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Why the Three-Point Rule Failed to Sufficiently Reduce the Number of Draws in Soccer: An Application of Prospect Theory

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Incentives guide human behavior by altering the level of external motivation. We apply the idea of loss aversion from prospect theory (Kahneman & Tversky, 1979) to the point reward systems in soccer and investigate the controversial impact of the three-point rule on reducing the fraction of draws in this sport. Making use of the Poisson nature of goal scoring, we compared empirical results with theoretically deduced draw ratios from 24 countries encompassing 20 seasons each (N = 118.148 matches). The rule change yielded a slight reduction in the ratio of draws, but despite adverse incentives, still 18% more matches ended drawn than expected, $t(23) = 11.04$, $p < .001$, $d = 2.25$, consistent with prospect theory assertions. Alternative point systems that manipulated incentives for losses yielded reductions at or below statistical expectation. This provides support for the deduced concept of how arbitrary aims, such as the reduction of draws in the world's soccer leagues, could be more effectively accomplished than currently attempted.

Keywords: loss aversion, Poisson distribution, reward systems

In sport contests, the alteration of behavioral constraints is a frequently used method to optimize processes within and outcomes of the system. A common way to do this is by adjusting the rules of the game, often to raise the attractiveness of a sport. For instance, the offside rule in soccer has been a result of the wish to make the game faster and therefore more interesting for the audience (Carosi, 2010).

In many team sports, point rewards are used instead of mere win–loss ratios to honor the relative success of the competing teams. A common system is to assign two points to the winning team and none to the losing one. If a game ends in a draw after regular match time, an overtime or penalty shootout is sometimes designated to decide the winner (e.g., basketball, ice hockey, American football). If the sport allows a competition to end in a draw, one point is usually assigned for both competing teams (e.g., soccer, team handball, volleyball). This yields a 2-1-0 system (2-point system, or "2PS").

In soccer, FIFA (Fédération Internationale de Football Association), which is responsible for all global rule changes, replaced the 2PS in the 1990s with a 3-1-0 system ("3PS"). This step was taken to encourage offensive play, increase the number of goals, and reduce the number of draws, which should in turn make the sport more attractive. The actual contribution of those changes to the attractiveness of this sport is, however, currently debated (e.g., Anderson & Sally, 2013). The 3PS is similar to the reward system in ice hockey, for which many countries use a 3-2-1-0 system, in which a winner after the regular match time receives 3, the loser 0, or in case of a decision in the overtime or penalty shootout, the winner receives 2 and the loser 1 point. Likewise, a 3-1-0-0 system has also been in use, where in the case of an extra time or shootout, only the winner gains 1 point. From a psychological point of view, FIFA follows the idea of simple learning by positive reinforcement.

A lot of research has been accomplished to explore whether the rule change from 2 to 3 points for a win has fulfilled the expectations that it was introduced for, and whether the incentives in these strategic settings fit the rules of economic models. According to game theory, for example, the Nash equilibrium as a balanced state in a noncooperative game of two or more players is expected to shift in response to a change in the reward structure (Moschini, 2010).

However, the empirical findings on this matter diverge. Results range from negative effects of the 3PS adoption on the fraction of draws in Portugal (Dewenter & Namini, 2013) to positive ones in Spain (Garicano & Palacios-Huerta, 2006). In Germany, Amann, Dewenter,

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and Namini (2004) used data from the seasons 1963/64 to 2001/02 and found fewer goals since the adoption of the 3PS in 1995/1996, especially by home teams. In contrast, Dilger and Geyer (2007, 2009) reported positive effects (more goals, fewer draws) for this league within an interval of 10 years around the rule change in 1995/96. Their methodology (no use of effect sizes, arbitrarily chosen 10-year interval) was in turn subject to critique by Strauss, Hagemann, and Loffing (2009a,b) and Hon and Parinduri (2014), who did not find any meaningful changes in the number of draws in the same league.

Two studies aggregated data from several countries. Aylott and Aylott (2007) found an increase in the number of goals in general (except for the German Bundesliga) but also an increase in the fraction of draws after the introduction of the 3PS on the basis of seven countries. Moschini (2010) used data of 35 countries between 1978 and 2007 and reported significantly more goals in 66% and fewer draws in 69% of the countries, meaning significant 3PS effects in the intended direction. However, the overall effect size was small, meaning that the located differences were often meaningless from a practical view. In addition, significantly fewer goals were scored in three countries (Austria, Czech Republic, Germany) and more draws in Italy were registered, giving rise to doubts on the generality of the supposed relation. Nonetheless, this study gives the most reliable results on the subject so far, owing to the large data set analyzed. In his multilinear regression analysis, Moschini accounts for linear time trends and country-specific effects. However, apart from the lacking investigation of effect sizes, a number of other serious methodological problems accompany—and perhaps disguise—the real effects of the 3PS in the study of Moschini (2010) and of current studies in general.

1. Probably the most important driver of the fraction of draws is the competitive balance (or heterogeneity of team abilities) within a league, as more draws are to be expected mathematically in more homogeneous leagues than in more heterogeneous ones. Potential assimilation (or dissimilation) trends of ability levels within the top leagues in the recent decades would therefore have considerably impacted the number of goals and fraction of draws that were empirically assessed. This has not been controlled by previous studies so far.
2. Timely trends should be considered also in the number of goals per match (e.g., due to tactical developments irrespective of the 3PS introduction) and the amount of home advantage, as they are additional diffusors of end results (e.g., Carosi, 2010; R. Pollard & Pollard, 2005). As long as these factors are not considered, a sound appraisal regarding the expected fraction of draws is seriously hampered. Moschini (2010) tried to handle this by controlling for linear trends, but in reality none of these effects have to be linear in nature.
3. While current research has looked solely at the absolute levels in the fraction of draws, it has entirely neglected to look for a theoretical expectation value to make out a "reference level." This addresses questions of overriding importance, such as, is the actual overall fraction of draws (still) (too) high, or what effect size has to be expected due to a rule change? (see also Maher, 1982; McHale & Scarf, 2011).

This article addresses these three problems by presenting an elaborated method to analyze the effects of reward system changes that overcome Problems 1 and 2 and a theoretical framework to respond to the questions mentioned by Problem 3.

Objective Versus Subjective Use of Rewards: Prospect Theory

Obviously, there is some empirical evidence that the introduction of the 3PS reward system did not work as well as expected, not in every country, and if, mostly with a small practical meaning. The application of the prospect theory (Kahneman & Tversky, 1979) offers a theoretical framework and explanation to this pattern that contradicts a simple reinforcement model. A particularity regarding a reward system is that the relevance of winning and losing (points) does not have to be symmetrical in the view of a performer. Prospect theory states that individuals are more highly motivated to avoid losses than to achieve gains of comparable magnitude in making decisions (Kahneman & Tversky, 1979). This is denoted as *loss aversion,* and some examples show that it extends to behavioral variables such as effort exertion (Camerer, Babcock, Loewenstein, & Thaler, 1997; Heath, Larrick, & Wu, 1999). The standard measure for its extent is the coefficient of loss aversion

$$\lambda = \left| \frac{\text{value of an additional unit in losses}}{\text{value of an additional unit in gains}} \right|$$

A typical value that is shared by the majority of researchers and studies (Abdellaoui, Bleichrodt, & Paraschiv, 2007) is $\lambda = 2.25$, so that people are expected to favor a risky gain over a potential loss (and act accordingly) only if the potential gain is 2.25 times higher than the potential loss. When estimated in several fields and conditions, λ has, however, yielded results in the range of $\lambda \in [1.4;4.8]$, and it has been shown to vary considerably from person to person (Lauriola, Levin, & Hart, 2007).

Specific causes for this effect have been identified. Most prominently, loss aversion is lower for experts (Abdellaoui, Bleichrodt, & Kammoun, 2013) or if losses are faced more frequently (van Oest, 2013). Loss aversion is also reduced following recent gains (Barberis, Huang, & Santos, 2001) or if greater attention is attributed to the gain (Jarnebrant, 2012). Finally, loss aversion decreases with the size of the outcomes (Bleichrodt & Pinto, 2000; Kahneman & Tversky, 1979). Unfortunately, an exact degree of loss aversion for the specific context of soccer matches by means of λ cannot be deduced, as the currently available studies do not yet suffice to allow for a transferring of the quantitative impact from one context to another. Following the findings described above, however, it can at least be expected to be reduced, on the one hand, by addressing experts who regularly deal with the situation of winning and losing, thus lowering the expectation for λ. To the knowledge of the authors, the only study that quantitatively tested loss aversion in sport competitions pertained to NFL coaches' kick-off decisions and yielded a coefficient of $\lambda = 1.55$. On the other hand, when dealing with the particularly tight matches in soccer in relation to the number of draws (i.e., small size outcomes), this likely increases the actual coefficient of loss aversion. Summarized, the standard value of 2.25 may be a reasonable expectation value, and the presence of loss aversion may mean that the change from 2PS to 3PS is too weak to provoke a change in human behavior (offensive play, number of draws, and number of goals).

The Aims of This Study

Because the problems discussed above have been found to accompany—and perhaps disguise—the real effects of the 3PS adoption, one major aim of this study is to overcome these problems and provide a consistent theoretical foundation for the appraisal of reward changes in soccer. In principle, this may apply to other sports as well. Concerning the distribution of theoretically expected match outcomes, we derive statistical expectancies that include all of the important general game factors known, but disregarding psychological effects of the score (Sub-Aim 1). Then, as introduced above, we apply prospect theory predictions to the soccer context, which yields predictions deviating from the mere statistical expectations approach. To test and discuss the validity of the respective predictions, we compare the 2PS with the 3PS as well as with other reward systems (Sub-Aim 2).

Sub-Aim 1: Comparison of Empirical Results With Theoretically Derived Expectations. The prediction of match results has a long tradition in scientific and non-scientific areas, addressing diverse sports (e.g., Boulier & Stekler, 2003; Rue & Salvesen, 2000). As for soccer, it has been shown that—when taking the differing capabilities of the teams into account—scoring goals can be accurately described with the help of individual Poisson distributions for the two competing teams (Heuer, Müller, & Rubner, 2010; Maher, 1982). We will use this method with minor adaptions. Modeling the goals of the teams can be used to estimate probabilities for individual results, and along with that, a reference level for the expected fraction of draws after inclusion of team abilities, home advantage, and the number of goals, adapted to every single match. A key feature of this theoretical model is (per construction) that it assumes teams to play their match independent from the actual score, yielding a statistical expectation. Deviances from this statistical picture are thus a natural measure for score-dependent behavior of the teams. In the case of the German Bundesliga, the above procedure yielded an almost perfect prediction of match results with the only major deviance precisely being an underestimation of the empirically measured fraction of draws at the expense of too many close wins for either team (Heuer et al., 2010). One mechanisms is that in case of a draw in the final period of a match, the frequency to score further goals significantly decreases. The phenomenon of an inflated number of draws has also appeared by means of other approaches, confirming the validity of the models (e.g., Karlis & Ntzoufras, 2003; McHale & Scarf, 2011). In turn, this *tendency toward the draw* directly refers to the matter of our interest: Compared with the "objective" estimation of the fraction of draws, the empirical deviances can be used to judge soccer players' subjective use of rewards and the effect of changes in the reward system. Concerning a single reward system, such as the 2PS, there rests an alternative explanation, saying that general team tactics independent of the reward system may account for the deviances in the theoretical expectation values. If a rule change would have an impact, however, that would mean that team tactics are not independent of the reward system and also the use of the reward shifts for the teams, at least as long as no other major changes in the soccer leagues take place at the same time similar to the reward system change.

Sub-Aim 2: Comparison of Several Reward Schemes to Test the Predictions of Prospect Theory. In the history of the world's highest soccer divisions, some countries have experimented with incentives other than the 2PS or 3PS to reward the performance of the teams. In China, for instance, an extra point was awarded for scoring a header goal between 1970 and 1990. In France, teams could gain an additional point via scoring at least three goals (1973/74) or by winning with a score difference of at least three goals (1974/75 and 1975/76). In the USA, a penalty shootout was played in matches that ended in a draw (1996–1999) and the 3-1-0-0 reward system was used. Similarly, Japan employed a 3-2-1-0 system in 1997–1998, in which only the winner in regular match time, extra time, or penalty shootout received 3, 2, or 1 point, respectively, and the loser went away empty handed. Finally, teams in Bulgaria received no point for a scoreless draw in the seasons 1984/85–1986/87 (referred to as 2PS*). In Table 1, we review the reward systems together with their standard coefficient of loss aversion that would establish an equal subjective use of the gain and the loss incentive for the case in which the actual result would be a draw. In the 2PS, an additional reward of +1 point for the winning goal is faced with the risk of –1 point in case of a conceded goal, yielding

$$\lambda = \left|\frac{1}{-1}\right| = 1 < 2.25$$

Therefore, the subjective negative use of losing the 1 point is far greater than the subjective reward for gaining an additional point, so loss aversion yields the expectation of too many draws in soccer before the introduction of the 3-point rule. In the 3PS, the coefficient computes to

$$\lambda = \left|\frac{2}{-1}\right| = 2 < 2.25$$

Thus, the threshold value of 2.25 is still not crossed despite the increased incentive for a victory, so we expected only minor changes in the fraction of draws after the 3PS adoption, in particular keeping the fraction of draws still too high. In leagues using reward schemes that feature $\lambda > 2.25$, by contrast, a considerable drop in the fraction of draws and a qualitative decline beneath the expectation value can indeed be expected. This is likely to be the case in the 3-1-0-0 and 3-2-1-0 systems. In the 3-1-0-0 system (USA), we valued a draw as a 50% chance to win 1 point (in the shootout) and therefore gave it a value of 0.5 point. This should on average be valid. Scoring a goal would then mean an additional 2.5 points, and conceding a goal –0.5 point, yielding

$$\lambda = \left|\frac{2.5}{-0.5}\right| = 5$$

In the 3-2-1-0 system of Japan, there was a 67% chance of a decision in overtime (61 out of 91 matches) and a 33% chance for a shootout (30 out of 91 matches) in these seasons. Assuming that this ratio meets the appraisement of the players, the expected number of points (reference value) in case of a draw in regular match time computes to 0.67 · (0.5 · 2 points) + 0.33 · (0.5 · 1 point) = 0.835 point (67% chance for 2 points in extra time, 33% for 1 point in the shootout), and thus

$$\lambda = \left|\frac{3-0.835}{0-0.835}\right| = 2.59$$

Therefore, based on these assumptions, both cases yield $\lambda > 2.25$. In particular, these systems should better induce the incentive to go for higher risks than the 3PS in case of a draw as an intermediate result. Finally, the coefficient of loss aversion in the Bulgarian 2PS* mathematically computes to

$$\lambda = \left|\frac{1}{0}\right| \underset{=\!=}{\text{def}} \infty$$

in the case of a 0:0, so this system can be theoretically expected to be very efficient in circumventing a match to end scoreless. The maximal penalizing of scoreless matches (0 points for both teams) should have a particular positive impact on the average number of goals.

In summary, our hypotheses are the following:

H1: The empirical fraction of draws in 2PS exceeds the mere statistical expectation level.

H2: The fraction of draws in a 3PS is smaller than in a 2PS, but it still exceeds the mere statistical expectation level.

H3: The fraction of draws in a 3-1-0-0 or 3-2-1-0 system undercuts the statistical expectation level. In particular, it is smaller than in the 3PS.

H4: The number of goals in the 2PS* exceeds the one in the 2PS.

H5: The fraction of scoreless draws in the 2PS* undercuts the statistical expectation level.

Methods

Data

The data for the main analysis comprises the soccer premier league results of 24 countries with 20 seasons each (N = 118.148 matches). We recorded the 10 seasons preceding and following the introduction of the 3PS (N_{2PS} = 59.774 matches, N_{3PS} = 58.374 matches). In some cases, single seasons were not played or were not available. For these, we recorded the Season 11 (12, and so on) before or after the rule change instead. A full data overview is given in Table 2. At the bottom of this table, the countries and seasons from analyses concerning leagues with alternative reward systems are shown. The six seasons available from the 3-2-1-0 / 3-1-0-0 systems were compared with the subsequent seasons using the 3PS (USA: 2000–2010, Japan: 2003–2010). In Japan, a sudden death was played in 1999–2002, in which both teams received 1 point in the event of no goals during this extra time. As this period differed from the 2PS control group, it was ruled out of the analysis. In Bulgaria, a 2PS was employed eight seasons before and after the 2PS* seasons, so we used these seasons as the control group in this case (the 3PS was introduced in the ninth season following the 2PS*).

Table 1 Point Reward Schemes and Coefficients of Loss Aversion in the Case of a Draw

Reward Scheme	2PS	3PS	3-1-0-0 (USA)	3-2-1-0 (Japan)	2PS* (Bulgaria)
λ(draw)	1	2	5	2.59	1
λ(0:0 draw)	1	2	5	2.59	∞

Procedure and Measures

We estimated the goals of the teams by making use of the Poisson nature of goal scoring in soccer (Heuer et al., 2010; Maher, 1982). For this, let $G_i^+(G_i^-)$ be the average number of goals in a match that team i scored (conceded) and $G_i = G_i^+ + G_i^-$. Let

$$G^h = \frac{1}{N}\sum_{i=1}^{N} G_i^h, \qquad G^a = \frac{1}{N}\sum_{i=1}^{N} G_i^a$$

and $G = G^h + G^a$ denote the average number of goals of home, away, and all teams in general, and let $HA = G^h - G^a$ be the seasonal home advantage. Home advantage was incorporated via shifting the computed results from x to $x + 1$ by an accordant probability u. As the empirical home advantage was sometimes higher in close matches than for larger values of $|\Delta G|$, an accordantly large probability $v \neq u$ was used in this case for shifting the results between $\Delta G = -1$ and $\Delta G = 1$. This increased home advantage for small $|\Delta G|$ may, for instance, be the result of a particular value that athletes derive of being successful at home rather than away. Finally, let $\Delta G_i = G_i^+ - G_i^-$ be the average goal difference of team i in a season. When using these seasonal means G_i and ΔG_i as estimates, the true width of their distribution will be overestimated due to the presence of random fluctuations in finite numbers of matches. This can be quantified and accounted for by the magnitude of regression to the mean effects (Heuer & Rubner, 2009). From now on, we therefore denote the regression to the mean-adjusted values with the definitions from above. For the prediction of specific matches, the number of goals for a team also depends on the ability of the opponent. Taking this into account, the number of goals g_i^{h+} and g_j^{a+} in a match between a home team i

Table 2 A List of the Countries and Seasons Incorporated

Country	Season (First)	Season (Last)	Seasons	Rule Change	Comparison	Matches	Data Coverage
ARG	1985	2004	20	1995	2PS vs. 3PS	7562	100%
AUS	1985	2005	20	1995	2PS vs. 3PS	3738	100%
AUT	1985	2004	20	1995	2PS vs. 3PS	3216	100%
ECU	1985	2004	20	1995	2PS vs. 3PS	3352	100%
ENG	1971	1990	20	1981	2PS vs. 3PS	8952	100%
ESP	1985	2004	20	1995	2PS vs. 3PS	7616	100%
FRA	1984	2003	20	1994	2PS vs. 3PS	7230	100%
GER	1985	2004	20	1995	2PS vs. 3PS	6194	100%
GRE	1982	2001	20	1992	2PS vs. 3PS	5534	100%
HUN	1984	2003	20	1994	2PS vs. 3PS	4664	100%
ITA	1984	2003	20	1994	2PS vs. 3PS	5856	100%
KOR	1984	2003	20	1994	2PS vs. 3PS	2266	100%
LUX	1985	2004	20	1995	2PS vs. 3PS	2388	100%
MEX	1984	2004	20	1995	2PS vs. 3PS	7046	100%
NED	1985	2004	20	1995	2PS vs. 3PS	6120	100%
NOR	1977	1997	20	1988	2PS vs. 3PS	2790	100%
NZL	1972	1992	20	1983	2PS vs. 3PS	2862	100%
POL	1985	2004	20	1995	2PS vs. 3PS	4962	100%
POR	1985	2004	20	1995	2PS vs. 3PS	6210	100%
ROU	1984	2003	20	1994	2PS vs. 3PS	5790	100%
RUS	1984	2004	20	1995	2PS vs. 3PS	4862	100%
SCO	1984	2003	20	1994	2PS vs. 3PS	4092	100%
SUI	1985	2004	20	1995	2PS vs. 3PS	1573	100%
VEN	1983	2002	20	1994	2PS vs. 3PS	3273	100%
JPN	1997	2011	11	2003	3PS vs. 3-2-1-0	3168	100%
USA	1996	2011	16	1999	3PS vs. 3-1-0-0	3054	100%
BUL	1974	1992	19	1984/1987	2PS vs. 2PS*	4560	100%

and away team j can eventually be estimated (Heuer et al., 2010) via

$$g_i^{h+} = \frac{G}{2} + \frac{(G_i + G_j)}{4} + \frac{\Delta G_i - \Delta G_j}{2} + \frac{HA}{2} (= g_i^{a-})$$

and

$$g_j^{a+} = \frac{G}{2} + \frac{(G_i + G_j)}{4} + \frac{\Delta G_j - \Delta G_i}{2} + \frac{HA}{2} (= g_i^{h-})$$

For this estimation of single matches, only the information of the other $N - 1$ matches is used, yielding individual estimates for every match result. As an example, if we define $p_{th}(\Delta G)$ as the Poisson probability that a match ends with a goal difference of ΔG, then the probability for a draw is given by

$$p_{th}(\Delta G = 0) = \sum_{k=0}^{\infty} p\left(g_i^{h+} = k\right) \cdot p\left(g_j^{a+} = k\right)$$

To identify if the fraction of draws exceeds or undercuts the theoretical expectation, we define the draw index D as

$$D = \frac{p_{emp}(\Delta G = 0)}{p_{th}(\Delta G = 0)}$$

with the empirical fraction of draws

$$p_{emp}(\Delta G = 0) = \frac{\#\{\text{end result} = \Delta G\}}{\#\{\text{all end results}\}}$$

If $D > 1$, this indicates that the subjective incentive for a victory is lower than the incentive for avoiding a defeat, thus yielding a *tendency toward the draw*. Accordantly, $D < 1$ hints at a reverse situation, yielding a *tendency away from the draw*, which was presumably intended with the 3PS.

Results

For the 2PS, the draw index D (aggregated over all countries) amounted to $D = 0.287/0.221 = 1.296 \pm 0.024$ (*SE* from country values). The D-value deviated significantly from 1, $t(23) = 12.19$, $p < .001$, $d = 2.49$. In absolute values 28.7% – 22.1% = 6.8% and in relative values [(28.7/22.1) – 1] = 29.7% more matches ended in a draw than statistically expected. This is shown in Figure 1, where the whole distribution curve is pictured. Therefore, Hypothesis 1 was confirmed. Twenty-two of the 24 countries had a significant D-value larger than 1; the other two countries had nonsignificant results. The lowest D-value was found in Romania, with $D = 1.003 \pm 0.037$.

For the 3PS, the draw index yielded $D = 0.254/0.215 = 1.176 \pm 0.016$, $t(23) = 6.930$, $p < .001$, $d = 2.25$. Twenty countries had a significant D-value larger than 1, four countries had nonsignificant results. Romania was the only country with a descriptive, but nonsignificant D-value smaller than 1, $D = 0.975 \pm 0.377$. To test whether the D-value was significantly reduced, a dependent t test for paired samples was computed, $t(23) = -8.013$, $p < .001$, $d = 1.64$. The overall tendency to the draw was therefore significantly reduced, but still existed in the 3PS despite the objectively converse incentives. This confirmed H2.

For the 3-1-0-0 / 3-2-1-0 systems, the draw index yielded $D = 0.9848 \pm 0.089$ in those seasons and $D = 1.081 \pm 0.041$ in the 3PS control group (*SE* from seasonal values). Owing to the overlapping standard errors, a decline of D is indicated descriptively but the draw index

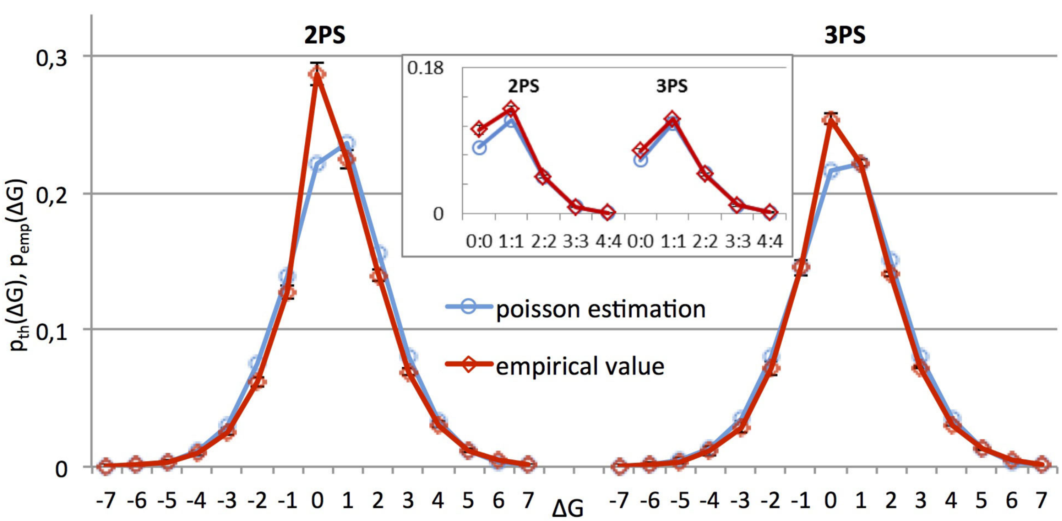

Figure 1 — Empirical ratios of match outcomes and the Poisson estimation, averaged over all 24 countries. The inset shows the results for the specific draw outcomes (0:0, . . . , 4:4). The error bars are the *SE* from the country values.

was not significantly reduced (Figure 2). In addition, $D < 1$ was found descriptively in the 3-1-0-0 / 3-2-1-0 systems, but it did not significantly fall below statistical expectation, $t(5) = -0.172$, $p = .870$. Therefore, H3 had to be rejected.

For the comparison of the 2PS with the 2PS*, in Bulgaria, the overall draw index yielded $D = 0.970 \pm 0.092$ in the 2PS* seasons and $D = 1.187 \pm 0.049$ in the 2PS control group (*SE* from seasonal values). The results for the number of goals per match and the fraction of *n*:*n* draws are shown in Figure 3. In the 2PS*, 0.52 ± 0.06 more goals per match were scored (3.18 vs. 2.66 goals), confirming H4. The fraction of scoreless draws fell from 8.5% in the 2PS to 2.6% in the seasons with the 2PS*, that is, it was made thirds. The difference of 5.9% ± 0.9% is highly significant, $\chi^2(1) = 55.08$, $p < .001$, $\phi = .078$. As hypothesized, the empirical fraction of 0:0 draws was significantly smaller than theoretically expected in the 2PS* seasons, $t(2) = -3.647$, $p = .034$, $d = 2.11$ (Figure 3B). Therefore, H5 was confirmed.

Discussion

This study investigated the effects of reward systems and loss aversion on match end results of national premier leagues in soccer. The results broadly follow the assumption that soccer teams behave risk averse, in accordance with an application of prospect theory to the behavioral context of sport. Risk averse behavior in sport competitions means that for athletes and teams, it is more important to avoid a defeat than to achieve a victory. Interestingly, this runs counter to the public focus on winners and the thinking of a second placed as the *first loser*. It also runs counter to rule changes that aim to make a reduction in draws.

The results were consistently close to the theoretical assumptions regarding the discrepancy of the empirical and theoretical fraction of draws. First, soccer matches in the 2PS yielded more drawn matches than one would expect under a natural result distribution that neglects loss-aversive behavior or tactical effects. This is an elementary finding that was significant for almost all countries investigated. Second, the fraction of draws was shown to depend on the reward system. The fact that such a dependency exists stresses the possible relevance of loss-aversive behavior. Under the 3PS, the number of draws decreased, but an excess of draws was still present. Thus, despite the increased incentive for a victory, this did not even suffice to push the fraction of draws to its statistical expectation values. The 3-point rule therefore failed to qualitatively reverse the preference of athletes to avoid defeats over achieving victories, and thus the fraction of draws in soccer was not affected meaningfully. This goes well beyond Moschini's (2010) findings of a significant drop in the fraction of draws in several methodological (e.g., better control of confounding variables) and theoretical regards (e.g., deduction of expected marginal effect sizes). The established link to the coefficient of loss aversion can explain these findings. Third, the reward systems in the USA and Japan were consistent with $D = 1$ or even smaller. This indicates the true λ-value to be consistent with (or even higher than) 2.25, that is, a considerable loss aversion for a professional context. Finally, the most interesting findings in our view were the results produced in Bulgaria: It is not known what magnitude in increasing goals and reducing draws that FIFA hoped to achieve, but the empirical consequences can be considered as rather weak (reduction of draw ratio from 28.9% to 25.5%, 0.18 more goals per match).

In contrast, the simple rule change of the Bulgarian Federation from 1984 to 1986 had tremendous consequences for the result distribution (and therefore presumably also for the character of the matches): 0.52 more goals per game were scored during the rule change, and

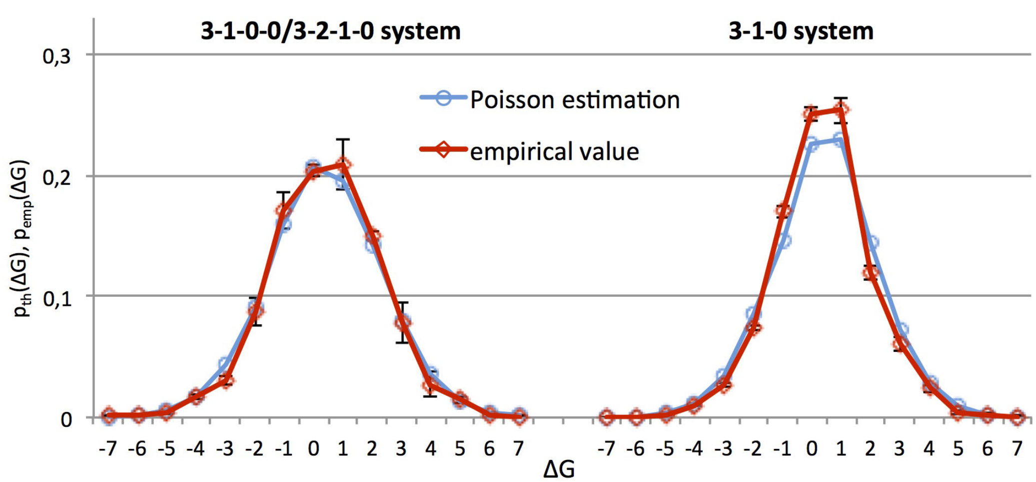

Figure 2 — Score curves from Japan/USA for the 3-2-1-0 / 3-1-0-0 systems and the 3PS (*SE* from seasonal values).

A)

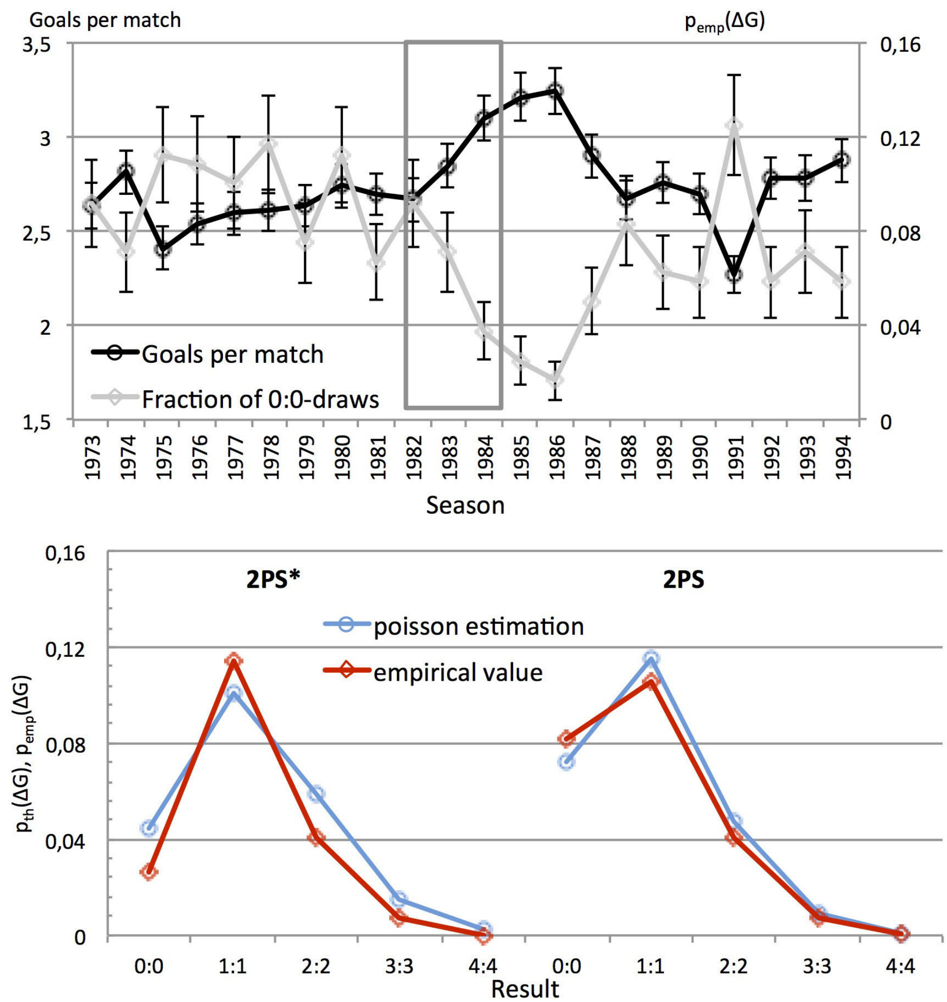

Figure 3 — The case of the 2PS* in Bulgaria. (A) The fraction of scoreless draws and the number of goals in the seasons 1975–1992. The 2PS* seasons are bordered. (B) The fraction of *n*:*n* results in the two reward systems. *SE* result from seasonal values.

the estimated effect is thus about three times higher than under the adoption of the 3PS. Scoreless draws fell from 8.9% to 2.6% compared with a decrease from 10.6% to 7.9% after the 3PS adoption. These results can be directly understood within the offered model. As a consequence, manipulating the incentives for losses (e.g., according a point less for a draw) rather than for gains (e.g., according an additional point for a victory) seems more effective because, as a result of loss aversion, manipulating rewards on the loss side *leverages* the effects. Following the classic idea to increase the incentive for a win, prospect theory would, however, predict that—in the case of a true λ-value of 2.25—the introduction of a 4-1-0 system ("4PS") should produce more dramatic results for soccer matches because $\lambda(4PS) = 3 > 2.25$, so that the true "critical value" is more probably surpassed.

Curiously, the *D*-value in the USA, Japan, and Bulgaria was not only low within seasons using their unconventional rewards, but also within the 3PS/2PS control seasons. This may have several reasons. First, the degree of loss aversion is in part a country-specific quantity. In Romania, for example, we have consistently measured the lowest degree of loss aversion before and after the introduction of the 3PS. Further, a correlation of the *D*-values even without Romania (that we will discuss separately) yielded $c = 0.73 \pm 0.10$ (Figure 4). There are thus indeed heavy differences in the degree of loss aversion among countries. This may be interesting to be further studied in the context of sports or also generalized to other life sciences. Second, the USA and Japan had also already experimented with other systems for about a decade before the introduction of the 3PS. It may be that a change in the incentives takes a while until it manifests in the playing style (and therefore in the results) of a league. This notion is also supported by the case of Bulgaria, where the seasons before and after the 2PS* (1983 and 1987) were found to be the ones with the highest number of goals in all seasons

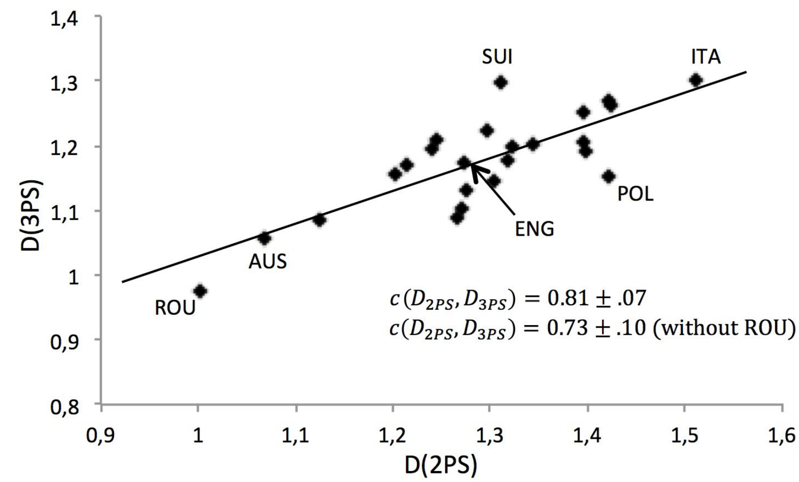

Figure 4 — Draw indexes of the countries for the 2PS and the 3PS. The line is a linear regression of the data.

analyzed within the 2PS, and 1987 was also the one with the lowest fraction of draws within the 2PS (Figure 3A). A similar pattern has been reported by Aylott and Aylott (2007). In other words, this indicates that the degree of loss aversion, as measured by the extent of its behavioral consequences, is modifiable in the long term, and may explain why the *D*-values differ among countries. Future research could more thoroughly examine whether this is indeed the case or if the nation dependence is of other origins. Another intriguing result suggests that even though the 2PS* seems to have prevented from 0:0 results, it has rather fostered matches to end 1:1 in comparison with the 2PS in this country (Figure 3B).

An issue that has not been regarded in former studies on the introduction of the 3-point rule is that a mere change in the number of goals per match already influences the expected (and likely also the empirical) fraction of draws—independent of the difference between the Poisson view of goal scoring and the empirical reality. In the 2PS, an average of 2.59 goals were scored per match, and 2.77 goals in the 3PS. Thus, the decline in the fraction of draws from 28.4% to 25.7% is in part due to the differing number of goals per match. By taking the increase of 0.18 goal and subtracting it in the statistical expectation model of the 3PS, this expected effect on the fraction of draws can be computed and amounts to 0.4%. Thus, although it has turned out to be not large in our sample, it is an effect that should generally be acknowledged.

Our study did encompass a few concerns. First, it is not clear on a theoretical level what behavioral effects in detail are to be expected in response to a rule change. It has been argued, for example, that although the 3PS encourages more offensive play toward the end of a game, it may also induce teams to play more defensively at the beginning of a match (Brocas & Carrillo, 2004). In this situation, the theoretical overall effect on the number of goals and ratio of draws is unclear.

Second, general team tactics in soccer could explain why more draws than statistically expected appear—independent of the reward system. If this was the case, however, it could at least not explain the effect of reward system changes. In addition, as the results for all single reward systems as well as the impact of the system changes quite accurately meet the idea of asymmetric player preferences via the draw index, the loss aversion–based explanation provided here is much better supported.

Third, we included the number of goals *G* in the statistical estimation as an independent variable for the expected fraction of draws *D*. However, there may be a higher order impact on the draw index *D*. However, a correlation of *G* and *D* from the countries within the 2PS or 3PS yields no significant results, $c_{2PS}(G, D) = -0.14$ ($p = .51$) and $c_{3PS}(G, D) = -0.04$ ($p = .87$). Assuming the minor correlation such as in the 2PS to be real would yield a regression slope parameter of $r = -0.045$ between *G* and *D*. As *G* increased from 2.59 goals per game within the 2PS to 2.77 goals within the 3PS, its impact on *D* would be estimated to $0.18 \cdot (-0.045) = -0.008$, that is, by far smaller than the measured differences in *D* and therefore negligible for the conclusions of this study.

Fourth, the presented incentive structure may be insufficient for particular matches. Additional incentives may influence the general value of λ, for instance in derbies or against close rivals in the overall ranking. Those differentiations exceed the general objective of our study. However, we can only speculate that the number of such games should be very small in comparison with the great amount of the other games, so that the influence on λ should be minor, if it exists at all. Future research could acknowledge varying incentives and investigate their particular impact on soccer matches.

Finally, another problem associated with the 3PS is addressed by Shepotylo (2006), who argues that the 3PS adoption could promote match fixings like “three-for-three” cheating. Here, two teams agree to each win their home match against the other. This can result in a sharp increase in the measured home advantage. Then, each team gets 3 points in comparison with, for instance, 2 points in the case of two draws. In the first place, this cheating is attractive for weaker teams, as stronger teams generally need more than on average 1.5 points per match to defend or improve their rank in the overall table. Shepotylo (2006) underlines his hypothesis by presenting data from Ukraine, where he found fewer draws, but more home wins after the 3PS adoption despite the general trend of a declining home advantage (Richard Pollard & Gómez, 2009). The outlier findings from Romania would at least fit this pattern, as relative home advantage—which was highest in Romania among all countries investigated in this study—even increased after the introduction of the 3PS to an outstanding value of 81.4% (mean home advantage of the other countries in the 3PS: 64.8%). A risk that goes along with the 2PS* or a 4-1-0 system is that these systems may even more incite athletes or functionaries to manipulate matches. In case of the 2PS*, for instance, teams may agree to each score a goal early in the match, so that at least 1 point for both teams is secured if the match ends in a draw.

In conclusion, loss aversion seems to play a substantial role in elite soccer. Instead of 30% (2PS) or 18% (3PS) more matches ending with a draw, considerably fewer than statistically expected matches can be conjectured in any league if individuals would not tend toward loss-averse behavior—or if simple alternative rule changes would be applied. For instance, the English Premier League had a significant D-value of 0.2622/0.2233 = 1.174 for the 3PS. A way that would reduce the draw index just to a value of $D = 1$ would mean on average 380 · (0.2622 – 0.2233) = 14.8 fewer draws per season in this league ($N = 380$ matches). It is notable that the external validity of loss aversion has been challenged in its original field of economics when laboratory experimental results have been transferred to real-life behavior of elites (Levitt & List, 2008). In contrast, our study provided support for the external validity of loss aversion in a highly professional setting. This is consistent to pioneering sports studies that have investigated its role in golf putting (Pope & Schweitzer, 2011) or match dynamics in basketball (Berger & Pope, 2011).

The contribution of this study is that it connected the framework of prospect theory and loss aversion to reward systems in sport, enabling us to test quantitative predictions concerning the coefficient of loss aversion. The authors believe that motivational shifts mediate this relation. Experimental research is, however, needed to validate this notion.

Besides its theoretical implications, it may also be of interest for the work of sport organizations. Future research may profit from tracking the consequences for in-match dynamics more proximally to reach a deeper understanding of the studied phenomena.

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