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Policy Timing and Footballers' Incentives: Penalties Before or After Extra Time?

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Abstract
Assessing the effect of the timing and sequencing of various policy regimes on optimizing agent behavior is both important and difficult. To offer some insights, this article examines a timing decision from sports. The penalty shootout in football (soccer) has long been seen as problematic, among other reasons because it creates incentives for excessively cautious play during extra time. One proposal to alleviate this has been to alter the timing, and stage the shootout *before* (rather than after) extra time with the result binding only if the subsequent extra time offers no resolution. Carrillo's (2007) theoretical model shows that since the effect of this rule change is ambiguous in theory, the proposal's desirability needs to be assessed empirically. Using a comprehensive match data set, the authors compare scoring outcomes of various treatment and control groups, whereby the former simulate closely players' incentives from the proposed rule change, and the latter represent the current timing. Most importantly, the authors examine how extra time scoring probabilities depend on a goal being scored in the first 5 (or 15) min of extra time. Their estimates suggest that bringing the shootout before extra time would substantially alter the players' incentives in extra time and produce more overall attacking play. Quantitatively, the rule change is predicted to increase the *odds* of

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extra time scoring about threefold. Specifically, for the FIFA World Cup and the UEFA club competitions, the *probability* of scoring in extra time is estimated to increase on average by 45–60%, depending on various factors such as the result in regulation time, balancedness of the teams, and home ground advantage. In summary, all these results suggest that the case for trialing the proposed rule is strong. More generally, they highlight the incentive channels through which sequencing of policies may determine their effectiveness.

Keywords

policy timing, incentives, sports economics, football, penalty shootout, logit regression, extra time

Introduction

How does the ordering and timing of policies matter for their effectiveness? To what extent does the sequencing of policies have the power to incentivize behavior of rational agents in an optimal manner according to a predefined objective? The answers to these questions are of considerable economic interest. The sport domain provides a valuable platform to obtain insights into these questions since the response of rational players/coaches to various rules can be measured accurately. This article considers a policy-sequencing rule change and its incentive consequences in football (soccer), the world's most popular sport.

The low-scoring nature of football creates the problem of finding a guaranteed winner in knockout style tournaments, such as the *Fédération Internationale de Football Association* (FIFA) World Cup—the world's largest single sporting event. Penalty shootouts, sanctioned by FIFA in 1970, are a way of mitigating the need for a full replay requiring tournament rescheduling.[1] However, shootouts are still deeply unpopular with some fans because of their numerous vagaries. Most importantly from an economics point of view, the shootout's existence seems to create undesirable incentives for excessively cautious and defensive play in the preceding extra time.[2] This conundrum was summed up succinctly by none other than FIFA President Sepp Blatter, who said in September 2006: "When it comes to the World Cup finals it is passion, and when it goes to extra time, it is a drama. But when it comes to penalty kicks, it is tragedy."

Several proposals have been put forward to alter footballers' incentives in extra time, and hence alleviate the "tragedy" associated with the penalty shootout. One prominent proposal has been to alter the sequencing, and stage the shootout before (rather than after) extra time with the shootout result binding only in the event that the subsequent extra time fails to resolve the deadlock. The shootout would thus play a similar role to an away-goal in two-leg series.[3]

The proposal itself is examined carefully in a theoretical model by Carrillo (2007). He shows that whether or not the proposed rule change increases the total amount of offensive play (and the probability of scoring in extra time) depends on the relative magnitude of two effects: The shootout loser playing more offensively and the winner playing more defensively. He concludes that the proposal's desirability in terms of which of these two effects is stronger remains an empirical issue that "can only be answered by looking at the data."

Our article provides empirical estimates of the proposed rule change compared to the current rule. We use a unique data set of football matches from various recent international and domestic competitions containing detailed information, including the exact minute of goals and bookmakers' odds. We consider three different objective functions discussed by Carrillo (2007), and in each case compare a control group in which the playoff series (one or two leg) is tied at a certain minute of the deciding game, to a treatment group in which one team is one goal ahead on aggregate (possibly only using the away-goal rule). These groups closely simulate the teams' incentives from the current and proposed rule, respectively.

We first focus on a sample of 440 games that went into extra time, as these are the games to which the rule would have been applied to if it had been adopted. We examine if/how the total amount of offensive play in extra time— measured by observed scoring outcomes—depends on whether a goal was scored in the first 5 minutes of extra time. The reason for this approach is that under current rules conceding a goal in the first few minutes of extra time means that the team in question must score at least once in the remainder of extra time, otherwise they will be eliminated. Therefore, the incentives on offer are similar to those provided by the proposed rule change.

We compare the treatment group (in which an early extra time goal was scored) and the control group (no early goal) initially via simple sample statistics: chi-square or *t* tests. We then use logit regressions that enable us to control for other factors such as home ground advantage, the "momentum" effect, unbalancedness of the teams, round and number of legs of the series.

Our estimates indicate that the rule change would have a sizable effect on players' incentives in the desired direction of promoting more attacking play and goal scoring. Quantitatively, it is predicted that the odds of scoring in extra time would increase approximately three times. In competitions such as the FIFA World Cup and UEFA club competitions, the probability of at least one extra time goal would rise on average by approximately 45–60%—depending on the specifics of the game/series. Most importantly, the highest marginal increases occur for (a) low-scoring games (i.e., one without a "momentum" effect); (b) with evenly balanced teams (i.e., no favorite); and (c) played on neutral ground (i.e., without the home ground advantage). This is because a scoring momentum, lack of competitive balance, and home ground advantage already produce more attacking and scoring under the current rule, hence the proposed rule change is a partial substitute for these characteristics.

To demonstrate point (a), let us depict an FIFA World Cup game at the quarter-final stage, played by equally balanced teams based on the bookmakers' odds. According to our estimates, under the proposed rule, the probability of scoring in extra time for a game tied at 0:0 after regulation time would rise from about 0.35–0.37 to 0.59–0.62, which is a 59–76% increase. In contrast, for the same type of game tied at 3:3 after regulation time, the extra time scoring probability would increase from 0.68–0.70 to 0.86–0.99, which constitutes a 27–42% marginal effect. Such increases in scoring probabilities would lead to a smaller proportion of games with the shootout outcome binding. Overall, the proposed rule would approximately halve the proportion of scoreless extra times: from almost 50% currently to below 25%.[4]

As a robustness check, we also examine the difference between the treatment and control groups over the second half of extra time only, as well as various periods of regulation time of all deciding knockout matches (e.g., over the second half or last 30 min). We find that the incentives effect is still present (albeit with a lower magnitude for regulation time), which implies that the direction of the impact of the rule change is robust to the match interval under investigation.

Our analysis also provides related insights of interest to sports economics researchers. For example, we report estimates of (a) the advantage of playing at home; (b) the scoring momentum effect; and (c) the differences in scoring probabilities based on a measure of competitive balance of the teams derived from the bookmakers' odds.

Most importantly, the analysis shows how even subtle changes of policy sequencing may have large incentive effects, and potentially important welfare implications. In particular, our analysis implies that outcomes can be improved if the more random component of policy precedes the less random one, which reduces the degree of uncertainty and improves agents' decisions.

Related Literature

Our article relates to several existing streams of research. Fundamentally, there is a significant and wide-ranging literature on policy timing: both intended and unintended effects. Pindyck's (2000) theoretical model shows that optimal environmental policy timing is influenced by the interaction of uncertainty and irreversibilities. Eliason and Ohlsson (2010) look at mortality over the course of a two-stage abolition of inheritance taxes in Sweden, finding that both stages produced identifiable breaks revealing incentive effects. Gans and Leigh (2009) showed analogous effects on the timing of births, whereby the sequencing of policy announcement and implementation proves to be vital.

In sports economics, the effect of rule changes on individual player and team behavior has also been analyzed, with applications as far ranging as perverse incentive effects to lose, to refereeing decisions, to drugs in sport policy. One specific branch of this work is the significant volume on playing mixed strategies, see, for example, two applications relating to penalty shootouts: Chiappori, Levitt, and Groseclose (2002) and Palacios-Huerta (2003).

Much of the early work in sports economics centers on the moral hazard effects arising from the "designated-hitter" rule in Major League Baseball. This rule provides a very rare example of a natural experimental framework in which incentives induced by a playing rule can be tested, since the rule was introduced in the American League in 1973, but not in the National League, yet the two leagues are highly comparable in all other aspects. Among the more significant contributions are those by Goff, Shughart, and Tollison (1997, 1998) and Bradbury and Drinen (2006), who show that the rule produces a higher rate of hit batters.

Similar literature relating to football, however, is somewhat sparser. Guedes and Machado (2002) estimate the effectiveness of increasing the value of a win from two to three competition points as a means of inducing more attacking play, using data before and after the rule change. Meanwhile, Haugen (2008) notes the implications of the rule on competitive balance of leagues.

On the specific issue of incentives in extra (or over) time, some analysis has been undertaken on incentives caused by the allocation of competition points in tournament design, with primary reference to Ice Hockey's National Hockey League. The collective works, such as Longley and Sankaran (2005) and Banerjee, Swinnen, and Weersink (2007), focus on the introduction of extra time and the incentives of the points system in creating attacking and defensive play. The articles show that the introduction of awarding one point for an extra time loss (compared to zero previously) and two points for a win, predictably generated more attacking play in extra time, but more defensive play in the latter stages of regulation time.[5]

There has also been some attempt at identifying similar aspects in football—Brocas and Carrillo (2004), in addition to the 3-point issue, also examine the effect of the sudden-death element of extra time (also known as golden goal), while Banerjee and Swinnen (2004) approach the problem from a theoretical angle. Analogously, Ridder, Cramer, and Hopstaken (1994) present a probability model estimating the marginal effect of the expulsion of a player (reducing the team to 10 players), also an event likely to make the team play more defensively, on a team's likelihood of winning.

It will become apparent that our findings in the rest of the article contribute to several streams of the literature mentioned above, both in sports economics and in microeconomics more broadly.

Data and Methodology

Our data set comes from a large database of over 500,000 football results kindly provided by a bookmakers' data provider www.trefik.cz. Of these games, there are close to 120,000 for which we have all the relevant information available including: (a) exact times of goals and (b) bookmakers' odds.[6]

The subsample we use in this article consists of 3,815 deciding matches in knockout stage playoffs, that is, games that can potentially go into extra time and penalties if drawn (on aggregate over the series). Of these games, approximately 70% come from the period 2007-2009, which is one of the strengths of the data set. This is because the style of play and the amount of attacking has certainly evolved over time, and such recent observations will enable us to provide estimates relevant to the current style of play. Table A1 in Appendix A lists the covered competitions and the number of matches/series within each of them.

The Results section reports several different ways of assessing the likely effects of the proposed rule change empirically, both in terms of the direction and magnitude. In each case we compare, at different times of the match, the differences in scoring outcomes between a treatment group simulating the proposed rule change, and a control group simulating the current rule. In order to be more precise in our discussion below, let us formally define several relevant concepts.

First, let a *decider* be a playoff game that concludes a series, that is, the second leg in a two-leg series and the single game in a one-leg series. In order to better approximate the incentives of the proposed rule change, we limit throughout our attention to deciders, where we take into account the aggregate score of the series as well as the away goal rule.[7] Second, denote M to be the *end of a certain minute or minute interval* of the decider. For example, M60 denotes the 1 hour mark, $M90^+$ indicates regulation time including stoppage time ("+" throughout indicates the inclusion of stoppage time occurring after that minute), and $M90^+$ to 120^+ denotes extra time. Third, define the status quo of a series at time M of the decider as either 1 (the home team leads on aggregate, possibly only on the away-goals rule), -1 (the away team leads on aggregate, possibly only on away goals), and 0 (neither team leads, not even on away goals). Fourth, an *objective* will throughout refer to the criterion according to which the desirability of the proposed rule change (and the treatment and control groups) will be compared.

Using these definitions, the control group will throughout consist of deciders in which the status quo of the series at M is 0. In contrast, the treatment group games will always satisfy two conditions: (a) the status quo at M of the decider is either 1 or -1 and (b) one goal for the trailing team changes the status quo of the series.[8]

Our main focus is on games in which extra time was played, as this sample coincides with the games to which the rule change would have been applied had it been adopted. Further, as the teams are tied after $M90^+$, they have demonstrated a high degree of homogeneity in terms of their quality, and hence we can be confident that the assignment into the treatment and control groups is largely random. We have 440 such games, about 85.5% of them one-leg and 14.5% two-leg series. While we use all of these in the simple statistical tests in the Simple Comparisons section, for the logit regressions in the remaining sections we use an unbiased subsample of 415 games for which we have betting odds data (for a breakdown of scoring outcomes and other statistics, see Tables A2 and A3 in Appendix A. In particular, we are interested in whether/how an early extra time goal (scored within the first 5 min) affects the scoring outcomes in the rest of extra time. Nevertheless, to make sure the incentive effect is robust, we examine whether it is present at different stages of the game, for example, over the second half of extra time only (with cutoff $M105^+$), the second half of regulation time (with cutoff $M45^+$), or over the last half an hour of regulation time (with cutoff M60).

In evaluating the proposed rule change several objectives seem plausible. Carrillo (2007) mentions the three most natural candidates: Objective I, maximizing the total amount of offensive play; Objective II, maximizing the sum of the probabilities of scoring; and Objective III, minimizing the probability of deciding the winner by penalty shootouts. We believe that these objectives are, using the available data, best approximated in the following way. In terms of Objective I, it is the mean or median number of goals over the period of interest. In terms of Objective II, it is the proportion of games in which at least one goal is scored over the period of interest. In terms of Objective III, it is the proportion of series in which the aggregate score is no longer tied at the conclusion of the period of interest.

Recalling that a circumventing the ‘‘tragedy’’ of the winner being determined by the shootout is a chief motivation for the rule change, we favor Objective III strongly on conceptual grounds. However, Objective III presents a significant practical dilemma in terms of measurement insofar that for one-leg playoffs, Objective III excludes games in which both teams score the same number of goals in the considered period. As such, it conceals a significant part of the improved incentives effect and increase in overall attacking play. Moreover, extra times in which both teams score an equal (non-zero) amount of goals are less problematic as they provide more entertainment to fans than goalless extra times, arguably making Objective II more attractive.

As a further clarification on the type of playoff, for two-leg series in which the away-goal rule applies, Objectives II and III are obviously equivalent in terms of extra time, since once a goal is scored the aggregate score (taking into account away goals) can no longer be tied. Given that under the proposed rule change this equivalence of Objectives II and III would be true for both one-leg and two-leg series, the latter seems less desirable for the evaluation of the new rule.

There is an additional reason for favoring Objective II for the purposes of our analysis—when considering the treatment group under Objective III we need to include an extra condition, namely that at least one additional extra time goal is scored after the first $M90^+$ to M95 goal. This is to make sure that our results are not driven by the selection criterion itself and overstate the treatment group effect. However, it needs to be remembered that this technical requirement does not reflect the nature of the proposed rule change.

Finally, Objective II (like Objective III) indicates the *proportion* of games in which attacking and scoring is high. A high mean in regards to Objective I could possibly be driven by a small number of outlying (high scoring) games, making it the least-preferred option. For all these compelling reasons, while our simple statistical comparisons of the treatment and control groups examine all three objectives, our logit regressions focus exclusively on Objective II.

Results

Our main focus is on scoring outcomes in extra time. We perform two different exercises depending on whether or not a goal was scored in: (exercise E1) the first 5 min of extra time, that is, M90$^+$ to 95 [all sections except Individual Team Scoring (M105)] and (exercise E2) in the first 15$^+$ min of extra time, that is, M90$^+$ to 105$^+$ [Individual Team Scoring (M105)]. For this purpose, we use all games in our sample in which extra time was played, both one- and two-leg series. As a further robustness check, we also examine scoring outcomes in regulation time.

In terms of capturing the effect of the rule change in extra time, one possibility is to focus on the differences between the treatment and control groups over the subsequent 25$^+$ or 15$^+$ min of extra time, that is, M95 to 120$^+$ for E1 and M105$^+$ to 120$^+$ for E2. We use this method for E2. The disadvantage of this method, however, is the fact that games in which two early extra time goals were scored are either excluded from both groups (if both goals are scored by the same team), or "incorrectly" appear in the control rather than the treatment group in one-leg series (if each goal is scored by a different team). Therefore, to avoid this problem in E2, we use an alternative method and examine scoring outcomes over the entire duration of extra time, M90$^+$ to 120$^+$, where for the treatment group the interval naturally begins the moment the first extra time goal was scored. It should be acknowledged, however, that there is a slight overlap between the criterion for group selection and the effect period, and hence this method is not as "clean" econometrically.[9]

We consider two main approaches in terms of the dependent variable implied by Objective II. In the Overall Scoring section, our dependent variable is *the probability that at least one team scores at least one goal* in the period of interest (e.g., extra time). It will, however, be shown that such an "overall" specification—not distinguishing between the teams—can hide some effects coming from each team that are offsetting each other. Therefore, our benchmark "individual team" specification used in all subsequent sections has the dependent variable as the probability that one specific *team (e.g., the home team) scores the first goal* in the period of interest. Obviously, the overall scoring probability in the latter case is simply the sum of the two individual ones.

Simple Comparisons

Table 1 provides the statistics for both the treatment and the control group for all three objectives. It shows that there is a large statistically significant difference between the two groups across Objectives I and II. In terms of Objective I, the average number of goals in the treatment group is 69.9% higher relative to the control group.[10] In terms of Objective II, the proportion of games in which there was at least one goal during extra time (not counting the first goal of the treatment group) is 59.8% higher in the treatment group relative to the control group. In terms of Objective

Table 1. Simple Comparisons for All Objectives

		Treatment group	Control group
	Number of games	48	392
	Proportion of the total	10.9%	89.1%
	Proportion of one-leg series	89.6%	85%
Objective I	Average number of goals in extra time (excluding the first goal in M90^{+} to 95, if any)	1.188	0.699
	Standard deviation	1.024	0.879
	Independent two sample (two-tailed) t-test p value	0.002	
	Marginal effect	69.9%	
Objective II	Number of games with at least one goal in extra time (excluding the first goal in M90^{+} to 95, if any)	36	184
	Proportion of games with at least one goal in extra time (excluding the first goal in M90^{+} to 95, if any)	75%	46.9%
	Chi-square test p value	.0002	
	Marginal effect	59.8%	
Objective III	Number of games in which the extra time resolves the tie, and there is at least one goal scored (excluding the first goal in M90^{+} to 95)	25	159
	Proportion of games in which the extra time resolves the tie, and there is at least one goal scored in M95 to 120^{+}	52.1%	40.6%
	Chi-Square test p value	0.127	
	Marginal effect	28.4%	

III, the marginal effect is 28.4% and statistically insignificant, but we will see below that this is due to the overly stringent requirement of an additional extra time goal discussed above.

It may be informative to consider which team scores the second extra time goal—in matches with more than one extra time goal. In this sample, in approximately 57% of such cases, it was the team that scored the first extra time goal, and in 43%, it was the opponent. Due to the small number of such matches, this difference is statistically insignificant. This seems to (tentatively) suggest that the proposed rule change would not excessively advantage the team that won the penalty shootout but leave the winner of the game to be determined in the subsequent extra time.[11]

While informative about the direction of the proposed rule change, such simple comparisons could potentially be misleading as they do not account for various

Table 2. Definitions and Summary Statistics of Included Variables

Variable	Variable Description	# of Obs	*Mean*	*Standard deviation*	Min	Max
GPROB	Dependent variable, the probability of goal scoring by any team in the period of interest	415	0.513	0.500	0	1
RULEΔ	Treatment/control group dummy indicating the (aggregate) goal difference at the start of the period of interest: 0 = *control*; 1 = *treatment group*	415	0.113	0.317	0	1
GRATE	A (game) "momentum" dummy: the sum of goals scored in the series prior to extra time (in two-leg series normalized per game)	415	1.605	1.628	0	8
INTL	Type of game dummy: 0 = *domestic*; and 1 = *international games* (the latter includes both the national team level and club level)	415	0.181	0.385	0	1
ROU	The stage of the tournament: 0 = *lower rounds*; 1 = *round of 16*; 2 = *quarter-final*; 3 = *semi-final*; 4 = *final*	415	0.834	1.266	0	4
LEGS	The type of series dummy: 0 = *one-leg*; 1 = *two-leg series*	415	0.154	0.362	0	1
NEUT	Neutral site dummy: 0 = *no*; 1 = *yes*	415	0.133	0.339	0	1
UNBAL	Measure of unbalancedness of the series using bookmakers' odds: for computation see Equation 1	415	0.826	0.646	0	2.823

important factors that may be driving them. Therefore, to have confidence in the magnitude of the effect, the rest of the article estimates it using logit regressions including a number of control variables. This will enable us to separate the incentive effect from other relevant factors.

Overall Scoring

The description of the dependent and independent variables used in this section's logit regression is provided in Table 2 (generally G will throughout stand for goal). The table also reports the summary statistics of all the variables, and the fact that we have 415 observations for this specification (in contrast to the previous section in which odds are not used).

Let us mention several relevant issues. The dependent variable, GPROB, refers to *any* goal scoring without distinguishing which teams scores. RULEΔ is the critical parameter, as a significantly positive (negative) estimate implies that an early extra time goal raises (reduces) the overall level of attacking and the probability of scoring. This parameter thus approximates the effect of the proposed rule change.

The other variables are included to control for certain characteristics of the match/series. Most of them are natural: (a) whether the game was played on neutral ground (NEUT); (b) whether it was an international or domestic competition (INTL); (c) which round (stage) of the tournament it occurred (ROU); and (d) whether it was a one-leg or two-leg series (LEGS).

The remaining two control variables are less obvious but more interesting. GRATE is included as a means of controlling for the scoring or game momentum. In particular, it expresses excess of attacking play over defensive play prior to the period of interest (regulation time), as this scoring momentum is likely to continue into the period of interest (extra time) as well.[12] In contrast, UNBAL captures the "uncertainty of outcome" or "competitive balance" of the contest—considered to be a crucial element in sports economics and behavioral economics that conditions the choices of attacking and defensive strategies of teams, see Guedes and Machado (2002), Easton and Rockerbie (2005), and Moschini (2010).

The UNBAL measure is computed as the absolute value of the natural logarithm of the teams' relative winning probabilities, which are derived from the bookmakers' odds:

$$\text{UNBAL} = \text{absolute value}\left(\ln\left(\frac{\text{probability of team 1 'win'}}{\text{probability of team 2 'win'}}\right)\right). \qquad (1)$$

"Win" refers to the team going through to the next round or securing the trophy in the final. In terms of one-leg series, we use the odds relating to the result in regulation time ($M90^+$). In terms of two-leg series, we use the "go-through" odds where available (about half of the series), and where unavailable we determine these from the odds of the first leg using a simple regression model.[13] Our specification implies that a higher UNBAL measure describes more unbalanced teams as their probabilities of "winning" differ more. Having described the variables, Table 3 reports the results of the logit regression.[14]

In terms of overall explanatory power of the regression expressed by the pseudo-R^2, it is "comparable" to logit models estimated in the literature.[15] Regression results using sports data broadly provide relatively low fit because of the general unpredictability of outcomes of sporting contests—a property of the data that helps explain the wide interest in sports by the general public, noted as far back as Rottenberg (1956). In addition, the logit model is being fitted to two distinct points rather than a locus of points.

The interpretation of estimated coefficients in logit regressions is not straightforward, and we will henceforth report the magnitudes of various effects in two different ways. First, the change in the *odds*, indicated by the "odds ratio" in the last column of Table 3. Formally, if we denote τ and γ to be the scoring probabilities

Table 3. Logit Results

Variable	Coefficient Estimate	p Value	Odds Ratio
CONSTANT	−0.727***	.001	
RULEΔ	1.096***	.002	2.992
GRATE	0.228***	.001	1.256
INTL	0.181	.624	1.198
ROU	0.211*	.058	1.235
LEGS	0.013	.972	1.013
NEUT	−0.489	.323	0.613
UNBAL	0.197	.217	1.218
Log-likelihood	−273.121		
Cragg–Uhler Pseudo-R^2	0.089		
Prediction rate	57.6%		

Note: *, **, and ***denote statistical significance at the 10%, 5%, and 1% level, respectively.

of the treatment and control groups respectively, the odds ratio is defined as $\frac{\tau/(1-\tau)}{\gamma/(1-\gamma)}$. Second, the "marginal effect" is commonly used for such purposes, which is the percentage change in the scoring *probabilities*, defined as $\tau/\gamma - 1$.

The advantage of the odds ratio is that it comes out directly from the logit regression, and it does not depend on values of other variables. On the other hand, the marginal effect is simpler and more intuitive, but it is not related directly to the logit regressions. Furthermore, it depends on the combination of all the other variables, and as such it is less general. We will use both below.

Turning to the estimates in Table 3, we see that the key variable RULEΔ is positive and significant, and its magnitude is quite large in comparison to the other coefficients. This implies that an early goal in extra time substantially increases the total amount of attacking play and the probability that at least one goal will be scored subsequently. Specifically, the odds ratio statistic implies that such an early goal triples the odds of subsequent scoring in extra time.

In terms of the more intuitive marginal effects, we report specific examples in Tables A4 and A5 in Appendix A. They relate to two major types of international competitions, namely the FIFA World Cup and the UEFA European Champions League. In each case, we report the marginal effects relevant to different regulation time scores, the quarter-final leg, and two different UNBAL levels (even teams and a 2:1 favorite). The tables show that the marginal effect is positive for all regulation time scores. Its weighted average (with weights being the proportion of each score from Table A2) is 60.8% and 55.3% for the World Cup with even teams and 2:1 favorite, respectively. The respective numbers for the UEFA club competitions are 59.8% and 54.3%. Let us point out that these results are in line with the simple statistics presented in Table 1.[16]

Additional interesting results emerge regarding partial substitutability of the proposed rule change with the momentum and unbalancedness of the teams. First, Tables A4 and A5 show that the marginal effect decreases with regulation time scoring, and is hence the highest for goal-less matches after $M90^{+}$. This can be interpreted as scoring (or game) momentum: high scoring during regulation time predicts high scoring in extra time, hence there is less need to improve the incentives of players in that type of match.[17] Such need is greatest for low-scoring games, which form a large proportion of all games (see Table A2). This result can more clearly be seen through the coefficient on GRATE, which predicts that every additional goal in regulation time leads to an increase in the extra time scoring odds by 26%.

Second, there is a negative relationship between the marginal effect and the UNBAL measure. Intuitively, one team being favored is likely to increase the scoring probability under the current rule for both groups, as the favorite tends to try to use its perceived superiority to decide the game in extra time rather than leaving it to the penalty shootout. Therefore, the proposed rule change would have a slightly lower marginal effect in such games as opposed to very even teams that play more cautiously in extra time and are more likely to rely on the penalty shootout.[18] This contradicts the implication of Table 3 in which UNBAL is insignificant, which would suggest at face value that uncertainty of outcome does not play a role. It must, however, be remembered that given our specification for UNBAL in Equation 1, there are two different effects that are potentially offsetting each other (due to the absolute value)—that of the favorite against that of the underdog. Such inability of the "overall" specification of the dependent variable in this section to disentangle the effects from each team's perspective implies that an alternative specification may offer a more accurate assessment of the rule change. Therefore, in the remainder of the article we "split" the dependent variable and consider the scoring probability for each team separately, which enables us to study the home advantage as well.

In terms of the other variables, ROU is found to be significantly positive at the 10% level, but our results below indicate that the significance of the round is not robust. The other remaining dummies are all statistically insignificant implying that they do not play a major role in the determination of scoring.

Individual Team's Scoring (M95)

The dependent variable in this section is no longer the overall scoring probability, but the probability that one team scores the first goal in extra time (not counting the first goal in the treatment group). We highlight this by denoting it GPROB1T. This specification has three main advantages.

First, despite using the same sample of games the number of observations doubles as both teams' perspectives are now included separately. Second, such refined specification will better account for competitive balance of the teams. To do so, we replace the UNBAL variable by FAV (short for favorite), which is defined as follows:

Table 4. Definitions and Summary Statistics of Included Variables

Variable	Variable description	# of Obs	*Mean*	*Standard deviation*	Min	Max
GPROB1T	Dependent variable, the probability of one team scoring the first goal in the period of interest	830	0.257	0.437	0	1
RULEΔ	As defined in Table 2	830	0.113	0.317	0	1
GRATE	As defined in Table 2	830	1.605	1.627	0	8
INTL	As defined in Table 2	830	0.181	0.385	0	1
ROU	As defined in Table 2	830	0.834	1.265	0	4
LEGS	As defined in Table 2	830	0.154	0.361	0	1
NEUT	As defined in Table 2	830	0.133	0.339	0	1
FAV	Measure of being a favorite/underdog using bookmakers' odds: for computation, see Equation 2.	830	0.000	1.048	−2.823	2.823
HOME	Home ground dummy: 0 = *away team or neutral site*, 1 = *home team*	830	0.434	0.496	0	1

$$\mathrm{FAV} = \ln\left(\frac{\text{probability of the team's 'win'}}{\text{probability of the opponent's 'win'}}\right). \quad (2)$$

Third, a home ground advantage dummy (HOME) can be included to estimate the benefit of a familiar environment (over and above the neutral site dummy and the information contained in FAV). This is desirable as a number of studies have showed it to play an important role, see, for example, Pollard (1986) and Clarke and Norman (1995).

Nevertheless, the specification of GPROB1T also has two minor disadvantages. First, the errors may be slightly correlated as there are two observations for each game with potentially common factors. For example, heavy rain is likely to affect both participating teams in a certain common way, which will transpire into the residuals of the regression. However, comparing the results of our various specifications will reveal that this issue is unlikely to play any major role. Second, as the overall scoring probability is obtained by doubling the individual team's scoring probabilities, it is possible in principle that its estimate will (slightly) exceed 1 for very high-scoring games.

The dependent and independent variables are summarized in Table 4, and the estimation results reported in Table 5.

Given the nature of this regression, we would expect the values of the parameters to be approximately half of those in the Overall Scoring section, since the dependent variable is "split" in two. The exceptions to this are the constant, the NEUT parameter likely to be affected by the inclusion of the new control variable HOME, and the re-specified variable UNBAL. Table 5 shows that these expectations are indeed met.

Table 5. Logit Results

Variable	Coefficient Estimate	*p* Value	Odds Ratio
CONSTANT	−1.712***	.000	
RULEΔ	0.610**	.013	1.840
GRATE	0.140***	.005	1.151
INTL	0.110	.711	1.117
ROU	0.126	.142	1.134
LEGS	0.024	.933	1.024
NEUT	−0.121	.766	0.886
FAV	0.525***	.000	1.690
HOME	0.321*	.075	1.379
Log-likelihood	−440.100		
Cragg–Uhler Pseudo-R^2	0.111		
Prediction rate	74.7%		

Let us first note the high prediction rate of 74.7%, which refers to the percentage of games (from one team's point of view) that our estimated model can forecast correctly (using the 50% threshold). This rate is higher than comparable studies in the literature such as Stefani and Clarke (1992) and Winchester (2012), where it is commonly around 65–70%.

RULEΔ is still positive and significant at the 5% level. While the odds ratio is reduced, it must be remembered that the dependent variable is the individual probability, and hence the overall probability and odds ratio are comparable to those in the Overall Scoring section. The marginal effects for the two major tournaments reported in Appendix A, Tables A6 and A7, are also very similar, and in line with the simple statistics of the Simple Comparisons section. Furthermore, all other related findings apply here as well—the marginal effect (a) is positive for all regulation time scores and (b) decreases with regulation time scoring as well as unbalancedness.

The new FAV variable is now highly statistically significant. This means that a shorter-price favorite would be even more likely expected to make their excess of class over their opposition count in extra time (as demonstrated by Boyd and Boyd, 1995), and hence a higher probability of it scoring. FAV also implies the reason that UNBAL was not significant in the Overall Scoring section. If one team is the favorite and the other is the underdog, the aggregate sum of the effect may be close to zero as they offset each other.

The fact that our results are robust is further confirmed by the fact that all the other variables have the same sign as in the Overall Scoring section, and those that were significant (GRATE) or insignificant (NEUT, LEGS, and INTL) remain so. The only variable with an altered significance is ROU: it is no longer statistically significant. This implies that once the home ground advantage is controlled for, the stage of the tournament does not seem to play a role.

Table 6. Definitions and Summary Statistics of Included Variables

Variable	Variable description	# of Obs	*Mean*	*Standard deviation*	Min	Max
GPROB1T	As defined in Table 4	792	0.199	0.400	0	1
RULEΔ	As defined in Table 2	792	0.265	0.442	0	1
GRATE	As defined in Table 2	792	1.626	1.521	0	9.429
INTL	As defined in Table 2	792	0.184	0.388	0	1
ROU	As defined in Table 2	792	0.823	1.262	0	4
LEGS	As defined in Table 2	792	0.154	0.361	0	1
NEUT	As defined in Table 2	792	0.136	0.343	0	1
FAV	As defined in Table 4	792	0.000	1.028	−2.776	2.776
HOME	As defined in Table 4	792	0.432	0.496	0	1

In terms of the newly introduced variable HOME, it is positive and statistically significant at the 10% level, predicting an increase in the odds ratio by 38%. This result is consistent with previous studies on home ground advantage in football, such as Pollard (1986) and Clarke and Norman (1995). Let us mention, however, that this effect is over and above that already included in the bookmakers' odds.[19]

We have also experimented with a "team momentum" dummy, describing whether or not the relevant team scored the last goal prior to the period of interest. In all specifications, the magnitude and significance of the RULEΔ dummy has not altered much. However, as the team momentum dummy was highly correlated with the game momentum variable GRATE, the p value of the latter was reduced to around 10%. As we believe the game momentum is a more important force of the two, we have not reported the results with the team momentum dummy (they are available upon request).

Individual Team's Scoring (M105+)

As a robustness check, this section examines a different (longer) period for the selection into the treatment and control groups, namely all of the first half of extra time (15^+ min). Furthermore, as explained above, unlike the previous sections it uses the $M105^+$ time as a fixed cutoff, and only examines the subsequent outcomes in the second half of extra time. The dependent and independent variables are summarized in Table 6, and the estimation results, using 792 observations, are reported in Table 7.

The results are broadly similar to those of the previous section, both in terms of the magnitude of the variables, and their statistical significance—with the prediction rate being even higher. There is one exception: the HOME dummy ceases to be significant. This seems to suggest that home ground advantage is not as useful in the second half of extra time.

In terms of the incentive variable RULEΔ, there is still a large and statistically significant effect, with a similar magnitude. The weighted averages of the marginal effect analogous to those reported in Tables A6 and A7 are as follows: for the FIFA World Cup 54.5% and 46.0% under even teams and 2:1 favorite, respectively,

Table 7. Logit Results

Variable	Coefficient Estimate	p Value	Odds Ratio
CONSTANT	−1.928***	.000	
RULEΔ	0.506**	.014	1.659
GRATE	0.130**	.035	1.138
INTL	0.052	.876	1.053
ROU	0.094	.325	1.099
LEGS	0.057	.855	1.058
NEUT	−0.234	.607	0.791
FAV	0.414***	.000	1.512
HOME	0.091	.644	1.095
Log-likelihood	−376.631		
Cragg–Uhler Pseudo-R^2	0.075		
Prediction rate	80.3%		

whereas for the UEFA club competitions, these numbers are 48.2% and 44.5%, respectively.

The Incentive Effect in Regulation Time

The results of the previous sections suggest that the rule change would have a strong effect on the incentives of players in extra time. As a further robustness check, we also carried out experiments on whether a narrow lead, as opposed to the game being tied, produces different player behavior and outcomes during regulation time.

We ran the logit regressions for a number of *M* cutoff specifications between $M45^+$ and M75, in the same fashion as we do in the previous section.[20] The results of all these regulation time regressions are mutually comparable. Furthermore, all the variables have the same sign as the reported extra time regression, and those that were or were not significant remain so.

In terms of the incentive effect, the RULEΔ variable is still positive and statistically significant at the 5% level. The magnitude of the incentive effect is however markedly lower in regulation time compared to extra time. The odds ratios are in the range of 1.1–1.2, and the marginal effects for the FIFA World Cup and European Champions League are in the order of 7–10%.

One obvious reason for the latter with the $M45^+$ specification is the fact that the scoring probability in the control group is much higher with more time (one whole half) remaining. Specifically, it is 0.64–0.83 on average for the two competitions, and hence any increase in the probability will constitute a smaller percentage. Nevertheless, this explanation does not apply to the M60-75 results.

Several alternative explanations for the lower incentive effect come to mind. First, unlike the RULEΔ dummy that is independent of the other variables and only contains information about the first 5 or 15^+ min of extra time, during regulation time it depends on other variables and relates to the whole match/series. Second, in extra time, the players are arguably more fatigued, so they are more likely to make mistakes. The "conversion" of these mistakes into goals is likely to be greater if there is more attacking and defending (the treatment group), as a greater proportion of playing time happens closer to (or inside) the penalty areas. Third, less "immediacy" of the goal separating the treatment group teams is another possible explanation. In extra time, the early goal immediately precedes the considered period, whereas in regulation time, a potential separating goal may have been scored 45 min earlier, or even 1 or 2 weeks earlier if scored in the first leg.

Fourth and most interestingly, one could hypothesize that the size of the incentive effect is decreasing in game time remaining. It seems plausible that as the end of the game is approaching the trailing team will have to take greater risks in trying to tip the game in its favor, which is likely to increase the probability of both the team's scoring as well as its conceding. Nevertheless, this hypothesis does not seem to be confirmed in the data—the relationship between the size of the dummy and the cutoff M is not monotone with a clear pattern. This is the case not only in the considered cutoff range $M45^+$ to M75, but also in extra time where the marginal effects for $M105^+$ were similar to (in fact slightly smaller than for) M95. More research is required to shed light on the reasons behind this and identify which of the above explanations is most relevant.

Summary and Conclusions

Sports data provide a valuable opportunity for empirical testing of hypotheses arising from theoretical analyses of games, incentives, and strategies in economics. In focusing on the possibility of improving policy timing to solve a fundamental dysfunction in football, this article empirically assesses whether and how players' incentives depend on the sequencing of various tie-breaking components of the game. Specifically, following a recent proposal we investigate to what extent, if any, the amount of attacking and scoring would differ if the penalty shootout was brought from after extra time to before extra time. We do so using a unique data set of recent football matches including detailed information such as the exact times of goals and bookmakers' odds.

Our analysis suggests that such a rule change would generate substantial increases in the overall attacking level and scoring outcomes in the subsequent extra time. Qualitatively, it is predicted that the rule change would increase the odds of scoring in extra time about threefold. In terms of the probabilities for competitions such as the FIFA World Cup and UEFA club competitions, the proportion of extra times with at least one goal would increase, on average, by 45–60%. The proportion of goal-less extra times would therefore approximately fall by half: from the current level of almost 50% to below 25%. The exact magnitude is shown to depend on various factors such as the result in regulation time, balancedness of the teams, and home ground advantage.

Given these findings, and additional beneficial features of the proposed rule change such as finishing the game as a team contest in open play, and alleviating the pressure and personal "tragedy" of individual players, the case for trailing this rule is strong. This is even more so since the results are likely to apply to other low-scoring sports in which finding a victor is imperative for tournament design, such as field hockey and ice hockey.

Our findings have crucial general economic implications for the sequence and timing of policy regimes. If the shootout is regarded as a lottery, whereas open play is more predictable, then our conclusions suggest that better outcomes arise from resolving the lottery component earlier in the model timeframe, in order to allow agents to adjust their behavior and operate with less uncertainty.

Appendix A

Summary of Competitions

Table A1 summarizes the competitions (cups) in the used subsample of knockout stage playoffs, and the reported number of observations relates to series, not individual games within the series. The table lists competitions with more than five series (and contains 3,743 games of the 3,815 we use).

Table A1. Summary of Competitions

Country	Competition	Existing Data Range	Number of Series
AUT	ŐFB Stiegl Cup	2008-2009	43
BEL	Beker van Belgie	2008-2009	55
BUL	Bulgarian Cup	2008-2009	38
CRO	HR Nogometni Cup	2008-2009	37
CZE	Czech cup	1998-2009	265
DEN	Landspokal	2007-2009	103
ENG	Carling Cup	2008-2009	97
ENG	Championship	2004-2009	18
ENG	FA Cup	2007-2009	269
ENG	LDV Trophy	2008-2009	59
ESP	Copa del Rey	2007-2009	108
FIN	Suomen Cup	2007-2009	42
FRA	Coupe de France	2007-2009	113
FRA	Coupe de la Ligue	2008-2009	46
GER	DFB Pokal	2007-2009	60
GER	Liga Pokal	2003-2007	20
INT	UEFA Champions League	1998-2009	130
INT	UEFA Champions League Qualification	1999-2009	208
INT	CONCACAF Champions League	2009	8

(continued)

Table A1 (continued)

Country	Competition	Existing Data Range	Number of Series
INT	Copa Libertadores	2009	7
INT	Copa Sudamericana	2008-2009	62
INT	Cup Winner's Cup	1997-2009	9
INT	EURO	1996-2008	28
INT	Gold Cup	2009	7
INT	UEFA Cup	1997-2009	918
INT	UEFA Europa League	2009	134
INT	UEFA Super Cup	2003-2009	6
INT	FIFA World Cup	1998-2006	48
INT	FIFA World Cup - Playoff - Europe	2005-2009	7
GRE	Greek Cup	2008-2009	35
IRL	FAI Cup	2008-2009	39
ITA	Coppa Italia	2007-2009	114
ITA	Serie B promotion/relegation	2005-2009	17
MEX	Primera Division	2008-2009	21
NED	Eredivisie	2006-2009	31
NED	KNVB Beker	2007-2009	108
NOR	NM Cupen	2008-2009	39
POL	Puchar Polski	2008-2009	31
POR	Taça de Portugal	2008-2009	41
SCO	League Cup	2009	14
SCO	Scottish Cup	2008-2009	60
SVK	Slovak Cup	2008-2009	48
SWE	Svenska Cupen	2008-2009	35
TUR	Türkiye Kupasi	2008-2009	68
UKR	Ukrainian Cup	2008-2009	43
USA	Major League Soccer	1999-2009	54

Summary of Match Outcomes

Table A2. Breakdown of Scores in the Extra Time Subsample

One-leg Series			Two-leg Series		
Regulation Score	Number of Deciders	Percentage of Games	Aggregate Series Score	Number of Deciders	Percentage of Games
0:0	151	43.0	0:0	17	26.6
1:1	133	37.9	1:1	8	12.5
2:2	55	15.7	2:2	27	42.2
3:3	10	2.8	3:3	8	12.5
4:4	2	0.6	4:4	3	4.7
			5:5	1	1.6

Table A3. Summary Statistics for the Extra Time Subsample

		Proportion of Games with at Least One Goal					
		In Extra Time			In Regulation Time		
Competition	Number of Extra Time Matches	*Mean* (both halves)	*Standard deviation* (both halves)	*Mean* (first half)	*Mean* (second half)	*Mean*	*Standard deviation*
Coupe de France	46	0.239	0.431	0.130	0.217	0.652	1.120
UEFA Cup	27	0.519	0.509	0.259	0.370	2.000	1.687
KNVB Beker	27	0.741	0.447	0.407	0.593	2.481	1.949
Coppa Italia	27	0.407	0.501	0.259	0.222	2.259	1.607
Carling Cup	24	0.667	0.482	0.458	0.375	1.917	1.613
DFB Pokal	21	0.619	0.498	0.429	0.524	1.714	1.454
Copa del Rey	20	0.500	0.513	0.350	0.350	1.100	1.210
Türkiye Kupasi	18	0.444	0.511	0.278	0.278	1.444	1.338
FA Cup	16	0.750	0.447	0.188	0.688	1.750	1.483
FIFA World Cup	15	0.400	0.507	0.200	0.200	1.200	1.265
UEFA Champions League	15	0.600	0.507	0.200	0.533	1.467	1.598
Coupe de la Ligue	15	0.600	0.507	0.267	0.533	1.733	1.486
Taça de Portugal	14	0.214	0.426	0.071	0.214	1.143	1.512
EURO	14	0.571	0.514	0.214	0.357	0.857	1.027
Landspokal	14	0.643	0.497	0.500	0.357	1.571	1.950
TOTAL (including ALL available extra times)	440	0.527	0.500	0.300	0.391	1.566	1.614

Note. The table only lists competitions with at least 14 extra times. The correlation between the extra time and regulation time values among these games is 0.577, which suggest that various competition/country-specific factors are present. As apparent when comparing Tables A1 and A3, the proportion of games ending in extra time differs substantially across competitions. The main factors that increase this proportion are (a) a higher proportion of one-leg series (due to less time to resolve the series than in two-legs, and the absence of the away goal rule); (b) more equally balanced teams; and (c) lower scoring games.[21] The UEFA EURO is a good example of these characteristics, and the proportion of extra times from 1996 has been a stunning 50%.

Estimated Marginal Effects of the Overall Scoring section for Selected Competitions

We depict two international tournaments (INTL = 1), namely the FIFA World Cup, involving one-leg series (LEGS = 0) played on neutral ground (NEUT = 1); and the UEFA European Champions League—with two-leg series (LEG = 1), and home and away games (NEUT = 0). For both competitions, we report the quarter-final stage (ROU = 2, which is the mean of this variable), and two different UNBAL levels, namely: (a) exactly even teams (predicted winning probabilities of the teams from bookmakers' odds are 1/2 and 1/2) and (b) a 2:1 favorite scenario (predicted winning

Table A4. FIFA World Cup

Regulation Time Score	Overall Probability of Extra Time Scoring for Exactly Even Teams			Overall Probability of Extra Time Scoring for the 2:1 Favorite Case		
	Treatment Group	Control Group	Marginal Effect (%)	Treatment Group	Control Group	Marginal Effect (%)
0:0	0.619	0.352	76.0	0.650	0.383	69.6
1:1	0.719	0.461	56.0	0.746	0.495	50.6
2:2	0.801	0.574	39.6	0.822	0.607	35.4
3:3	0.864	0.680	27.1	0.879	0.709	24.0
Weighted Mean	0.692	0.438	60.8	0.719	0.471	55.3

Table A5. UEFA Club Competitions

Aggregate Regulation Time Score	Overall Probability of Extra Time Scoring for Exactly Even Teams			Overall Probability of Extra Time Scoring for the 2:1 Favorite Case		
	Treatment Group	Control Group	Marginal Effect (%)	Treatment Group	Control Group	Marginal Effect (%)
0:0	0.622	0.355	75.4	0.653	0.386	69.1
1:1	0.674	0.408	65.0	0.703	0.442	59.2
2:2	0.721	0.464	55.5	0.748	0.498	50.2
3:3	0.765	0.521	46.8	0.789	0.555	42.1
4:4	0.803	0.577	39.2	0.824	0.610	35.1
5:5	0.837	0.631	32.5	0.855	0.663	29.0
Weighted Mean	0.700	0.443	59.8	0.728	0.476	54.3

Table A6. FIFA World Cup

Regulation Time Score	Overall Probability of Extra Time Scoring for Exactly Even Teams			Overall Probability of Extra Time Scoring for the 2:1 Favorite Case		
	Treatment Group	Control Group	Marginal Effect (%)	Treatment Group	Control Group	Marginal Effect (%)
0:0	0.595	0.374	59.0	0.757	0.497	52.2
1:1	0.718	0.467	53.8	0.893	0.609	46.5
2:2	0.852	0.575	48.2	1	0.734	36.2
3:3	0.991	0.696	42.4	1	0.869	15.1
Weighted Mean	0.693	0.451	54.5	0.852	0.589	46.0

probabilities of the teams are 2/3 and 1/3). In each case, we report the marginal effects relevant for different regulation time scores. Tables A4 and A5 do so for the specification with overall probability of scoring.

Table A7. UEFA Club Competitions

Aggregate Regulation Time Score	Overall Probability of Extra Time Scoring for Exactly Even Teams			Overall Probability of Extra Time Scoring for the 2:1 Favorite Case		
	Treatment Group	Control Group	Marginal Effect (%)	Treatment Group	Control Group	Marginal Effect (%)
0:0	0.731	0.478	52.9	0.746	0.501	48.9
1:1	0.797	0.531	50.1	0.809	0.553	46.3
2:2	0.865	0.587	47.3	0.873	0.608	43.6
3:3	0.934	0.647	44.4	0.938	0.665	41.0
4:4	1	0.709	41.0	1	0.725	37.9
5:5	1	0.774	29.2	1	0.787	27.1
Weighted Mean	0.838	0.567	48.2	0.847	0.588	44.5

Estimated Marginal Effects of the Individual Team's Scoring (M95) Section for Selected Competitions

This section performs an identical exercise except that the estimates come from the logit specification with individual team's probability of scoring (the two individual probabilities are summed to provide the overall probability of scoring).[22] The results are reported in Tables A6 and A7.

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Notes

1. See FIFA (2009, pp. 50–51) for a technical summary.
2. This is partly due to the fact that players may tend to overestimate the probability of their team winning the penalty shootout, see Carrillo (2007). The additional criticisms of shootouts refer to the perception that the outcome it generates is merely a lottery rather than a true separation of quality; that it puts undue pressure on a small subset of players rather than the team; and that the game does not end in open play.
3. The exact score of the penalty shootout would be irrelevant, only the win/loss would matter. A team that would score more goals than the opponent in the subsequent extra time would win the game even if it lost the penalty shootout by a greater goal margin.

4. At the same time, fans that like to see (nonbinding) shootouts would also be pleased as their incidence would increase under the proposed rule. Anecdotally, the 2006 World Cup semi-final provides a famous epitome of our result, where (traditionally defensive) Italy seemingly attacked at all costs in extra time against Germany, providing a most entertaining 30 min. Arguably, their abysmal relative past shootout record conditioned Italian tactics as if they had already lost a pre-extra time shootout. In major international competitions, Germany's past penalty shootout win/loss ratio had been 71%, whereas Italy's only 20%, for more details see www.penaltyshootouts.co.uk/countries.html.
5. It is apparent that the proposed rule change we consider is unlikely to have such perverse effects on the play in regulation time as there is no reward for a tie.
6. While we have odds by a number of bookmakers, for consistency we use only those of the three largest agencies in the Czech Republic, as they cover the whole considered period.
7. In two-leg series such as the European Champions League, the winner is based on the score aggregated over the two legs. In case of both teams scoring, the same number of goals in the series the one that scored more goals at the opponent's ground is the winner. Only if both teams score the same number of home and away goals does the second leg game proceed to extra time.
8. An alternative would be to require that the status quo is not just changed but reversed fully. However, it would be arguably very stringent in one-leg games as it would require two goals scored by the trailing team. Note that the payoff for scoring is lower under our specification than under the proposed rule change where one goal reverses the status quo fully. This would imply that our estimates can be considered as a lower bound of the actual effect. Nevertheless, it may be the case that if one goal fully reverses the status quo the trailing team may be cautious not to jeopardize its future come back chances. This is in line with the concept of loss aversion, and empirical relevance of the latter effect requires further research.
9. The results of the two methods for E1 are very similar because (a) the overlap is on average around 2 min, which is negligible relative to the nonoverlapping period of 25^+ min and (b) there are only four games with two early extra time goals in our sample.
10. Let us mention that 14 games in the sample were ended by a golden or silver goal. Table 1 makes no adjustment for this fact, but we recalculated the statistics making an appropriate normalization using games to which the golden/silver goal rule did not apply. Since the average number of goals in both the treatment and control groups increases similarly, the proportional difference between the groups remains virtually identical.
11. Let us also mention that the winner of the penalty shootout in our data set is random: it correlates with neither the bookmaker's odds nor the home ground. Specifically, the favorite won 48% and the underdog 52% of the shootouts, which is not statistically different from a random draw (p value .67). Similarly, the percentages for the home and away team are 53% and 47%, respectively (p value .5).
12. We will below discuss a variable expressing a "team momentum" as opposed to the "game momentum."
13. We fit a simple linear regression from the first leg probabilities. The correlation coefficient of 0.97 suggests it is a good way of doing so.

14. Let us mention two related issues. First, another variable of interest would be the presence of red cards in the game. As our sample only has this information for a minority of games, we cannot control for this feature in our regressions. Second, we have also estimated probit regressions but the results are very similar to the reported logits.
15. It must be emphasized that one cannot directly compare various pseudo-R^2 statistics across different models/specifications, or with the standard R^2, since their nature differs.
16. Note that unlike the marginal effects (i.e., *percentage increases* in the probability) that differ across the two competitions and the two unbalancedness levels, the *level* of the scoring probability increases by about 0.25 in all cases.
17. Intuitively, a goal is likely to increase the confidence of the scoring team but also momentarily reduce its concentration, whereas for the conceding team a goal provides distress as well as an impulse to try harder. All these circumstances are likely to increase the probability of goal scoring for a given status quo of the game.
18. For both competitions and any regulation time score, the marginal effect is about 10% lower for a 2:1 favorite scenario relative to evenly balanced teams.
19. A different way of assessing the home ground advantage is to look at the proportion of games won by the home team relative to the away team. We have 127,161 football games in our sample that are not played on neutral ground. Of these, 42.6% were won by the home team and 25.4% were won by the away team (the rest were tied). According to these numbers, the away team's probability of winning would increase by 67.7% if it played at home rather than away. One should, however, make two important distinctions. First, for two-leg series, it was shown that the size of the home ground advantage depends on the leg and is greater for the second one, see Page and Page (2007). Second, it should be distinguished between cup games (playoff stage) and league games (non-playoff). In each, the incentives are obviously different due to a different reward system: in league games, the three points for a win and one point for a draw system arguably lead to less caution and more attacking play than in playoffs. This is consistent with the recent contribution of Dilger and Geyer's (2009) natural experiment comparing German League and Cup games (in a style similar to the framework advocated here) and is confirmed by the statistics in our data set. The average number of goals in regulation time of playoff games is 0.79 for home teams and 0.63 for away teams, whereas in league games the respective numbers are 1.44 and 1.04.
20. The sample size is obviously different for each M cutoff. For example, for $M45^+$ it is 5,050 observations (2,525 series) and for M60 it is 4,324 observations (2,162 series).
21. There are additional idiosyncratic factors, such as the existence of replay matches in the FA Cup in English football.
22. For this reason in very high-scoring games, the overall probability may add up to slightly more than 1, in which case we have normalized it to 1. The presence of such cases implies that the specification with individual scoring probabilities is likely to be a slight overestimate for high-scoring games. Nevertheless, since this applies to both the control and treatment groups, the marginal effect will be largely unaffected.

References

Banerjee, A. N., & Swinnen, J. F. M. (2004). Does a sudden death liven up the game? Rules, incentives, and strategy in football. *Economic Theory*, *23*, 411-421.

Banerjee, A. N., Swinnen, J. F. M., & Weersink, A. (2007). Skating on thin ice: Rule changes and team strategies in the NHL. *Canadian Journal of Economics*, *40*, 493-514.

Boyd, D. W., & Boyd, L. A. (1995). Strategic behaviour in contests: Evidence from the 1992 Barcelona Olympic games. *Applied Economics*, *27*, 1037-1043.

Bradbury, J. C., & Drinen, D. (2006). The Designated Hitter, Moral Hazard, and Hit Batters: New evidence from game-level data. *Journal of Sports Economics*, *7*, 319-329.

Brocas, I., & Carrillo, J. D. (2004). Do the "three-point victory" and "golden goal" rules make soccer more exciting? *Journal of Sports Economics*, *5*, 169-185.

Carrillo, J. D. (2007). Penalty shoot-outs: Before or after extra-time? *Journal of Sports Economics*, *8*, 505-518.

Chiappori, P.-A., Levitt, S., & Groseclose, T. J. (2002). Testing mixed strategy equilibria when players are heterogeneous: The case of penalty kicks in soccer. *American Economic Review*, *92*, 1138-1151.

Clarke, S. R., & Norman, J. M. (1995). Home ground advantage of individual clubs in English soccer. *Journal of the Royal Statistical Society, Series D (The Statistician)*, *44*, 509-521.

Dilger, A., & Geyer, H. (2009). Are three points for a win really better than two? A comparison of German soccer league and cup games. *Journal of Sports Economics*, *10*, 305-318.

Easton, S. T., & Rockerbie, D. W. (2005). Overtime! Rules and Incentives in the National Hockey Leaguer. *Journal of Sports Economics*, *6*, 178-202.

Eliason, M., & Ohlsson, H. (2010). *Timing of death and the repeal of the Swedish inheritance tax*. Uppsala University Working Paper, 2010:5.

Fédération Internationale de Football Association (2009). *Laws of the game*: *2009/2010*. Retrieved from http://www.fifa.com/mm/document/affederation/federation/81/42/36/lawsofthegameen.pdf

Gans, J., & Leigh, A. (2009). Born on the first of july: An (Un)natural experiment in birth timing. *Journal of Public Economics*, *93*, 246-263.

Goff, B. L., Shughart, W. F., II., & Tollison, R. D. (1997). Batter up! moral hazard and the effects of the designated hitter rule on hit batsmen. *Economic Inquiry*, *35*, 555-561.

Goff, B. L., Shughart, W. F., II., & Tollison, R. D. (1998). Moral hazard and the effects of the designated hitter rule revised. *Economic Inquiry*, *36*, 688-692.

Guedes, J. C., & Machado, F. S. (2002). Changing rewards in contests: Has the three-point rule brought more offense to soccer? *Empirical Economics*, *27*, 607-630.

Haugen, K. K. (2008). Point score systems and competitive imbalance in professional soccer. *Journal of Sports Economics*, *8*, 191-210.

Longley, N., & Sankaran, S. (2005). The NHL's overtime-loss rule: Empirically analyzing the unintended effects. *Atlantic Economic Journal*, *33*, 137-138.

Moschini, G. (2010). Incentives and outcomes in a strategic setting: The 3-points-for-a-win system in soccer. *Economic Inquiry*, *48*, 65-79.

Page, L., & Page, K. (2007). The second leg home advantage: Evidence from European football cup competitions. *Journal of Sports Sciences*, *25*, 1547-1556.

Palacios-Huerta, I. (2003). Professionals play minimax. *Review of Economic Studies*, *70*, 395-415.

Pindyck, R. S. (2000). Irreversibilities and the timing of environmental policy. *Resource and Energy Economics*, *22*, 233-259.

Pollard, R. (1986). Home advantage in soccer: A retrospective analysis. *Journal of Sports Sciences*, *4*, 237-248.

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

Rottenberg, S. (1956). The baseball players' labor market. *Journal of Political Economy*, *64*, 242-258.

Stefani, R. T., & Clarke, S. R. (1992). Predictions and home advantage for Australian rules football. *Journal of Applied Statistics*, *19*, 251-261.

Winchester, N. (2012). Optimal super rugby bonus points revisited. In Lenten, L. J. A. (Ed.), *Economics of sports leagues: An international perspective.* Northampton, MA: Edward-Elgar, Northampton, forthcoming.

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