Point Score Systems and Competitive Imbalance in Professional Soccer

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Abstract

This paper addresses effects caused by the transition from a 2-1-0 to a 3-1-0 award system in soccer. The first part of the paper discusses consequences of the transition on offensive vs. defensive play. This part may be seen as a valuable supplement to work by Carillo and Brochas [2] as the choice of a different game theoretic framework provides increased insight into the concept offensive/defensive play in soccer. The second and main part of the paper addresses additional effects induced by the award system transition – especially effects on competitive imbalance. It is shown by simple game theory that under a relatively general set of team descriptions, such a transition may affect competitive balance adversely. In final sections of the paper some empirical examples strengthens the hypothesis on adverse competitive effects.

Keywords: Sports Economics, point score systems, game theory, sports regulation, competitive imbalance

1 Introduction

1.1 Rules of soccer

Changing the rules of sporting activities are as old as sports itself. Soccer, as most other sports, has had it's good share of rule changes. The most significant one, perhaps being the change of the offside rule in 1925 changing the so called "three-opponent" rule to today's "two-opponent" rule. Without being too detailed – See for instance [11] or [1] for an in-depth discussion of these matters – the point was that under the "three-opponent" rule, defending players had this law worked to such a fine art, that in the early 1920's the full-backs had developed an almost fool-proof tactic to catch attacking players off-side [1]. Consequently, the goal-scoring rate was decreasing year by year as well as public demand.

Soccer fans tend to say that these rule changes are made to preserve game-play. An economist however, would say that such changes are economically motivated and a necessary instrument in a continuous product design and development plan. Product design and development is especially challenging in sports, where not only competitors (other sport activities) as well as customers' changing preferences must be taken into account, but also the altering of soccer players skills or technological change. If for instance shoe producers were able to construct soccer-shoes that made it possible for most players to score on free- or penalty-kicks, rule changes would most certainly be the result.

1.2 The "three-point" victory rule

A more recent rule change, the award system of match outcomes, is the candidate for analysis of this paper. In the 1981/82 season of UK Premier league (then named Division one) the 3-1-0 award system (3 points for victory 1 for draw and 0 for loss) was first applied internationally as an alternative to the former 2-1-0 system. The reason for this change was largely motivated by a development during the sixties and seventies of more defensive play. Hence, the motivation behind the change seemed to be to induce more offensive play[1]. It seems reasonable to assume that increasing the "reward" from a victory relative to a draw by 100% should have impact on soccer teams strategic choices favoring more offensive play. A recent paper by Brochas and Carillio [2] address this problem from a theoretic point of view. The authors claim, by applying a game model, that a 3PV[2] rule induces more defensive play in the first half of a game and more offensive play in the last part of a game as opposed to a 2PV rule where the teams do not change their strategy. The fact that teams play more defensively in the first half of a game and more offensively in the lats half does unfortunately not answer the question that ought to be the interesting one; does the 3PV rule induce more offensive play than the 2PV rule? Fernandez-Cantelli and Meeden [4] state empirical evidence which neither supports a hypothesis of increased offensive nor defensive play after the rule change – quote;

> *"Half of the countries did have increased scoring after the change but the others had a decrease in scoring. Six of the ten had fewer ties, but only Turkey and Italy saw noteworthy decreases."*

Consequently, it is hard to state whether the rule change has had the intended effect, both based on empirical as well as existing theoretical work.

1.3 Regulatory "side-effects" – wanted and unwanted

It is well known from traditional economic theory that regulation (which indeed rule changes in soccer may be compared to) is a hard subject. Very often the full consequences of regulatory policy (rule changes) are hard to trace initially, and in many cases, the actual result is far from the desired. Stiglitz [15] describes a classical example: In 1696, English authorities decided to introduce income tax. In those days, registration of income was unsatisfactory, and as a consequence, the authorities needed to find a proxy for income. Windows on houses were luxury, and it seemed reasonable to put taxes on individuals by the number of windows they had on their houses. Such a proxy was easy observable, and it seemed fair to use windows as a proxy for income or wealth. Unfortunately, englishmen at the time were not any stupider than today, and responded by removing most windows. Hence, the situation ended with dark houses and no income tax.

A more recent example (and more relevant in this context) may be found in Norway. As an alternative to the 3-1-0 award system, the Norwegian Football association proposed a hybrid system before the 1987 season. This hybrid, which may be referred to as the 3-2-1-0 system, contained a mandatory penalty-kick competition after all drawn matches[3]. The idea was presumably to "remove" drawn matches

[1] The concept of offensive/defensive play will be treated more thoroughly in later sections

[2] "Three point" victory rule or 3-1-0 award system.

[3] If the game was won in ordinary time, the winner got 3 points, while the looser got 0. Given a draw, the winner of the penalty shoot-out got 2 points, while the loose got 1

under the assumption that such matches were viewed as a signal of defensive play. The result of this experiment was that "low-quality" teams saw the opportunity to get 2-points by winning the penalty-kick competition inducing extreme defensive strategies. The "high-quality" teams had to respond by less offensive strategies as the risk of loosing increased due to the extreme defensive tactics of the "low-quality" teams. As a consequence, the original intention of improving offensive play ended up by the total opposite. Surely, this was a one time experiment in Norwegian soccer.

It seems reasonable to raise the question on whether this type of effects could not have been predicted in advance as an alternative to making costly experiments with highly uncertain outcomes. Or more importantly; does the system in use today (the 3-1-0) system have any interesting side-effects? After all, the primary desired effect of increased offensive play is very hard to establish – see the above discussion. As the title of this paper should indicate, the side-effect under investigation here is that of competitive balance.

Competitive balance in sports leagues is a primary candidate for analysis in sports economics. This is not very surprising as the competitive balance (or imbalance) normally is assumed decisive on public demand. The idea is simple; uncertainty of outcome is a necessity for public demand, and competitive imbalance may hence lead to decreased public demand. After all, who would attend a soccer match if the outcome is given.

Analysis of competitive balance in sports leagues are widely treated in sports economics literature. Contributions by Quirk and El-Hodiri [12] and subsequent works by Quirk and Fort [13], Fort and Quirk [5], Vrooman [16], [17], [18], Hausman and Leonard [7], Rasher [14], Késenne [10], [9] and Goddard and Dobson [3] build on the modelling frame of Quirk and El-Hodiri investigating different league situations. This literature tradition builds largely on modelling of general equilibrium type. As discussed previously, a different tradition based on game theory seems to be emerging. Subsequent sections will show that the approach of Haugen [6] will prove especially convenient for analyzing the problem at hand.

As an initial intuitive hypothesis, it seems reasonable to assume that the change from a 2-1-0 to a 3-1-0 system should induce negative effects on competitive balance. If "good" teams more often choose an offensive strategy, the share of matches won against "bad" teams ought to increase, and competitive imbalance ought to increase. Note however[4], that this initial hypothesis assumes that the degree of offensive play is increasing, which neither literature nor empirical evidence supports fully, Consequently, some more light need to be shed also on whether the rule change induces more offensive play as a whole.

1.4 Outline and objectives

The paper starts out by introducing the game model, then continues to analyze the effects on offensive/defensive play induced by the rule change.

Further on, the effect on competitive balance/imbalance will be analyzed showing that under reasonable assumptions on team performance, the competitive imbalance will increase after the introduction of the 3-1-0 award system.

Finally, some empirical examples are added showing that if competitive balance/imbalance is measured by a more general measure than Fernandez-Cantelli and Meeden [4] (who choose to say that goals-scoring and occurrence of tied games are good proxies for offensive/defensive) there is strong evidence for increased competitive imbalance in professional soccer. Additionally, some thoughts on the concept of an optimal point score system is introduced, following more or less directly

[4]See the conclusions in Brochas and Carillo [2] dicussed above.

form the initial results.

2 The game model

2.1 Basic assumptions

The soccer match description of Haugen [6] is adopted. The basic assumptions in this setting are:

1) Two teams named T_1 and T_2.

3) Uncertainty regarding match outcome. Teams can not predict the outcome of a game given known skills perfectly.

4) Both teams agree on each others assessment of the uncertainty regarding match outcome. This means that the probability that team 1 beats team 2 (and all other probabilities involved) is assumed equal from both teams point of view[5].

5) Two discrete strategic choices O=Offensive, D=Defensive[6].

6) Both teams choose strategies simultaneously before the match[7].

7) Points (without loss of generality) are given according to the following rule: Win=ω, Draw=δ, Loss=0 depending on the choice of award system.

8) "Rationality"; Teams maximize expected point score[8].

2.2 A simple example

Table 1 gives a simple example on consequences of previous definitions and assumptions.

Table 1: An example soccer game

T_1	T_2	p_{12}	p_{21}	p_D	Pay-off 1	Pay-off 2
O	O	0.8	0.1	0.1	2.5	0.4
D	O	0.3	0.2	0.5	1.4	1.1
O	D	0.65	0	0.35	2.3	0.35
D	D	0.1	0	0.9	1.2	0.9

Table 1 contains defined probabilities for some (more or less randomly chosen) soccer match between teams T_1 and T_2. As the numbers indicate, team T_1 is assumed "better" than team T_2 ($p_{12}^{xy} > p_{21}^{xy} \forall x, y$-pairs)[9]. The numbers on the Pay-off columns of table 1 are based on to-day's award system; that is, $\omega = 3$ and $\delta = 1$.

[5]This assumption defines a game of complete information.

[6]Assumptions 3), 4) and 5) then lead to assumed existence of probabilities p_{ij}^{xy} meaning The probability that team T_i beats T_j given that Team T_i chooses strategy x and team T_j choose strategy y and similarly, a draw probability p_D^{xy} where $p_{ij}^{xy} + p_{ji}^{xy} + p_D^{xy} = 1$.

[7]This simplistic "one-shot" game differs from the dynamic formulation of Brochas and Carillo [2]

[8]Consequently, $P_{ij}(x, y)$ denotes pay-off to team T_i playing team T_j given strategic choices x and y are defined as $P_{ij}(x, y) = \omega \cdot p_{ij}^{xy} + \delta \cdot p_D^{xy}$

[9]Note that this match definition does not secure that one team is "better" than the other.

Given the other assumptions of subsection 2.1 the normal-form games of figure 1 may be defined.

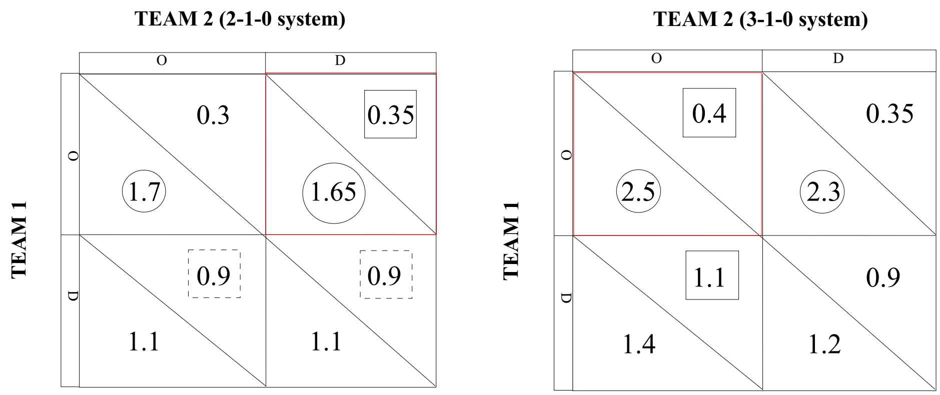

Figure 1: A normal form game based on both award systems.

As figure 1 indicates, the 3-1-0 system is applied to the right, while the 2-1-0 system is applied to the left. Now, as figure 1 also shows, this example confirms increased offensive play under the 3-1-0 system as both teams choose to play offensively in the 3-1-0 case as opposed to the 2-1-0 case, where one of the teams choose the defensive strategy[10].

2.3 A generalized analysis

In order to obtain some more general results, it will prove worthwhile to narrow down to the case of equal teams. Surely, this does not imply total generality, but it is analytically handy.

Before the case is analyzed further, the concept of equally good teams must be defined more precisely. If two equal teams engage in a soccer match it seems obvious to state the following:

$$p_{ij}^{xx} = p_{ji}^{xx} \text{ and } p_{ij}^{yy} = p_{ji}^{yy} \tag{1}$$

Likewise, if they choose different strategies, the probability of T_1 beating T_2 should equal the probability of T_2 beating T_1 if strategies are swapped or:

$$p_{ij}^{xy} = p_{ji}^{yx} \tag{2}$$

Consequently, utilizing the probabilistic normalizing condition and equation (2); (ie. $p_{ij}^{xy} + p_{ji}^{xy} + p_D^{xy} = 1$):

$$\begin{aligned} p_{12}^{OD} + p_{21}^{OD} + p_D^{OD} &= 1 \quad (3) \\ p_{21}^{OD} + p_{12}^{OD} + p_D^{DO} &= 1 \quad (4) \end{aligned}$$

or

$$p_D^{OD} = p_D^{DO} \tag{5}$$

Next, the following assumption is made:

$$p_D^{DD} > p_D^{OO} \tag{6}$$

[10]Both games contain unique pure-strategy Nash equilibria; (OD) under the 2-1-0 system and (OO) under the 3-1-0 system.

The assumption of equation (6) may be judged as the "essential difference" between offensive and defensive play. The meaning is straightforward; if two equal teams engage in a soccer match and both teams choose to play defensively, the probability of a draw should be larger than if both teams choose to play offensively.

As it will be shown subsequently, the next and stricter assumptions play an important role in the understanding of offensive vs. defensive play.

$$P_D^{DD} > P_D^{OD} \tag{7}$$

$$P_D^{OD} > P_D^{OO} \tag{8}$$

Equation (7) states: Given that both teams choose a defensive strategy, the probability of a draw should be larger than if one of the teams choose an offensive strategy.

Equation (8) states: Given that one of the teams choose a defensive strategy, the probability of a draw should be larger than if both teams choose an offensive strategy.

Basically, this seems reasonable; if more teams choose to play defensively, the draw-probability increases. However, the validity of equations (7) and (8) may be discussed – more on these matters later.

Following up, it will prove convenient to introduce simplified notation by applying equations (1) and (2). Defining $p_{12}^{OO} = p_{21}^{OO} = p$ and $p_{12}^{DD} = p_{21}^{DD} = q$ as well as $p_{12}^{DO} = p_{21}^{OD} = s$ and $p_{21}^{DO} = p_{12}^{OD} = r$ the situation may be summed up as in table 2 –

Table 2: Probabilities and expected point scores for a 3-1-0 and 2-1-1 system and equally good teams

					3-1-0 system		**2-1-0 system**	
T_1	T_2	p_{12}	p_{21}	p_D	Pay-off 1	Pay-off 2	Pay-off 1	Pay-off 2
O	O	p	p	$1-2p$	$p+1$	$p+1$	1	1
D	O	r	s	$1-r-s$	$2r+1-s$	$2s+1-r$	$r-s+1$	$s-r+1$
O	D	s	r	$1-r-s$	$2s+1-r$	$2r+1-s$	$s-r+1$	$r-s+1$
D	D	q	q	$1-2q$	$q+1$	$q+1$	1	1

– keeping in mind that equation (6) simplifies to

$$1-2q > 1-2p \Rightarrow p > q \tag{9}$$

Note also that equations (7) and (8) simplifies to:

$$1-2q > 1-r-s \Rightarrow r+s > 2q \tag{10}$$

$$1-r-s > 1-2p \Rightarrow 2p > r+s \tag{11}$$

Figure 2 shows the content of table 2 as 2 normal form games. At this point, it seems reasonable to try to show under which parameter values, the transition from a 2-1-0 to a 3-1-0 award system would impose more offensive play – read Nash equilibria containing O's in the equilibrium strategy.

However, it will turn out to be convenient to do an opposite type of attack (the "ad absurdum" way). That is, firstly, a Nash equilibrium of $\{O, O\}$-type is secured under the 2-1-0-system. Then, a check on the possibility of inducing more offensive play under a 3-1-0 system is carried out.

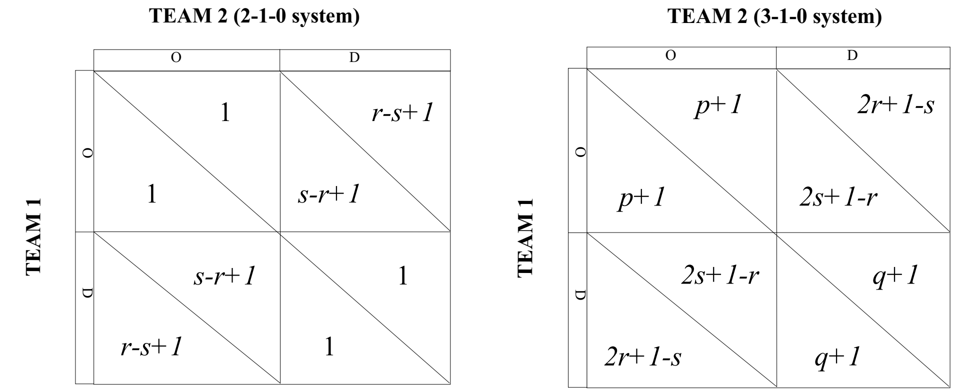

Figure 2: A parametric move from a 2-1-0 to a 3-1-0 point score system with equally good teams

It is straightforward to realize that the pure unique $\{O, O\}$ Nash equilibrium in the 2-1-0 award system case (the game on the left in figure 2) is secured by satisfying the following inequalities:

$$1 > r - s + 1 \tag{12}$$
$$1 < s - r + 1 \tag{13}$$

both implying

$$s > r \tag{14}$$

Consequently, given the assumption $s > r$, the two generalized equal teams will always play offensively. That is, $\{O, O\}$ is a pure and unique Nash equilibrium.

Then, the next step is to check under which assumptions it is possible (if any) to force Nash equilibria containing choices of the D-strategy under the 3-1-0 award system. Due to symmetrical conditions of the game matrix on the right of figure 2, only three possibilities exist:

1) The unique pure $\{D, D\}$ case
2) The "Stag-Hunt" case
3) The "Chicken" case

2.3.1 The unique pure $\{D, D\}$ case

The Nash equilibrium of item 1) is secured by the inequalities:

$$q + 1 > 2s + 1 - r \tag{15}$$
$$p + 1 < 2r - s + 1 \tag{16}$$

Observing that:

$$2s + 1 - r > 2r - s + 1 \Rightarrow 2s - r > 2r - s \Rightarrow s > r \tag{17}$$

it is readily observed that

$$q + 1 > p + 1 \Rightarrow q > p \tag{18}$$

As a consequence, due to the assumption of equation (9), this outcome can not be enforced. That is, given the assumption (eq. (9)) , both teams will not simultaneously choose to change their strategy from offensive to defensive under a transition from a 2-1-0 to a 3-1-0 system.

2.3.2 The "STAG-HUNT" case

The "STAG-HUNT" case implies a Nash equilibrium structure containing 3 Nash equilibria, the pure $\{D, D\}$ and $\{O, O\}$ as well as one in mixed strategies. This outcome is secured by the inequalities (see figure 2):

$$q + 1 > 2s + 1 - r \tag{19}$$
$$p + 1 > 2r - s + 1 \tag{20}$$

or

$$q > 2s - r \tag{21}$$
$$p > 2r - s \tag{22}$$

It turns out that to block this outcome, the assumption of equation (7) is needed. Utilizing equation (14) and rewriting as $s = r + \epsilon$[11], equation (7) may be expressed

$$2q < r + s \Rightarrow 2q < r + (r + \epsilon) \Rightarrow q < r + \frac{\epsilon}{2} \tag{23}$$

Equation (21) may be rewritten:

$$q > 2s - r \Rightarrow q > 2(r + \epsilon) - r \Rightarrow q > r + 2\epsilon \tag{24}$$

Clearly, as $r + 2\epsilon > r + \frac{\epsilon}{2}$ for any positive ϵ, equations (23) and (24) can not be satisfied simultaneously.

2.3.3 The "CHICKEN" case

The "CHICKEN" game also contains 3 Nash euqilibria, 2 pure $\{D, O\}$ and $\{O, D\}$ as well as one in mixed strategies. These equilibria-outcomes are secured by the following equations:

$$p + 1 < 2r + 1 - s \tag{25}$$
$$q + 1 < 2s - r + 1 \tag{26}$$

or

$$p < 2r - s \tag{27}$$
$$q < 2s - r \tag{28}$$

Progressing similarly as in subsection 2.3.2 it is straightforward to show that equations (29) and (30)

$$p < 2r - s \Rightarrow p < r - \epsilon \tag{29}$$

$$2p > r + s \Rightarrow p > r + \frac{\epsilon}{2} \tag{30}$$

cannot be satisfied simultaneously for any positive ϵ.

[11] $\epsilon > 0$ – not necessarily small

2.4 Final remarks on offensive/defensive strategies in soccer

At this point, it may be sensible to address the actual meaning of the somewhat lengthy algebraic arguments of previous subsections. It has been shown, that given assumptions (6), (7) and (8), no teams will choose to alter their strategic choices in a more "defensive direction" – after the introduction of a 3-1-0 award system. It has not been shown that more offensive play is guaranteed. However, it has been demonstrated that certain cases will induce more offensive play – recall the example of figure 1. Consequently, some teams may play more offensively after an introduction of the 3-1-0 system, other teams play unaltered strategies, but no teams will choose to play more defensively. Hence, largely (given assumptions (6), (7) and (8)), the transition from a 2-1-0 to a 3-1-0 system should mean more offensive play – as no teams choose to play more defensively and some teams choose to play more offensively. This type of conclusion is somewhat stronger than that of Carillo and Brochas [2].

However, maybe more important; This analysis has shown that the direction of 3 simple inequalities (6), (7) and (8) are the sole explaining factors guaranteeing that the 3-1-0 system does not induce more defensive play. A simple example may clarify. Suppose assumption (8) is relaxed.

$$p_D^{OD} < p_D^{OO} \tag{31}$$

The meaning of the "relaxed" assumption (31) is that if two teams play a soccer game and one of the teams choose to play defensively, the probability of a draw is smaller than if both teams choose the offensive strategy. At first sight, such an assumption may seem highly questionable. However, suppose one of the teams choose to play in a ball-possessive style while the other chooses a "kick and run"[12] type of strategy. In such a case, even if the "kick and run" strategy by most "soccer experts" would be regarded defensive, it is not obvious that the relaxed assumption (31) is wrong. Table 3 along with figure 3 shows possible consequences of the substitution of (6) with (31).

Table 3: An example with $p_D^{OD} < p_D^{OO}$ – probabilities and expected point scores

					3-1-0 system		**2-1-0 system**	
T_1	T_2	p_{12}	p_{21}	p_D	Pay-off 1	Pay-off 2	Pay-off 1	Pay-off 2
O	O	0.38	0.38	0.24	1.38	1.38	1.00	1.00
D	O	0.40	0.41	0.19	1.39	1.42	0.99	1.01
O	D	0.41	0.40	0.19	1.42	1.39	1.01	0.99
D	D	0.35	0.35	0.30	1.35	1.35	1.00	1.00

Note that $p_D^{OD} = 0.19 < p_D^{OO} = 0.24$ while the other assumptions (equations 6 and 7) are valid as $p_D^{DD} = 0.30 > p_D^{OO} = 0.24$ and $p_D^{DD} = 0.30 < p_D^{OD} = 0.19$.

As figure 3 indicates, in such a case, the transition from a 2-1-0 to a 3-1-0 system may lead to more defensive play.

Actually, this type of example may serve as an explanation for the type of results reported by Cantelli and Meeden [4] with some leagues reporting less offensive play (decreased goal scoring) after the award system transition.

[12]Keeping the team low waiting for the attacking possibility.

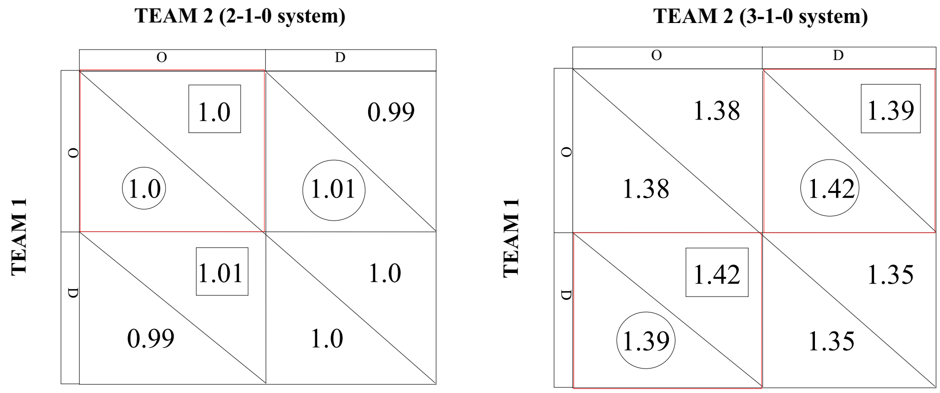

Figure 3: An example with $p_D^{OD} < p_D^{OO}$ – the normal form games

3 Measuring competitive balance/imbalance

Even though the above results ought to be interesting by themselves, at least as an addition to the results of Carillo and Broches [2], the main topic of this paper is to move one step further – investigating the effect the award system transition has had on competitive balance/imbalance.

In order to achieve such a goal it is necessary to measure competitive balance/imbalance effects (some kind of distance measure) between Nash equilibria of different award systems. Clearly this is not possible comparing the 2-1-0 and 3-1-0 system directly, as the two systems are not "point-neutral"[13]. Consequently, it seems reasonable to measure change in competitive balance/imbalance by computing the "distance" between Nash equilibria between the two award systems for general point score schemes. The example below demonstrates the technique.

Using the generalized award system defined by assumption 7) of subsection 2.1 together with the example of table 1, expected point scores for the two teams in the $\{O, D\}$ and $\{O, O\}$ cases are:

$$\begin{aligned} E(T_1^{OD}) &= 0.65 \cdot \omega + 0.35 \cdot \delta && (32) \\ E(T_2^{OD}) &= 0 \cdot \omega + 0.35 \cdot \delta && (33) \end{aligned}$$

$$\begin{aligned} E(T_1^{OO}) &= 0.8 \cdot \omega + 0.1 \cdot \delta && (34) \\ E(T_2^{OO}) &= 0.1 \cdot \omega + 0.1 \cdot \delta && (35) \end{aligned}$$

Now, if

$$E(T_1^{OO}) - E(T_2^{OO}) > E(T_1^{OD}) - E(T_2^{OD}) \qquad (36)$$

(the left part of equation (36) measuring the generalized distance between the two teams under the 3-1-0 system, the right part similarly for the 2-1-0 system) then, it seems reasonable to conclude (by example) that the competitive imbalance has <u>increased</u>.

The actual computation is straightforward: (inserting equations (32) to (35) into (36))

[13] The average point score of any team is larger under the 3-1-0 system than under the 2-1-0 system.

$$0.8 \cdot \omega + 0.1 \cdot \delta - (0.1 \cdot \omega + 0.1 \cdot \delta) > 0.65 \cdot \omega + 0.35 \cdot \delta - (0 \cdot \omega + 0.35 \cdot \delta) \tag{37}$$

giving

$$0.7\omega > 0.65\omega \tag{38}$$

holding for any positive ω. Consequently, the distance between the teams under the Nash equilibria of the 2-1-0 system has increased under the 3-1-0 system. Hence, it seems reasonable (for this example) to conclude that the competitive imbalance has increased between the two systems.

Surely, one could ask for greater generality here, possibly doing this kind of exercise for generalized unequal teams. However, this task is algebraically cumbersome, and it is not possible to guarantee the result even though it does hold "almost always". As a consequence, proofs are left to appendix A.

4 Some empirical examples

In previous sections it has been argued that a transition from a 2-1-0 to a 3-1-0 system implies more offensive play at large. If more offensive play also implies less competition (at large), it seems reasonable to conclude that the award system transition should imply **both** more offensive play **and** increased competitive imbalance. This ought to be an important theoretic conclusion.

4.1 Methodical issues

In this section a few empirical tests for various European soccer leagues will be presented. The aim of the tests, is to check if competitive imbalance has increased as a result of introducing the 3-1-0 award system.

It is clear that such tests raises many difficult issues. First, the award system change is not the only change within the actual time period. For instance, the introduction of the Champions League tournament may have had significant effects on competitive imbalance – possibly in the direction as proposed by the the change in award system. One simple way of dealing with this matter, is to pick examples from leagues containing teams strongly and weakly economically affected by Champions League.

Second, other obvious changes like changes in the number of teams within leagues may also have effects disturbing the singular "award-system-effect". It is proposed to cope with such matters by picking leagues which either have a large number of teams (small changes in the number of teams ought to have negligible effects) or alternatively (for leagues containing a smaller number of teams) picking time periods within the league history with a constant number of teams.

4.2 Measuring league variation

In order to perform tests of the type discussed above, a tool for measuring league variation is needed. The following measure is used:

$$\rho_L = \frac{\sum_{i=1}^{N} (LCP_i - AP_i)^2}{\sum_{i=1}^{N} (LCP_i - MCP)^2} \cdot 100 \tag{39}$$

with definitions:

$$
\begin{aligned}
\rho_L &= \text{League variation defined on} [0, 100]\% \\
N &= \text{Number of teams in the league} \\
AP_i &= \text{Actual point score for team } i \text{ in the final league table} \\
MCP &= \text{Maximal competitive point score } = N \cdot \delta \\
LCP_i &= \text{Least (or minimal) competitive point score for team } i = (N - 2(i-1))\,\omega
\end{aligned}
$$

The league variation ρ_L is defined computationally simple and logical – see Dobson et. al [3] for other possible league variational measures. MCP denotes the maximal competitive outcome and is defined by a league table where **all** matches end in a draw. LCP_i, the minimal competitive situation implies a league table where the best team wins all matches, the second best wins all but 2, and so on. A ρ_l value of 100% then implies $AP_i = MCP$ while $\rho = 0\%$ is obtained if $AP_i = LCP_i$.

4.3 Cases from UK, Norway and Romania

ρ_L is then computed[14] over a time span covering a reasonable amount of years before and after the award system change[15]. Next, average ρ's are computed for the time span before and after the award system transition. Finally, t-tests are performed checking statistical significant differences between the two time periods.

The countries are not picked randomly. Basically, the three cases are meant to span three structurally different soccer leagues. Premier League is picked as a high quality league league with (possibly) high Champions League (**CL**) impact. Tippeligaen is picked as a low quality league – but with (possibly) high **CL** impact. Divizia A is picked representing a low quality league with low **CL** impact[16].

Results are shown in figures 4, 5 and 6:

As shown in figure 4, ρ_L varies over time. The average ρ_L values (shown by the red dashed lines) are significantly different (smaller – in a one-tailed t-test) at the 99% level between the two time horizons; 1947-1981 and 1981-2004. During these (relatively long periods), the number of teams in Premier League has changed. However, the total number of teams has stayed large over the period so the changes are assumed insignificant related to the test.

The same pattern may be observed in figure 5. The average ρ_L in the period 1988-1994 is significantly smaller (99.5% level) than the previous period (1972-1986). The periods are picked to keep the team number constant. Note also that the year 1987 is omitted due to the "experimental" 3-2-1-0 system applied.

As for the other two leagues, Divizia A in Romania shows similar development of competitive imbalance. Not however, that the level of significance is somewhat lover in this case – 95%. As for the case of Tippeligaen, the time periods are chosen with equal team numbers in the league.

Consequently, it seems reasonable to reject a hypothesis of equal average ρ's for the three cases.

5 Policy implications and conclusions

This paper has shown – by applying a simplistic game theoretic framework – that given certain (not too strict) assumptions, an award system change from a 2-1-

[14] All computations are made from internet data sources [8]

[15] Note that the transition time from 2-1-0 to 3-1-0 varies between countries. For the examples picked here, the transition took place in 1982, 1988 and 1994 for Premier League, Tippeligaen and Divizia A respectively.

[16] Note that UK is placed 3. (401 points) on the countrywise CL all-times table [8], Norway is placed 13 (65 points) while Romania is placed 21 (16 points).

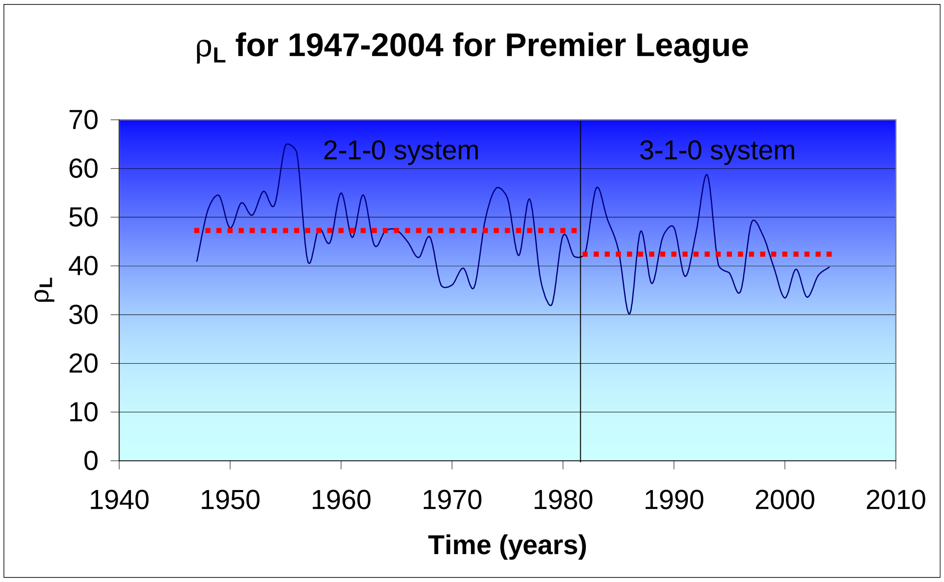

Figure 4: Competitive development in Premier League.

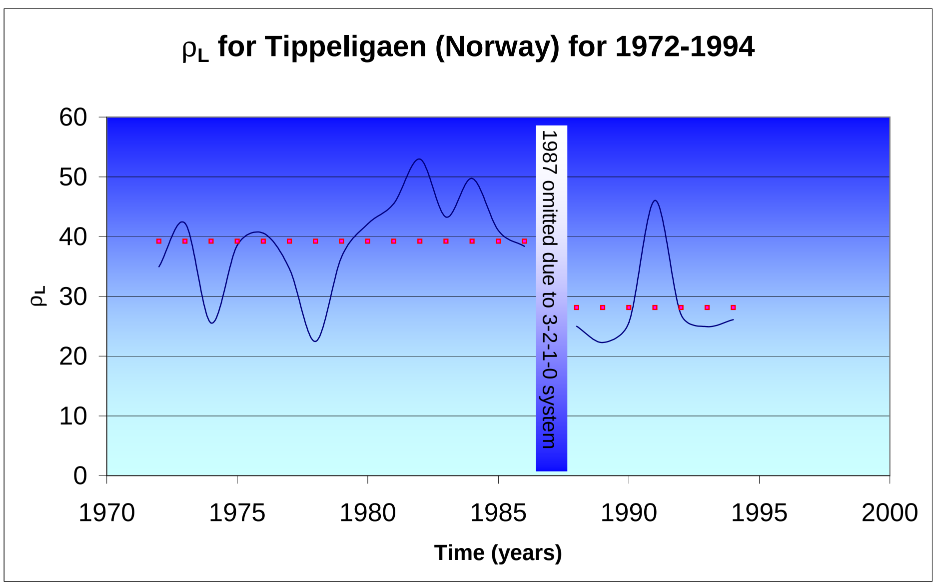

Figure 5: Competitive development in Norwegian Tippeligaen.

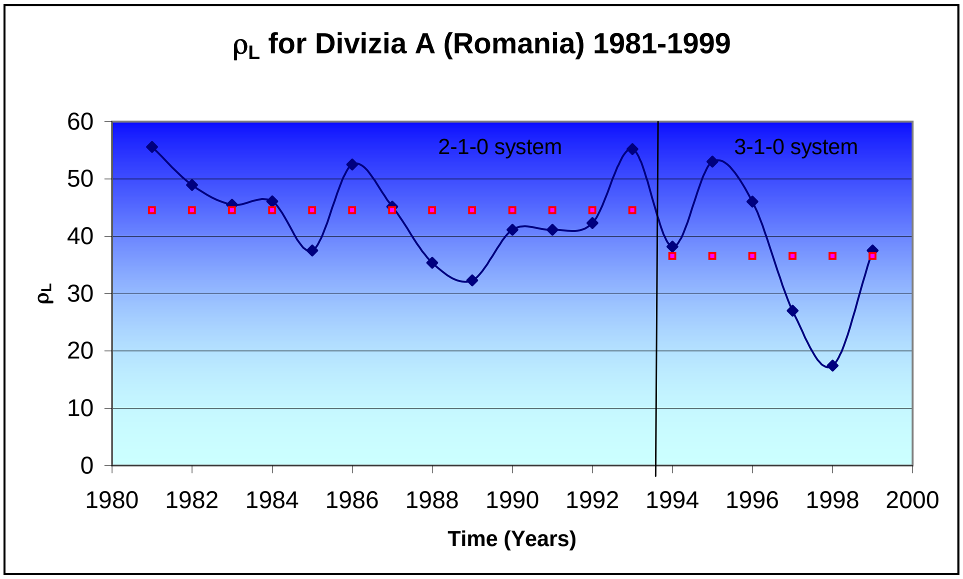

Figure 6: Competitive development in Romania – Divizia A.

0 to a 3-1-0 point system affects both soccer teams strategic choices as well as competitive imbalance in a league. Some added empirical examples strengthens the result of influence on competitive imbalance. This duality ought to be important, if an important objective for all soccer teams and soccer foundations is to maximize attendance. The fact that the degree of offensive play (by itself) affects attendance (demand) positively, seems like a safe assumption. But, more important, if the choice of more offensive strategies also imply increased competitive imbalance, such a decrease in competition may also affect attendance (demand) negatively. After all, a standard assumption in sports economics (see for instance [13]) on the shape of the revenue function imply that if one team becomes too skilled compared to another, the public interest in watching soccer games may be negatively affected. Consequently, there is a trade-off between the positive effect on demand by increased offensive play and the negative effect by the increased competitive imbalance.

Principally, such a trade-off makes it meaningful to address the concept of an **optimal** point-score system in soccer along these two dimensions. Surely, this paper does not answer any questions regarding the structure or values of such an optimal award system. However, as opposed to the suggestions of Meeden and Fernandez-Cantelli [4], it should be safe to say that this question is not elementary.

The results of subsections 2.3 and 2.4 ought to be interesting both by themselves but also as a supplement to the results of Carillo and Brochas [2]. The fact that 3 inequalities (alone) decides whether a 3-1-0 system induces more offensive play than a 2-1-0 system is both surprising and surprisingly simple. Additionally, such a result may serve as an explanation for the seemingly hard to explain empirical results of Meeden and Fernandez-Cantelli [4] of leagues showing less offensive play after the award system change.

Finally, it must be stressed that the game-theoretic framework of the exposition is simplified. Both the fact that teams choose static strategies in complete information games, as well as the assumption of equal teams in the proofs of subsection 2.3 undermines the generality of the results. However, at least intuitively, if the 3-1-0 system's effect on competitive balance is negative given equal teams, it seems reasonable to expect similar behavior if teams are assumed unequal.

A Competitive imbalance between 2 unequal teams

As the example of section 3 indicates, in this case it is (obviously) necessary to investigate two unequal teams. Table 4 defines probabilities and strategies for this case.

Table 4: General probabilities

T_1	T_2	p_{12}	p_{21}	p_D
O	O	p_{12}^{OO}	p_{21}^{OO}	$1-p_{12}^{OO}-p_{21}^{OO}$
D	O	p_{12}^{DO}	p_{21}^{DO}	$1-p_{12}^{DO}-p_{21}^{DO}$
O	D	p_{12}^{OD}	p_{21}^{OD}	$1-p_{12}^{OD}-p_{21}^{OD}$
D	D	p_{12}^{DD}	p_{21}^{DD}	$1-p_{12}^{DD}-p_{21}^{DD}$

A reasonable approach would be to define any Nash equilibrium containing more O's than the one to compare with as more "offensive". Consequently, table 5 below contains the inequalities which needs to be checked for (eventual) necessary assumptions of the probabilistic structure.

Table 5: Relevant inequalities – more vs. less offensive Nash equilibria

$E(T_1^{OO})-E(T_2^{OO})>E(T_1^{DD})-E(T_2^{DD})$
$E(T_1^{OO})-E(T_2^{OO})>E(T_1^{OD})-E(T_2^{OD})$
$E(T_1^{OO})-E(T_2^{OO})>E(T_1^{DO})-E(T_2^{DO})$
$E(T_1^{OD})-E(T_2^{OD})>E(T_1^{DD})-E(T_2^{DD})$
$E(T_1^{DO})-E(T_2^{DO})>E(T_1^{DD})-E(T_2^{DD})$

It is straightforward to realize that the following condition must hold:

$$E(T_i^{xy})-E(T_j^{xy})=\omega\left(p_{ij}^{xy}-p_{ji}^{xy}\right)\forall i,j,x,y \tag{40}$$

Given equation (40), any of the inequalities, for instance the second one of table 5 can be written: (given positive ω)

$$p_{12}^{OO}-p_{21}^{OO}>p_{12}^{OD}-p_{21}^{OD} \tag{41}$$

The point is then to show that this expression – (41) – holds, or more specifically, under which assumptions does it hold. In order to make progress, one of assumptions (6), (7) or (8) must be applied. In this case (8) is the relevant one.

$$p_D^{OD}>p_D^{OO}\Rightarrow 1-p_{12}^{OD}-p_{21}^{OD}>1-p_{12}^{OO}-p_{21}^{OO} \tag{42}$$

Rearranging terms;

$$p_{12}^{OO}+p_{21}^{OO}>p_{12}^{OD}+p_{21}^{OD} \tag{43}$$

Then, subtracting $2p_{21}^{OO}$ from the right and left side of (43) giving

$$p_{12}^{OO}-p_{21}^{OO}>p_{12}^{OD}+p_{21}^{OD}-2p_{21}^{OO} \tag{44}$$

Now, as (44) holds. If

$$p_{12}^{OD}+p_{21}^{OD}-2p_{21}^{OO}>p_{12}^{OD}-p_{21}^{OD} \tag{45}$$

holds, then (41) must also hold. A slight algebraic manipulation of equation (45) yields;

$$p_{21}^{OD} > p_{21}^{OO} \tag{46}$$

It turns out that completely analogue arguments can be applied for all other inequalities of table 5 giving similar constraints as shown in table 6

Table 6: Necessary extra assumptions for validity of inequalities

$E(T_1^{OO}) - E(T_2^{OO}) > E(T_1^{DD}) - E(T_2^{DD})$	$p_{21}^{DD} > p_{21}^{OO}$
$E(T_1^{OO}) - E(T_2^{OO}) > E(T_1^{OD}) - E(T_2^{OD})$	$p_{21}^{OD} > p_{21}^{OO}$
$E(T_1^{OO}) - E(T_2^{OO}) > E(T_1^{DO}) - E(T_2^{DO})$	$p_{21}^{DO} > p_{21}^{OO}$
$E(T_1^{OD}) - E(T_2^{OD}) > E(T_1^{DD}) - E(T_2^{DD})$	$p_{21}^{DD} > p_{21}^{OD}$
$E(T_1^{DO}) - E(T_2^{DO}) > E(T_1^{DD}) - E(T_2^{DD})$	$p_{21}^{DD} > p_{21}^{DO}$

It is important to note, that not all of the inequalities of table 6 must be satisfied simultaneously. They describe all possible transitions from a less offensive to a more offensive Nash equilibrium, and it is hence only one of them that need to be satisfied in a given situation. (Refer to the example of section 3 as well as table 1, where only one is satisfied). Consequently, for all possible matches where assumptions (6), (7) and (8) and the relevant inequality of table 6 hold, a more offensive Nash equilibrium leads to larger "distance" between teams no matter point score scheme, and hence increased competitive imbalance. The term "almost all" is then related to the added constraint which only restricts the parametric space of all probabilities slightly.

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