The Value of Information: The Case of Soccer

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Abstract

This paper studies the effect of a change in soccer rules proposed by the International Federation of Association Football —the announcement of the duration of time added to the game due to injuries and other time lost during the game. I find that while the rule change has not had much of an impact on the total number of goals scored per game, as that figure has remained relatively constant, it has stimulated player performance during the time added, thus keeping the fans interested until the very last second of the game. This additional intensity, however, is offset by a decrease in performance during the final minutes before the announcement, when players seem to stand around, waiting to learn how much time they have left to work with.

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1. Introduction

Soccer is the most popular sport in the world, yet it still faces competition from other professional sports leagues, and from other types of entertainment. In an effort to further heighten soccer's appeal, the Union of European Football Association (UEFA) and the International Federation of Association Football (FIFA) set out to develop the game. Specifically, this involves assessing the various rules of the game and changing them as necessary in order to keep the game interesting for the fans. These practices are not unique to soccer. Similar measures are commonly taken by many other professional leagues. The National Hockey League (NHL), for example, has been experimenting with the size of the goalie's crease area, rules against rough play, etc. The National Football League (NFL) has changed rules to speed up the game. And the National Basketball Association (NBA) has redesigned rules to improve the flow and pace of the game. This paper focuses on the effect of one particular rule change designed to keep soccer games fast paced and interesting: the announcement of the duration of added time.

Unlike in many other sports, in soccer the game clock is always running, i.e., the referees do not stop the clock for fouls, injuries, penalty kicks, etc. This factor might encourage players on the leading team to waste time during the game so as to increase the probability of staying in the lead. In order to decrease player incentives to waste time, FIFA instructs its referees to add at the end of each half the estimated amount of time lost. This extra time is called "added time"[1] (AT). The duration of AT is at the sole discretion of the referee, and the referee alone decides when the match is officially over. Originally, the duration of AT was not made public as the game neared halftime or its conclusion—referees would only announce the very end of the game. This changed in September 1998 when FIFA instructed its referees to announce toward the end of each half the length of AT. The referee now signals

[1] Also referred to as "injury time."

how many minutes of AT he intends to add. Another official then shares this information with the players and spectators by holding up a board showing this number. The signaled AT may be further extended at the discretion of the referee.

The intention of the new rule is to make games more exciting by letting the players and spectators know that *all* of the time spent on injuries and other lost time is indeed added back to the game. This paper posits that the new rule has had additional positive and negative externalities. In particular, it has affected the players' strategy during AT. The act of announcing the duration of AT gives players full information on the time left in the game, in contrast to the uncertainty with which they used to play. With full information on the time left, players can now choose the strategy that maximizes the net benefits for their team. This, however, has an additional effect: since players find the information on the duration of AT very important, they tend to decrease their level of effort in the few minutes before the AT announcement, waiting for the additional information before deciding on the optimal strategy to close out the half or the game.

Economists have long been interested in studying sports. In the case of soccer, both theoretical and empirical analyses have investigated various aspects of the game, such as modeling the demand (e.g., Bird, 1982; Falter, Perignon and Vercruysse, 2008; Simmons, 1996), predicting the behavior of teams (e.g., Palomino et al., 1999) and estimating the effect of a red card on the team's chance of winning (Ridder et al., 1994). This article is closer to studies that have looked at the effect of a rule change on teams' behavior.[2] Brocas and Carrillo (2004) use game theory to study how two rule changes, the three-point victory (3PV) and the golden goal (GG), affect the allocation of effort. They show that increasing the value of a victory will induce tied teams to adopt a more offensive strategy toward the end of the game. However, under some conditions, it will also induce teams to use a more defensive

[2] The effect of rule changes was studied in other sports as well. See, for example, Abrevaya (2004) and Easton and Rockerbie (2005).

strategy toward the beginning of the game in order to avoid being led early in the match. In addition, they find that the GG rule modifies the payoff for scoring but not teams' incentives to play offensively. The 3PV and the GG were also studied by Guedes and Machado (2002) and Banerjee and Swinnen (2004), respectively. Both studies show that the rule changes might not have had the desired effect on teams' behavior.

The main results of this paper are as follows. I find that the number of goals scored during AT has increased since the rule change. This confirms the conjecture that players can better choose their strategy under full information. However, the rule change has had no effect on the overall number of goals scored during a match. The results show that the increase in the number of goals scored during AT is being offset by a decrease in the number of goals scored during the 85^{th}-89^{th} minutes. Finally, I find that the additional information has benefited lagging, and hurt leading, teams.

2. Research Method

In order to motivate the analysis, I propose a simple model, where players have to choose between two types of plays: *Coach* and *Improv*. I call a *Coach* play any structured play—offensive or defensive. This type of play involves different strategies that have been designed by the coach and that teams have worked on during practice. An *Improv* play is defined as an improvised and generally disorganized play, where players neglect the coached strategy and randomly try to score a goal. I assume that a *Coach* play, being well thought-out ahead of time, has a higher probability of resulting in a score and a lower probability of resulting in a goal received than the *Improv* play. Formally, if the probability of scoring and conceding a goal under the *Coach* and *Improv* plays is P_{Coach}, C_{Coach}, and P_{Improv}, C_{Improv}, respectively, then $P_{Coach} > P_{Improv}$ and $C_{Coach} < C_{Improv}$. That is, the *Coach* play dominates the *Improv* play in all respects. The Coach play, however, requires a minimum time, T*, to be completed

successfully; otherwise its probability of success is very low. Consequently, players tend to be drawn to the *Improv* play toward the end of the game when they are tight on time and feel that they have "nothing to lose" from abandoning the *Coach* play.

I assume that players choose between *Coach* and *Improv* plays based on the team's relative position in the game. Teams that are behind typically feel a lot of pressure during the last minutes of the game and are, therefore, more likely to take more risks and resort to a less organized play. These teams typically reach a point where they "panic" and fear that their loss is inevitable; it is at this point in time that players are assumed to switch from a *Coach* play to an *Improv* play. Leading teams, on the other hand, are focused on guaranteeing their lead, minimizing the probability of conceding a goal. I, therefore, assume that leading teams follow the *Coach* play throughout the entire game. Finally, while there are definitely cases where a tie is a desirable outcome, in most games at least one of the teams would make an effort to win the game.[3] Consequently, I assume that tied teams are drawn to the *Improv* play as well; however, in their case the switch from *Coach* to *Improv* typically occurs at a later point in time than in the case of lagging teams.

During the seasons preceding the 1998 rule change, players played under time uncertainty as they did not know the exact duration of AT. This, however, changed after September 1998, once referees started announcing the length of AT. Players have since been able to use the information on the duration of AT in order to assess whether they have enough time to choose a *Coach* play. That is, players have had greater clarity with respect to their decision on whether and when to switch to an *Improv* play. Consequently, I assume that for teams that tend to switch to an *Improv* play at a certain point during the game, the rule change has extended the period of time they play *Coach*. This suggests that the teams that should benefit from the rule change are lagging and tied teams.

[3] This is especially true with the three point value system FIFA introduced in the mid 1990s. For a game-theory analysis of the effect of this rule on players' incentives, see Brocas and Carrillo (2004).

While the rule change might increase the number of goals scored by lagging and tied teams during AT, the overall effect of the number of goals scored during AT is not clear. On one hand, lagging and tied teams increase their probability of scoring a goal. On the other hand, these same teams decrease the probability of conceding a goal. That is, we have two contrasting effects on the number of goals scored during AT. The net effect, however, can go both ways.

3. Results

The data for the analysis were compiled from individual game's box scores, largely obtained from the online site Soccerbot.com. The site reports results and standings for soccer leagues around the world. I collected data on primary leagues starting with the 1995-1996 season and ending with the 2003-2004 season for the following countries: England, Germany, Italy, Scotland, and Spain. For each match, I collected data on the total number of goals scored during the match and the exact minute in which each goal was scored.

The English, Italian, German and Spanish leagues have, on average, 20 teams playing in the top division. The Scottish league has an average of 10 teams in that category. In all the leagues studied, each team plays on average 38 games per season, resulting in about 1,500 observations per season. Table 1 summarizes the number of matches observed, the average total number of goals scored, and the average number of goals scored during AT over the 1995-2003 period.

Season	No. Observations	Goals overall	Goals during AT
1995-1996	1326	2.73	0.083
1996-1997	1627	2.71	0.120
1997-1998	1167	2.75	0.115
1998-1999	1549	2.67	0.125
1999-2000	1552	2.73	0.126
2000-2001	1600	2.77	0.136
2001-2002	1599	2.67	0.133
2002-2003	1602	2.68	0.156

2003-2004	1372	2.73	0.139

Table 1: Descriptive Statistics

The table highlights two interesting effects: (1) there is an increase in the average number of goals scored during AT starting with the 1998-1999 season, which also marks the first season during which the AT rule was in effect; and (2) in general, the average total number of goals scored during a match stayed relatively constant during the period of time studied. In order to examine these effects, I combine all of the matches during the seasons prior to the 1998-99 season into one set—Pre98; and I group all of the matches in the seasons following the rule change into the Post98 set. Table 2 summarizes the descriptive statistics for these two sets. As the table shows, while the average number of goals scored during AT increased after the rule change, the change did not affect the total number of goals scored in a game. A simple t-test confirms that the difference in the number of goals during AT is significant, while the difference in the total number of goals is not.

	Season	Average	SD	Range	t-test	Sample size
Total Goals	Pre98	2.727	1.725	0 to 11	0.62	4,120
	Post98	2.708	1.679	0 to 11		9,274
AT Goals	Pre98	0.107	0.326	0 to 3	-4.54*	4,120
	Post98	0.136	0.358	0 to 3		9,274

SD = standard deviation
* = significant at the 5% level

Table 2: Descriptive Statistics before and after the Rule Change

3.1 Performance during AT

To understand better the effect of the new rule on performance during AT, I run a set of linear regressions, with the number of goals scored during AT as the dependant variable. I restrict the data in this analysis to games during the first six seasons listed in Table 1 (1995-96 to 2000-01), in order to balance the number of observations before and after the rule

change.[4] Table 3 presents the results for three different sets of games: (I) all games (8,821 observations); (II) games with at least one goal scored in the final ten minutes (3,374 observations); and (III) games with at least one goal scored in the final five minutes (2,374 observations). I define the following dummy variables for the analysis: Rule98 takes on the value of one if the game took place during the 1998-99 season or after, and zero otherwise; Tie89 takes on the value one if the game was tied at the beginning of AT; Diff1in89 and Diff2in89 indicate one- and two-goal differentials at the beginning of AT, respectively. The variables Tie89, Diff1in89 and Diff2in89 are designed to capture any changes in player strategy, i.e., the type of play chosen, during the final minutes of a match resulting from their effort to tie the game if their team is behind or to win a tied game. I also define country dummies for England, Germany, Italy and Spain. Finally, the variable GoalsTill80 is defined as the number of goals scored during the game up until the 80th minute. I include this variable in order to demonstrate that, in general, more goals may be scored during certain matches due to a discrepancy in the level of play between the two teams or for any other reason.

	I		II		III	
	Coef.	SE	Coef.	SE	Coef.	SE
Rule98	0.019*	0.007	0.039*	0.016	0.049*	0.020
Tie89	-0.002	0.012	0.152*	0.026	0.210*	0.035
Diff1in89	0.044*	0.011	0.193*	0.023	0.221*	0.030
Diff2in89	0.032*	0.012	0.114*	0.025	0.135*	0.032
England	-0.017	0.012	-0.028	0.027	-0.009	0.035
Germany	0.003	0.012	-0.023	0.027	-0.026	0.035
Italy	0.049*	0.013	0.101*	0.029	0.135*	0.036
Spain	0.031*	0.012	0.066*	0.027	0.081*	0.034
GoalsTill80	0.006*	0.002	0.017*	0.006	0.020*	0.007
constant	0.056*	0.016	0.089*	0.033	0.157*	0.042
R^2	0.012		0.037		0.047	
Number of Observations	8,821		3,374		2,374	

SE = standard error
* = significant at the 5% level

Table 3: Regression Results

[4] The regression results with the full dataset (i.e. seasons 1995-96 to 2003-04) are qualitatively similar. The coefficients on Rule98 are larger and significant for all three regressions.

In all three regressions the coefficient of Rule98 is positive and significant, suggesting that the average number of goals during AT increased by 0.02 overall, and by 0.04 and 0.05 in games were at least one goal was scored in the final ten and five minutes, respectively. Given an average of 0.11 goals scored during AT before the rule change, this corresponds to an increase from 17 to 46 percent in the number of goals scored during AT following the rule change.

Tie89 is negative and not significant in the first regression. However, given that at least one goal was scored during the last ten or five minutes, there are, on average, about 0.2 more goals scored during AT if the game was tied prior to AT. The coefficients on Diff1in89 and Diff2in89 are positive and significant. These results confirm the hypothesis that, overall, players change their behavior toward the end of the game if there is a relatively high probability that the outcome of the game can change. Finally, as expected, the coefficient of GoalsTill80 is positive and significant, suggesting that in games with a probability of a higher number of total goals scored, more goals are also scored during AT.

It is important to note that the regressions do not have a very high explanatory power, as shown by the low values of R^2. To a large extent, this is due to the nature of the data, since the performance of a team is largely determined by a series of factors that are either random or difficult to account for, such as the manager's game philosophy, the issuance of red cards, the occasional absence of influential players, the weather conditions and the team's standing when the match is played. Notwithstanding the unsurprising lack of overall fit, most parameter estimates are statistically significant and have the expected sign.

The above analysis strongly suggests that the information about the duration of AT has improved overall performance during the 90^{th} minute of the game—i.e., during AT. Consequently, one would expect the average total number of goals per game to increase after the rule change. As noted before, however, the total number of goals stayed unchanged

throughout the studied period. Next I claim that this result stems from the change in player behavior during the five minutes preceding the announcement about the duration of the AT.

Goals during Minutes	Season	Mean	SD	Range	t-test	Sample Size
85-89	Pre98	0.192	0.436	0 to 3	1.94*	4,120
	Post98	0.177	0.409	0 to 3		9,274
>85	Pre98	0.300	0.546	0 to 4	-1.29	4,120
	Post98	0.313	0.540	0 to 4		9,274

SD = standard deviation
* = significant at the 5% level

Table 4: Goals during the Last Five Minutes of the Game

Table 4 presents descriptive statistics for goals scored in the 85th and 89th minutes, before and after the rule change, as well as the same statistics for goals scored after the 85th minute. A t-test confirms that the decrease in the number of goals scored in the 85th and 89th minutes is significant. Conversely, the difference between the average number of goals scored after the 85th minute is not significant. That is, teams' level of performance decreases during the 85th-89th minutes of the game. This suggests that players may be waiting during this time to receive the information regarding the duration of AT in order to choose the play that maximizes their probability of scoring a goal.

Robustness Check

One might argue that the decrease in the figure representing the number of goals scored during the 85th-89th minutes is due to reporting differences. As it turns out, before the rule change there were cases where, following a match, the media would report that certain goals were scored during the 90th minute, but during the match, those same goals were announced as being scored in the 89th minute. That is, if the game lasted 90+X minutes, then all goals scored between the 90th minute and the 90+(X-1) minute were reported as having been scored during the 89th minute. This suggests that the decrease in the number of goals scored in the 85th-89th minutes and the increase in the number of goals scored in the 90th minute may

simply be the outcome of reporting discrepancies. I, therefore, look at the number of goals scored during the 89th-90th minutes. If the change is a result of this reporting inconsistency, the average number of goals scored during the 89th-90th minutes should not have changed with the introduction of the new rule. As Table 5 shows, this is not the case. The average number of goals scored during these minutes increased after the rule change from 0.160 to 0.176. I performed a t-test to confirm that the difference is significant.

Goals during Minutes	Season	Mean	SD	Range	t-test	Sample Size
>=89	Pre98	0.159	0.392	0 to 3	-2.2*	4,120
	Post98	0.176	0.410	0 to 4		9,274

SD = standard deviation
* = significant at the 5% level

Table 5: Goals during and following the 89th Minute

3.2 Who Benefited from the Change?

The model assumes that the rule change has affected the behavior of lagging and tied teams, pushing their decision to switch to an *Improv* play to a later point in time. Since a *Coach* play is assumed to dominate an *Improv* play in all respects, one would expect the rule change to affect teams asymmetrically, benefiting lagging and tied teams while hurting leading teams.

I first test this hypothesis for leading and lagging teams. I look at the score difference at the beginning of AT and test whether goals scored during AT typically increase or decrease the goal differential. If lagging teams switch to an *Improv* play later than they used to and are ultimately better off, we should see more cases following the rule change of a decrease in the score differential. The results are presented in Table 6.

Goal Differential	Season	Mean	SD	t-test	Sample Size
Increased	Pre98	0.608	0.490	1.75*	342
	Post98	0.554	0.497		928
Decreased	Pre98	0.371	0.484	-1.97*	342
	Post98	0.432	0.496		928

SD = standard deviation

* = significant at the 5% level

Table 6: Goal Differential Before and After Rule Change

Table 6 gives the probability of the goal differential increasing/decreasing when a goal is scored during AT and the game is not tied at the onset of AT. That is, the table demonstrates whether the leading team or the lagging team is more likely to score, as well as whether this probability has changed since the introduction of the new rule. As the table shows, there has been a decrease in the number of games with a higher goal differential and an increase in the number of games with a lower goal differential with both effects being significant. When a goal has been scored during AT, the probability of catching up has increased from 0.37 to 0.43. Note that despite the higher probability of the losing team catching up, a goal during AT is still more likely to be scored by the leading team (0.55), as was the case before the rule change (0.61). The intuition behind this result is that the leading team is typically the stronger team and thus, the leader is more likely to score. This analysis suggests that the rule change has helped weaker teams move up in the standings. Obviously this outcome was not intentional; nevertheless, it does make the game more interesting—supporting FIFA's initial objective.

Testing the above hypothesis for tied teams is a bit more subtle, as whenever one team improves its position, it is at the expense of the other team. I, therefore, only look at the overall probability of breaking a tie during AT. As Table 7 shows, the probability of breaking a tie increased after the rule change. This result supports the hypothesis that the information about the duration of AT helps players use the time left more constructively—optimizing the probability of scoring a goal. Note that this result does not imply that, on average, fewer games end up in a draw (a t-test rejects this hypothesis). The increase in breaking a tie is being offset by the increase in lagging teams scoring and catching up.

	Season	Mean	SD	t-test	Sample Size
Breaking a	Pre98	0.070	0.255	-3.81*	1,127

tie	Post98	0.107	0.310		2,484

SD = standard deviation
* = significant at the 5% level

Table 7: Before and After Rule Change

4. Conclusion

Rule changes are the main tool for FIFA and other sports organizations to affect the way players play. These rule changes, however, do not always achieve the desired outcome. For example, the Golden Goal rule introduced in the early 1990s was later canceled because it did not have the expected effect on player incentives. In this paper I study the effect of one such rule change—announcing the duration of AT. I find that while the rule change has not had much of an impact on the total number of goals scored per game, as that figure has remained relatively constant, it has stimulated player performance during AT, thus keeping the fans interested until the very last second of the game. This additional intensity, however, is offset by the decrease in performance during the final minutes before the announcement, when players seem to stand around, waiting to learn how much time they have left to work with.

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