outcome of Team B. In all specifications, we control for 7 time dummies. Standard errors (reported in parentheses) are corrected for heteroskedasticity. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

3.3. Non-Linear Effects of Rest

We now investigate whether the effect of days of rest is non-linear. In fact, it could be that a difference of two or more days of rest is important in affecting performance, while a difference of only one day is not relevant. To this aim, we build four new dummy variables: "*Rest<=–2*" if Team A had two (or more in absolute terms) fewer days of rest than Team B; "*Rest=–1*" if Team A had one fewer day of rest than Team B; "*Rest=+1*" if Team A had one day more of rest than Team B; "*Rest>=+2*" if Team A had two (or more) days of rest than Team B. The reference category is when the two opposing teams had the same rest.

In columns (1) and (2) of Table 6 we estimate with an Ordered Probit model a specification with basic controls and a specification with a full range of controls. In column (3) we control for the FIFA Ranking Difference. In all the three specifications, none of the dummies representing differences in days of

[15] We also use together *FIFA Ranking Difference*, *Average Points Difference* and *# Matches Difference*, obtaining very similar results.

rest between the two opposing teams is statistically significant in affecting *Points*. Furthermore, we are not able to reject the hypothesis that these four dummies are jointly equal to zero.

Table 6. Non-Linear Effects of Rest. Ordered Probit Estimates

	(1)	(2)	(3)
Rest<=-2	-0.1803	-0.1019	0.1806
	(0.2021)	(0.2175)	(0.4278)
Rest==-1	0.0388	0.0744	0.0018
	(0.1202)	(0.1294)	(0.1701)
Rest==+1	-0.0844	-0.0216	-0.0821
	(0.1175)	(0.1261)	(0.1800)
Rest>=+2	0.2194	0.2933	0.0085
	(0.1978)	(0.1999)	(0.2797)
Average Points Difference	0.1510**	0.1555**	
	(0.0622)	(0.0667)	
# Matches Difference	0.0124***	0.0139***	
	(0.0024)	(0.0024)	
Host Country Difference		0.3801***	0.6482***
		(0.1174)	(0.1910)
Extra Time Difference		-0.2494	-0.2633
		(0.1723)	(0.2404)
FIFA Ranking Difference			-0.0188***
			(0.0031)
Cut-off 1	-0.6651***	-2.1623***	-0.2862***
	(0.0673)	(0.3544)	(0.0990)
Cut-off 2	-0.0217	-1.4142***	0.3608***
	(0.0640)	(0.3536)	(0.0997)
Observations	739	739	347
F Joint Hypotheses All Rest Dummies=0	3.08	3.03	0.43
(*p*-value)	0.544	0.553	0.979
Pseudo R-squared	0.046	0.145	0.059

Notes: The Table reports Ordered Probit estimates. The dependent variable is Points gained by Team A. All the differences are defined as the outcome of Team A minus the outcome of Team B. In all specifications, we control for 7 time dummies. Standard errors (reported in parentheses) are corrected for heteroskedasticity. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

3.4. Heterogeneous Impact of Rest over Time

As explained above, since our data cover a very long period of time (in total about 80 years), many changes in soccer might be occurred possibly correlated to the period of rest between matches allowed to teams and, importantly, the impact of rest could have changed over time.

In particular, in the Nineties some important changes occurred: the sale of TV broadcasting rights drastically increased revenues for club teams in most countries; Champions League previously reserved only for national champions was transformed since 1992-1993 and extended to several teams for each nation, the number of matches played each year in national Leagues and international competitions generally increased, the market for players became really global, with top players from around the world attracted to major

European Leagues. Furthermore, there has been an increased application of science and medicine for the assistance and athletic preparation of players.[16]

To better investigate if over time these transformations in soccer have influenced the effect of our interest we estimate separately for the period before 1993 (until 1992 European Cup) and for the period afterwards (since 1994 World Cup).

Table 7. Ordered Probit Estimates. Heterogeneity over Time

	(1)	(2)	(3)	(4)	(5)
	Before 1993	Before 1993	After 1993	After 1993	Whole
Difference in Days of Rest	0.0907*	0.1152**	-0.0596	-0.0720	0.1118**
	(0.0499)	(0.0479)	(0.0817)	(0.0816)	(0.0461)
Average Points Difference	0.1240	0.1585*	0.1148	0.1317	0.1463**
	(0.0820)	(0.0912)	(0.0994)	(0.1002)	(0.0668)
# Matches Difference	0.0146***	0.0160***	0.0135***	0.0133***	0.0139***
	(0.0047)	(0.0045)	(0.0028)	(0.0028)	(0.0024)
Host Country Difference		0.3517**		0.3598**	0.3565***
		(0.1585)		(0.1781)	(0.1180)
Extra Time Difference		-0.2940		-0.2473	-0.2667
		(0.2302)		(0.2362)	(0.1672)
After 1993					-0.1545
					(0.2010)
After 1993* (Difference in Days of Rest)					-0.1877**
					(0.0954)
Observations	392	392	347	347	739
Pseudo R-squared	0.039	0.155	0.066	0.073	0.147
Marginal Effect of Difference in Days of Rest	0.0332*	0.0411**	-0.0229	-0.0277	0.0443**
	(0.0182)	(0.0170)	(0.0315)	(0.0314)	(0.0182)

Notes: The Table reports Ordered Probit estimates. The dependent variable is Points gained by Team A. All the differences are defined as the outcome of Team A minus the outcome of Team B. In all specifications, we control for 7 time dummies. Standard errors (reported in parentheses) are corrected for heteroskedasticity. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Interestingly, in column (1) of Table 7, with only basic controls, we show that until 1992 the *Difference in Days of Rest* has a positive impact on *Points* (significant at the 10 percent level): the probability of winning increases of about 3.3 percentage points with an additional day of rest (last row of Table 7). In column (2) of Table 7, with additional controls and time fixed effects, we find a stronger impact of rest on team performance (the probability of winning increases of 4.1 percentage point for each additional day of rest, significant at the 5 percent level).

In columns (3) and (4) of Table 7 we estimate the same specifications of, respectively, columns (1) and (2), for the period starting from 1994. The estimation results for this period – in contrast to the tournaments held before Nineties – show that there is any more an impact of rest on the performance.

In column (5) we pool together the observations for the two periods and control for a dummy "After 1993" and for an interaction term "*After 1993*"*"*Difference in Days of Rest*". Our results are confirmed:

[16] Some important rules of soccer also changed: substitutions of players during the match were not allowed before Seventies, subsequently two substitutions for each team were allowed. Since 1994-1995, three substitutions are possible.

whereas before 1993 the days of rest had a positive impact on team performance (the marginal effect of winning is equal to 4.4 percentage points more for each day of rest), after this period it does not emerge any effect, since the interaction term is negative and significant: the combined effect for the impact of rest after 1993 is nearly zero with a *p*-value of 0.37.

Results qualitatively similar to those shown in Table 7, although with lower statistical significance, are obtained if, instead of splitting the sample at 1992-1994, we split the sample at the years 1984-1986 or, alternatively, if we split at the years 1998-2000.

Although currently soccer is played with much higher intensity and at fast pace than in the past, and this factor should have made more important recreation, at the same time the athletic preparation of players has also much improved due to much more intense training, medical assistance, etc. This has made probably much easier for players to recuperate from fatigue with respect to the past: all in all, we find that while rest time was essential in the past for better performance, modern professionals do not need much rest.

3.5. Poisson Estimators

As robustness check for the evaluation of the impact on team performance of days of rest, instead of using *Points*, in this sub-section we measure team performance with the number of *Goals Scored* and the number of *Goals Conceded* per game. These two measures are aimed at describing respectively the offensive and defensive capabilities of a team (see also Koning, 2003).

The separate analysis for *Goals Scored* and *Goals Conceded* is also interesting because if some categories of players are more affected by fatigue than others (for example, it seems that forward players tend to provide more effort than defenders or goalkeeper in a match, see Mohr *et al.*, 2003), then the number of goals scored could be more affected than the number of goals conceded by rest.

We estimate the determinants of *Goals Scored* and *Goals Conceded* using a Poisson estimator given that the latter are count variables and take on non-negative integer values. Moreover, since these variables may be correlated, we estimate a Bivariate Poisson model which takes into account possible correlation of residuals in the two equations (see Karlis and Ntzoufras, 2003).[17]

In Table 8 we report estimation results replicating some specifications of Table 2 and Table 5. Panel (a) reports results for *Goals Scored* and Panel (b) for *Goals Conceded*. The results show that, regardless of the specification, *Difference in Days of Rest* has no impact neither on *Goals scored* nor on *Goals conceded*.

[17] Since it is reasonable to think that the determinants of goals scored and goals conceded are not different, we obtain identification through the functional form, without imposing an exclusion restriction.

Table 8. The Effect of Rest on Goals scored and Conceded. Bivariate Poisson Estimates

Panel (a) – Goals scored

	(1)	(2)	(3)	(4)	(5)
Difference in Days of Rest	0.0200	0.0007	-0.0043	0.0047	-0.0698
	(0.0362)	(0.0364)	(0.0366)	(0.0286)	(0.0535)
Average Points Difference		0.2227***	0.2361***	0.1986***	
		(0.0441)	(0.0444)	(0.0365)	
# Matches Difference		0.0020*	0.002	0.0046***	
		(0.0012)	(0.0012)	(0.0014)	
Host Country Difference			0.2470***	0.1835***	0.5418***
			(0.0795)	(0.0678)	(0.1261)
Extra Time Difference				-0.1085	-0.0386
				(0.0859)	(0.1741)
FIFA Ranking Difference					-0.0130***
					(0.0021)
Constant	0.5481***	0.4865***	0.4670***	1.0015***	0.1709***
	(0.0324)	(0.0335)	(0.0348)	(0.0970)	(0.0598)

Panel (b) – Goals conceded

	(1)	(2)	(3)	(4)	(5)
Difference in Days of Rest	-0.0344	-0.004	-0.001	-0.0025	0.0125
	(0.0365)	(0.0353)	(0.0346)	(0.0338)	(0.0553)
Average Points Difference		-0.0301	-0.0393	-0.0371	
		(0.0531)	(0.053)	(0.0536)	
# Matches Difference		-0.0107***	-0.0104***	-0.0105***	
		(0.0016)	(0.0016)	(0.0016)	
Host Country Difference			-0.2189***	-0.2146**	-0.3305***
			(0.083)	(0.0849)	(0.1268)
Extra Time Difference				-0.0272	0.1002
				(0.1171)	(0.1405)
FIFA Ranking Difference					0.0132***
					(0.0020)
Constant	0.0677*	0.0851**	0.0928***	0.0836	0.1440**
	(0.0361)	(0.0349)	-0.0348	(0.1425)	(0.0588)
Rho (ρ) (*p*-value)	0.0077	0.0545	0.0669	0.1014	-0.0302
	(0.8338)	(0.1381)	(0.0689)	(0.0058)	(0.5737)
Observations	739	739	739	739	347

Notes: The Table reports Bivariate Poisson estimates. The dependent variable in Panel (a) is *Goals scored* by team A. The dependent variable in Panel (b) is *Goals conceded* by team A. All the differences are defined as the outcome of Team A minus the outcome of Team B. In all specifications, we control for 7 time dummies. Standard errors (reported in parentheses) are corrected for heteroskedasticity. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

The impact of rest for the period before 1993 when we use as dependent variables goals scored and goals conceded turns out to be not statistically significant (not reported). However, if we exclude matches in which one of the teams has scored more than 4 goals (which could be considered as outliers) the effect is again statistically significant.

As a further robustness check, we also estimate with OLS estimators both when using *Points* and *Goal Difference* as dependent variables. The qualitative results of the OLS fully confirm those found using Ordered Probit and Bivariate Poisson regressions (estimates not reported).

4. Is the Performance-Rest Function "Kinked"?

In the light of the findings of Section 3, it is worthwhile to explore an alternative hypothesis about the impact of recreation on player performance. Instead of supposing that performance is simply an increasing function of rest, we suppose – inspired by Hart (2004, p. 55) – that the function $F_1(R_k)$ in equation [1] ($Y_k = F_1(R_k) + F_2(X_k)$) relating rest time to performance has the following properties:

[2] $F_1(R_k) = R_k^{\alpha}$ if $R_k < \bar{r}$ and

[3] $F_1(R_k) = M = (\bar{r})^{\alpha}$ if $R_k \geq \bar{r}$

where $0 < \alpha \leq 1$ and $\bar{r}$ is a fixed threshold beyond which additional rest time is no longer useful.

The implication of this simple function is that *R* is "productive", that is, performance increases with rest until the threshold of $\bar{r}$. After that point, *R* has no longer an impact on performance. The function $F_1(R)$ is represented in Figure 1.

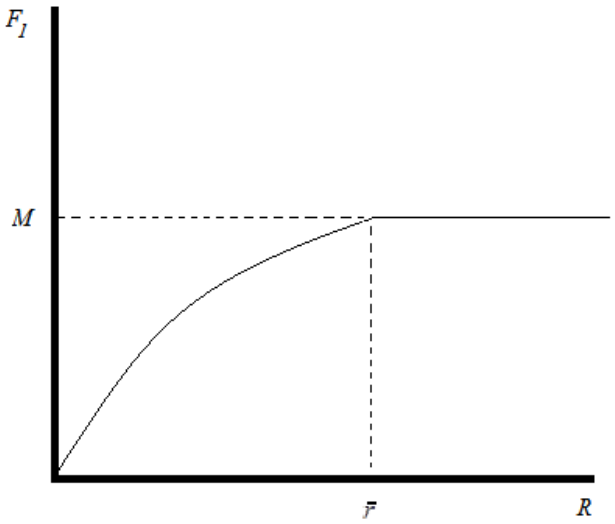

Figure 1. Team Performance and Rest Time

On the basis of this function, we should expect a positive impact of rest on performance if: (*a*) for at least one of the opposing teams, *R* is below the threshold $\bar{r}$ and (*b*) if there is a difference between teams in *R* (taking as constant all the other factors). On the other hand, no impact of rest time is expected if *R* is above $\bar{r}$ for both teams (even if rest time is different for the two teams). Therefore, a difference of one day could matter if opposing teams had respectively two and three days of rest, whereas the same difference could be irrelevant if the teams had six and seven days of rest.

To the aim of empirically analyzing if the difference in days of rest has a different impact when rest of the opposing teams has been particularly brief or long, for each match in our sample we determine the minimum between the days of rest of Team A and Team B. Then, on the basis of this variable we split the sample in two subsamples: the first subsample includes the matches in which the minimum rest has been less or equal to 3 days and the second subsample comprises matches in which the minimum rest has been equal to

4 or longer. We expect an impact of rest higher in the first case in which at least one of the two teams enjoyed a particularly brief period of rest.

The results of this analysis are shown in Table 9. We study the effect on *Points* using the Ordered Probit Estimator. In column (1) we estimate only on the sample with brief periods of rest, while in column (2) we use the sample of longer pauses.

Interestingly, confirming our assumptions, we find that differences in days of rest has a positive and significant impact on performance when one of the teams enjoys a very short period of rest: notwithstanding the reduced variability in the explanatory variable, the coefficient is significant at the 5 percent level: in the last row we show that the probability of winning a match increases of 4 percentage points for the team enjoying one more day of rest. On the other hand, we see in column (2) that the *Difference Days of Rest* has no impact when the minimum rest has been sufficiently long.

In column (3) we estimate on the whole sample using the interaction between *Difference Days of Rest* *(*Min Rest>=4*). From the coefficient on *Difference Days of Rest* (showing the impact for brief pauses) we confirm that the impact is positive (*p*-value=0.069). The probability of winning increases in this case of about 4 percentage points. On the other hand, the effect of rest vanishes when the minimum rest time has been at least four days: the combined coefficient is almost null and its *p*-value is 0.703.

From these results we conclude that the days of rest typically allowed to teams in international tournaments (on average, 4.2) are probably higher than the threshold $\bar{r}$, that is, four days of rest are enough time to recuperate. This explains why in Section 3 we did not find any effect of rest time on the performance.[18] However, our results show that if the time between matches were reduced to 3 days or less, this would negatively affect the performance of teams and would create a serious disadvantage for teams with less rest.

[18] As shown in Section 1, in basketball a significant effect for rest is found. This result is likely due to the fact that in basketball rest time is very limited. In the Ashman et al. (2010) the authors find that a team playing back-to-back games (that is, with only 24 hours of rest) performed poorly against teams with more rest. It is likely that this time is not completely sufficient to recuperate whereas in the soccer four days are enough.

Table 9. The Impact of Rest after Brief and Long Pauses. Ordered Probit Estimates

	(1) Min Rest<=3	(2) Min Rest>=4	(3) Whole
Difference Days of Rest	0.1240**	-0.0314	0.1007*
	(0.0586)	(0.0634)	(0.0553)
Average Points Difference	0.0480	0.1975**	0.1541**
	(0.1103)	(0.0839)	(0.0666)
# Matches Difference	0.0158***	0.0132***	0.0138***
	(0.0053)	(0.0028)	(0.0024)
Host Country Difference	0.1578	0.5201***	0.3641***
	(0.1861)	(0.1568)	(0.1180)
Extra Time Difference	-0.3325	-0.2133	-0.2622
	(0.2463)	(0.2306)	(0.1699)
Difference Days of Rest *(Min Rest>=4)			-0.1250
			(0.0840)
Min Rest>=4			-0.0307
			(0.1127)
Cut-off 1	-6.2444***	-1.7736***	-2.2048***
	(0.2218)	(0.4155)	(0.3509)
Cut-off 2	-5.4631***	-1.0315**	-1.4561***
	(0.1979)	(0.4159)	(0.3497)
Observations	249	490	739
Pseudo R-squared	0.172	0.128	0.145
Marginal Effect of Difference in Days of Rest (Outcome= Win)	0.0402**	-0.0125	0.0399*
	(0.0188)	(0.0253)	(0.0219)

Notes: The Table reports Ordered Probit estimates. The dependent variable is Points gained by Team A. All the differences are defined as the outcome of Team A minus the outcome of Team B. In all specifications, we control for 7 time dummies. Standard errors (reported in parentheses) are corrected for heteroskedasticity. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

5. Concluding Remarks

We have investigated the role of fatigue in soccer. Although almost neglected in the economics of sports literature, this issue is relevant for the productivity of players and the optimal scheduling of national and international tournaments, because whether fatigue has any impact, the "productivity" of players could be seriously undermined and the balance between teams could be altered.

We have used data from all the matches of the final tournaments of World Cup and the European Championship. In these tournaments, matches are staggered to increase TV audience and, as a consequence, teams are often assigned different spells of rest between consecutive matches: we are therefore able to investigate the impact of differences in days of rest on team performance.

Using different estimation methods and controlling for several measures of teams' abilities, we do not find any significant effect of rest on team performance (neither in terms of points gained nor on goal scored and conceded) when we focus on the whole sample of tournaments.

However, we find that before Nineties days of rest had a positive impact on performance, presumably because athletic preparation of players was significantly worse in the past and teams enjoying less rest suffered a disadvantage.

Furthermore, we show that when rest time of one of the opposing teams is equal or less than three days, the advantage of additional days of rest is quite relevant. Therefore, it seems that there is a threshold of

about three days under which rest time is important, whereas beyond this threshold additional rest is no more useful.

Our results imply that, notwithstanding several concerns of coaches, players and supporters, the current organization of international championships as regards the scheduling of the matches is adequate and players' productivity and the competitive balance do not seem to be altered. In addition, these findings have key implications for the organization of national League matches interspersed with matches of international competitions, such as Champions League and Europa League in European countries. If our results are also valid at level of club teams, teams playing on average two matches at week (one for the national League and the other for some European Cups) – should not be less competitive with respect to other teams involved only in national League, playing only once a week. Future research is aimed to verify this aspect.

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