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TV Revenue Sharing as a Coordination Device in Sports Leagues

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Abstract

As sports clubs jointly produce contests, they cannot determine contest quality through their private talent investments. Sports leagues therefore try to coordinate talent investments towards the profit-maximizing contest quality. In this paper I analyze how revenue sharing mechanisms may serve this goal when demand comes from hard-core club and neutral sports fans. Performance-based sharing turns out to be an inefficient sharing rule for the cartel, although it is not harmful for social welfare. This inefficient cartel behavior can be rationalized as the result of bargaining with asymmetric outside options. Data from US and European sports leagues illustrate the theoretical findings.

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1 Introduction

Consumers of sports competitions come in two kinds. A first type of consumer is committed to one team only. This "hard-core club fan" prefers to see his favorite team win and therefore has a preference for one team dominating the competition. A second type of consumer is not committed to one team, but instead enjoys a tense competition with a high level of play. As this "neutral sports fan" appreciates uncertainty of outcome in the competition, his willingness-to-pay for a sports competition decreases when one team continuously dominates. Typically, hard-core fans are held responsible for match-day income (i.e. ticket sales, catering in the stadium,...), while neutral fans predominantly determine revenues from the sale of TV rights. A sports club maximizing profits would ideally want to provide a contest that has exactly the right mix of features to get maximal profits from both groups of consumers.

Sports clubs cannot produce contests on their own and the decisions of all clubs in a contest determine its features. Most importantly, their talent investments impact strongly on the revenues that may be attained from a sports contest. In a competitive environment clubs would compete in talent and possibly overinvest. However, the sports industry is not a typical competitive environment, as clubs join together to create cartels in the form of sports leagues. Most leagues have created coordination devices to steer talent investment decisions in an attempt to maximize joint profits. Famous examples of such devices are salary caps (where the league limits the amount teams may spend on player wages) and the sharing of broadcast or gate revenues (where the league may set the sharing rule to influence club incentives). Since these devices are not outlawed by antitrust authorities, sports leagues communicate their existence and application openly. This brings about an opportunity to evaluate whether leagues have efficiently used these devices to coordinate club decisions. As such, we may obtain some insight in the functioning of these cartels.

In this paper I focus on sharing rules for collectively sold broadcast rights, which may be used to coordinate talent investments made by clubs. I evaluate how three different sharing mechanisms (equal sharing, performance-based sharing and sharing based on home market sizes) influence talent investments, joint profits and social welfare. Equal sharing of broadcast revenues is the system used in the American Major leagues. European soccer leagues on the other hand have used a variety of systems. As can be seen in Table 1, they often combine equal and performance-based sharing with a part of revenues being shared based on TV appearances.

<INSERT TABLE 1 ABOUT HERE>

My analysis first shows that performance-based sharing of broadcast revenues is an inefficient way to maximize the cartel's joint profit, compared to equal and market size based sharing. From the league's point-of-view performance-based sharing provides too strong incentives to invest in talent. This does not necessarily imply that performance-based sharing is also harmful to social welfare. I secondly explain that performance-based sharing, although sub-optimal, may be the result of bargaining between teams. When clubs have asymmetric home markets and antitrust authorities prevent sharing purely based on market size, an agreement between teams can only be reached when the cartel uses performance-based sharing to allocate a larger share of revenues to large-market teams. I provide summary data on European soccer and American major leagues to support the main theoretical results.

Antitrust concerns about practices in the sports industry have given rise to a significant literature, which goes back to the seminal papers by Rottenberg (1956) and Neale (1964). A large part of these contributions (see e.g. El Hodiri & Quirk (1971) and Szymanski & Késenne (2004)) primarily focus on the issue of competitive balance (i.e. uncertainty of outcome) in sports leagues. Szymanski (2001) introduces the idea of hard-core and neutral fans for sports in this literature. Forrest et al. (2005) empirically identify the demand for televised matches as coming from more "neutral" fans than demand for stadium seating. I further develop these insights by embedding them in a complete theoretical framework. In doing so, I also build on the model of Falconieri et al. (2004). They examine the effect of collective and individual sales of broadcast rights, but focus only on TV viewers. Several earlier contributions have looked at aspects of cartel behavior in sports, for example Ferguson et al. (2000) in Major League Baseball, Forrest et al. (2004) in English Premier League soccer and Kahn (2007) in college sports. The possible use of revenue sharing as an incentive device has first been highlighted by Atkinson et al.(1988) in an analysis of the National Football League. The analysis of Palomino and Sakovics (2004) is most closely related to mine. They evaluate performance based versus equal sharing of TV revenue by leagues who either face or do not face international competition when bidding for players. I extend their analysis in three ways. First, I allow clubs to have asymmetric home markets, a major issue of concern in the competitive balance literature. Second, on the revenue side I include match-day income on top of TV revenues and I introduce the notion of different consumer types. Finally, I look at the decision process within the league cartel, which may lead to inefficient cartel behavior.

In the next section I introduce a model of the sports industry with horizontally diversified consumers and look at the pricing decisions of clubs and broadcasters. In section three I determine the equilibrium talent investments under different sharing rules. I further provide an overview on a few European soccer leagues to show the validity of the model results. A fourth section holds the evaluation of the sharing mechanisms from the cartel's point of view and looks at social welfare. Then I present the bargaining stage to explain cartel inefficiency. I also include summary data on US and European leagues to illustrate the main theoretical findings here. In the final section I formulate some conclusions.

2 Model setup

This section presents a simple model of a professional sports league. The timing of the model consists in three stages. First, the league decides on a distribution rule for broadcast revenues through bargaining between teams. In a second stage the fully informed clubs decide on talent investments. Finally, their joint product is sold to hard-core fans by means of stadium tickets and to neutral fans through broadcasters. In this stage the clubs and broadcaster make their pricing decisions. Working backward, I first solve the pricing problem and then turn to the other stages of the game in the next sections.

2.1 Clubs and league

In the model two profit-maximizing clubs (k and j) play a competition consisting of two matches, one at each team's venue. As in Palomino and Sakovics (2004) clubs determine talent investments (t_j and t_k) by making a discrete choice. They either invest a high amount, h, or a low amount, l. These investments result in the following win probabilities:

$$w_j(t_j, t_k) : \left\{ \begin{array}{c} w(l,l) = w(h,h) = 1/2 \\ w(h,l) = \beta \\ w(l,h) = 1-\beta \end{array} \right\} \tag{1}$$

where: $1 > \beta > 1/2$

For simplicity in notation l is normalized to zero. As in Szymanski and Késenne (2004) players to accommodate both choices are readily available, so there is no bidding for talent between clubs and talent is available at fixed marginal cost. For the international labor market of European sports, this seems a very sensible assumption to make. Some authors (e.g. El Hodiri and Quirk, 1971) assume a fixed talent supply, as they feel this is more realistic for the American major leagues. Such an alternative setting would probably strengthen my results, because with a fixed supply of talent extra talent demand drives up marginal talent costs. The demand enhancing effects of performance-based sharing would then reduce profitability even more.

After having observed talent investments, clubs set prices to hard-core fans. As is common in the literature, clubs do not compete for each other's fans and are consequently monopolists in their home markets. Both teams differ in the size of their home market and therefore in the maximum amount of hard-core fans they may serve. The large market club, from now on club 1, may serve m_1 fans, while the small market club, further on called club 2, has m_2 potential hard-core fans, with $0 < m_2 < m_1$. After clubs have taken their pricing decisions, they sell tickets for the match in their home venue. I assume that thereafter no sharing of gate revenues takes place.

In order to serve neutral fans clubs pool their broadcast rights and sell them to the highest bidding broadcaster in an auction setting. Revenues from these sales may be distributed in three different ways, given by the sharing mechanism d_i. The league either sets an equal sharing rule ($d_i = 1/2$), a performance-based sharing rule ($d_i = w_j$) or a sharing rule based on market sizes ($d_i = \frac{m_j}{m_j+m_k}$). Clubs know the sharing rule before making talent investments.

2.2 Sports consumers

A crucial innovation in the present model is that sports fans are not a homogeneous group. Instead, they come in two distinct groups that have a different appreciation for several aspects of the sports product. This shows in the model through the fact that both groups attach different quality levels to the same product. Quality for both types depends on the talent investments chosen by clubs. As hard-core fans primarily enjoy a high winning percentage, their quality, $f(t_j, t_k)$,is given by:

$$f(h,l) > f(h,h) = f(l,l) > f(l,h)^1 \tag{2}$$

where:

$$f(h,l) - f(l,l) = f(l,l) - f(l,h) \tag{3}$$

[1] An alternative specification might be $f(h,l) > f(h,h) > f(l,l) > f(l,h)$. This would mean hard-core fans also enjoy talent per se. As this would probably strengthen the investment incentives for clubs, I feel the present specification is the more restrictive to arrive at my conclusions.

This last condition implies that hard-core fans consider a similar fall in winning percentage as a similar quality decline whether or not it is in the “winning” or the “losing” region. In other words, avoiding a loss has the same importance as obtaining a win.

Neutral sports fans enjoy tension and a high level of playing talent in a sports match. This is indicated by their quality variable $b(t_j, t_k)$:

$$b(h,h) > b(h,l) = b(l,l) = b(l,h) \tag{4}$$

When both tension and level of play increase, the quality of the competition goes up. In case one aspect improves at the expense of the other, quality remains at the same level. As neutral fans have no preference for one team over the other they attach the same value to domination of the contest by either team. Both groups of fans have a demand for sports contest which depends on quality and price. As in Falconieri et al. (2004), fans in both groups have individual specific preferences (x_v^b and x_v^f) that are uniformly distributed along the interval $[0,1]$. As such, each fan is, depending on his type, confronted with the maximization problem:

$$Max\left\{x_v^b b(t_j,t_k) - p_b, 0\right\}$$

or

$$Max\left\{x_v^f f(t_j,t_k) - p_f^j, 0\right\}$$

This leads to a market demand for one fixture from both groups given by:

$$D_b = n\frac{b(t_j,t_k) - p_b}{b(t_j,t_k)} \tag{5}$$

$$D_f^j = m_j\frac{f(t_j,t_k) - p_f^j}{f(t_j,t_k)} \tag{6}$$

Demand from hard-core fans is given separately for both clubs, as index j shows, while neutral fan demand is equal to market demand.

2.3 Broadcasters

The demand for televised matches cannot be met directly by clubs. The league therefore sells broadcasting rights in an auction to the highest bidding broadcaster, who in turn faces demand from neutral fans. As such, it is the broadcaster which takes the pricing decision. From the specification of neutral consumers and normalizing the cost of broadcasting to zero, the profit for a monopolist broadcaster is given as:

$$\pi_b = 2p_b n \frac{b(t_j, t_k) - p_b}{b(t_j, t_k)} \tag{7}$$

In the model the broadcasting sector is assumed to be competitive in nature. The auction is then a common value auction with a sufficient number of bidders. Consequently, broadcasters are willing to pay every amount up to the monopoly profit when bidding for the broadcast rights. The league then succeeds in capturing the entire monopoly rents.

2.4 Pricing decisions and profits

Solving backward the first step is to determine the pricing decisions of the broadcaster and both teams. These decisions are made after both clubs have taken talent investment decisions that are common knowledge. Both the broadcaster and the clubs aim to maximize revenues from fans for a given quality level. Their maximization problem is:

$$\begin{aligned} &\underset{p_b}{Max}\left\{2p_b n \frac{b(t_j, t_k) - p_b}{b(t_j, t_k)}\right\} \\ &\underset{p_f^j}{Max}\left\{p_f^j m_j \frac{f(t_j, t_k) - p_j}{f(t_j, t_k)}\right\} \end{aligned}$$

Solving these problems for both prices leads to:

$$\begin{aligned} p_b &= \frac{b(t_j, t_k)}{2} \\ p_f^j &= \frac{f(t_j, t_k)}{2} \end{aligned}$$

As clubs succeed in capturing the monopoly rent of the broadcaster, this translates into club revenues given by:

$$R_b = n \frac{b(t_j, t_k)}{2} \tag{8}$$

$$R_f^j = m_j \frac{f(t_j, t_k)}{4} \tag{9}$$

Revenues from neutral fans are then divided following the sharing rule, which was agreed on up-front by both teams and the league. Expected club profits for the large club (1) and small club (2) can now be determined as a function of talent investments and the distribution scheme:

$$\pi_1^i(t_1,t_2) = m_1\frac{f(t_1,t_2)}{4} + d_i n\frac{b(t_1,t_2)}{2} - t_1 \tag{10}$$
$$\pi_2^i(t_2,t_1) = m_2\frac{f(t_2,t_1)}{4} + d_i n\frac{b(t_2,t_1)}{2} - t_2 \tag{11}$$

2.5 League profits and social welfare

As a cartel of clubs, the league's objective is to maximize joint profits by implementing an optimal distribution scheme d_i. Her objective function boils down to:

$$\pi_L = \frac{1}{4}\left[m_1 f(t_1,t_2) + m_2 f(t_2,t_1) + 2nb(t_1,t_2)\right] - (t_1+t_2) \tag{12}$$

where $t_j(d_i)$ is written as t_j.

Since the consumer demand curves are specified in the model I may establish these expressions for consumer surplus:

$$CS_b = \frac{1}{4}nb(t_j,t_k)$$
$$CS_f^j = \frac{1}{8}m_j f(t_j,t_k)$$

Social welfare in the industry as a whole is the sum of consumer surplus, club profits and broadcaster profits (which equal zero), which results in:

$$SW = \frac{3}{8}\left[m_1 f(t_1,t_2) + m_2 f(t_2,t_2) + 2nb(t_1,t_2)\right] - (t_1+t_2) \tag{13}$$

3 Talent investments

This section presents the results of the talent investment stage. It is clear that four different outcomes may arise:

1. mutually high investments: $t_1 = h, t_2 = h$
2. large market domination: $t_1 = h, t_2 = l$
3. small market domination: $t_1 = l, t_2 = h$
4. mutually low investments: $t_1 = l, t_2 = l$

The approach adopted here consists in determining under which conditions on m_1, m_2 and n each of these four outcomes is a Nash-equilibrium of the investment stage of the game. First proposition 1 looks into the case of small market domination. In order to ensure unique Nash-equilibria at all parameter values (except for the thresholds at which clubs are indifferent) it is necessary to impose $m_1 - m_2 \geq \frac{n(b(h,h)-b(l,l))}{f(h,l)-f(l,l)}$. In an extension, which is available on request, I examine which model results hold when this assumption is relaxed. This case is however only interesting for completeness and adds little to the insights of the analysis.

Proposition 1 *A situation in which the small market club invests more in talent than the large market club is under none of the three distribution schemes a Nash-equilibrium of the talent investment stage.*

Proof. see appendix. ∎

Proposition 1 contains a very intuitive result, as in practice leagues in which talent investments from smaller clubs dominate the investments made by larger clubs are indeed hard to think of. It is important to stress perhaps that proposition 1 by no means implies that small clubs may never win the sports contest. Even under large market domination the small club obtains a part $(1-\beta)$ of total wins, while under equal investments this amounts to half of the wins. The driving force behind this result is that under none of the distribution schemes the small club's incentives to make high talent investments are as great as the large club's. Distributing revenues from neutral fans must always give the same incentives to both clubs. When a distribution scheme aims to inspire high investments in the small club, it inevitably does the same in the large club. Therefore no scheme can ever compensate for the greater incentives the large club receives from its hard-core fans and small market domination is not an equilibrium outcome.

Proposition 2 *A situation of mutually high investments is the unique Nash-equilibrium of the investment stage when m_2 is higher than the threshold value $\theta^h_{d_i}(h,n)$, which is increasing in h and decreasing in n. The threshold is lowest under performance-based sharing ($\theta^h_{win}(h,n)$) and highest under sharing based on market size ($\theta^h_{market}(h,n)$), while equal sharing ($\theta^h_{equal}(h,n)$) is in the middle.*

Proof. see appendix. ∎

To gain some intuitive insights into the results of proposition 2, it is crucial to see that, from proposition 1, it is never the large team which deviates in the mutually high investment situation. Therefore mutually high investments constitute a Nash-equilibrium when it is profitable for the small team to invest heavily in talent rather than to undergo the large club's domination. The small club's assessment in this case is simply whether increased revenues from fans when moving to high investments are enough to pay for them. Therefore lower investments costs and more fans increase the probability of a Nash-equilibrium in mutually high investments. Hence, the intuition behind the influence of h and n on $\theta^h_{d_i}(h,n)$.

To explain differences across distribution schemes, again the small club's incentives are crucial. The increase in the small club's revenues when moving to mutually high investments consists in three parts. First, revenues from hard-core fans increase. As these revenues are not shared, they cannot explain differences between sharing mechanisms. Second, total league broadcast revenues from neutral fans rise. The choice in distribution scheme determines how large a part of this increase goes to the small club. Equal and performance-based sharing grant the small club half of these revenues under mutually high investments. Sharing based on market size provides a smaller share. Hence, this scheme motivates less to invest heavily in talent. Third, the share of total broadcast revenues a club is entitled to, may also rise when moving to high investments. The only scheme which has this feature is performance-based sharing. Therefore small clubs receive a triple dividend when moving to high investments under this scheme. Revenues from hard-core fans, total league broadcast revenues and the share of broadcast revenues all increase. Consequently, performance-based sharing provides the strongest incentives for high investments.

Proposition 3 *A situation of mutually low talent investments is the unique Nash-equilibrium of the investment stage, when m_1 is below the threshold value $\theta^l_{d_i}(h,n)$, which is increasing in h and decreasing in n in the case of performance-based sharing. Under both other systems $\theta^l_{d_i}(h,n)$ is increasing in h, but independent of n. The threshold is the same for equal sharing and sharing based on market size ($\theta^l_{equal}(h) = \theta^l_{market}(h)$), yet lower for performance-based sharing ($\theta^l_{win}(h,n)$).*

Proof. see appendix. ■

As in the case of mutually high investments, proposition 1 again allows ruling out unilateral deviation by one of the clubs (i.e. the small club). Therefore the focus should be on the large club to understand the intuition behind proposition 3. The large club's choice is between mutually low and unbalanced investments. So the crucial issue is whether larger revenues from dominating the league may offset high talent costs. Obviously, higher talent costs reduce the temptation to invest heavily and as such h positively impacts on the threshold.

On the revenue side, willingness-to-pay from hard-core fans goes up when moving to high talent levels. The same cannot be said of neutral fans, as this group has no preference for an unbalanced contest over a low level contest. Therefore total broadcast revenues fail to increase upon the large club's decision to raise investments. This implies that higher investments can only be offset by enhanced revenues from hard-core fans or a larger share of broadcast revenues. Under equal sharing or sharing based on market size the large club's share of broadcast revenues does not rise when it dominates the league. Therefore the amount of neutral fans has no impact on the threshold value under these systems. Since performance-based sharing allocates a larger share of broadcast revenues to a dominating club, it provides extra incentives to deviate from mutually low investments. Consequently, mutually low talent investments are less likely under this system.

Proposition 4 *Large market domination is the unique Nash-equilibrium of the investment stage when m_1 is above the threshold $\theta^l_{d_i}(h,n)$, while m_2 is lower than the threshold $\theta^h_{d_i}(h,n)$. The necessary difference in fan base, given by $\theta^u_{d_i}(n)$, is increasing in n and larger under equal and performance-based sharing than under sharing based on market size.*

Proof. see appendix. ■

From proposition 4, unbalanced investments appear as an equilibrium when both mutually low and high investments are unstable. The amount of hard-core fans for the large club has to be too large to allow for mutually low investments, while at the same time the small team has too little fans for mutually high investments. As a result it is necessary (though not sufficient) that the amount of hard-core fans differs substantially between clubs. Under all three schemes the threshold $\theta^l_{d_i}(h,n)$ is higher than $\theta^h_{d_i}(h,n)$. This implies that under none of the distribution schemes unbalanced investments can be ruled out as a possible equilibrium. However, the necessary difference in market size between both clubs differs across schemes and therefore the probability of an equilibrium in unbalanced investments is affected by the choice of distribution scheme. Since $\theta^l_{equal}(h,n) = \theta^l_{market}(h,n)$ while $\theta^h_{equal}(h,n) < \theta^h_{market}(h,n)$, it is clear that sharing based on market size allows unbalanced investments more easily and protects competitive balance less than equal sharing. Observe also that $\theta^l_{equal}(h,n) > \theta^l_{win}(h,n)$ and $\theta^h_{equal}(h,n) > \theta^h_{win}(h,n)$, meaning that under performance-based sharing unbalanced investments arise at lower levels of m_1, yet matching these investments happens at lower levels of m_2. Comparing both systems reveals that the necessary difference between market sizes is exactly the same under both.

<INSERT TABLE 2 ABOUT HERE>

Propositions 1 to 4 suggest it should be possible to find sports leagues that exhibit mutually high, mutually low and unbalanced talent investments. Assuming that talent investment costs are equal across leagues in the same sport, the driving factors behind such a classification should be the distribution of hard-core fans between clubs and the relative importance of both fan groups for the league. To give an indication of this table 2 compares several European soccer leagues which apply collective sales of broadcasting rights for the period 2005-2008. The table depicts the average competitive balance and UEFA points to categorize the leagues in terms of talent investments.

Leagues exhibiting a high level of competitive balance (i.e. showing a low figure in column 2) and a high amount of UEFA points may be thought of as exhibiting mutually high investments. England, France and Germany are clearly in this situation. Following the results of propositions 1 to 4, smaller teams in these leagues should be well supported and/or they should serve a relatively large amount of neutral fans. This result is easily confirmed for England and Germany as these leagues show a very high average attendance for their bottom 3 clubs. France may have somewhat less supported small clubs, but the French TV market turns out to be more important relative to stadium attendances.

Belgium, the Netherlands and Scotland best fit the situation of large club domination, as they appear to have an average level of play, combined with a low competitive balance. According to the model this should imply that smaller clubs have low amounts of hard-core fans and do not cross the relevant thresholds therefore investing low amounts. At the same time the well supported large clubs do cross their thresholds and invest heavily. On top of this, the amount of neutral fans should be too low to compensate for this difference. Since these countries appear to have a high average top 3 attendance, but a low bottom 3 average attendance, combined with a relatively low amount of TV viewers, the predictions of the model again appear to be reasonable.

Finally, a third group of leagues, Sweden, Austria and Norway may be characterized as showing mutually low talent investments. They show a low amount of UEFA points and a high competitive balance. The model explains this as the result of top teams in these countries failing to reach enough hard-core fans to cross their threshold. The table shows that average attendance of the three best supported clubs in these countries is indeed rather low. In this case the model predicts that the relative importance of TV markets has less influence on the decisions of large clubs, which also shows in the data.

4 League profits and social welfare

This section looks into the question which distribution scheme maximizes joint profits and social welfare. I define the threshold values on n, $m_1$and m_2 for the cartel's optimal talent investment outcome as $\lambda^{l,h}, \lambda^{u,l}$ and $\lambda^{u,h}$. The superscripts indicate which talent investment outcomes are being compared, for example $\lambda^{u,l}$ gives the threshold at which unbalanced investments are preferred over mutually low investments. $\lambda^{u,h}$ and $\lambda^{u,l}$ are thresholds on the difference between the clubs' home market sizes $(m_1 - m_2)$. A large difference causes unbalanced investments to be preferable over equal investments. $\lambda^{l,h}$ is a threshold on the amount of neutral fans the league may reach (n). A high amount of neutral fans leads to high investments being preferred over low investments. Mutually low investments are then optimal for the league when both $n \leq \lambda^{l,h}$ and $m_1 - m_2 \leq \lambda^{u,l}$, mutually high investments when $n \geq \lambda^{l,h}$ and $m_1 - m_2 \leq \lambda^{u,h}$ and unbalanced investments when $m_1 - m_2 \geq \lambda^{u,h}$ and $m_1 - m_2 \geq \lambda^{u,l}$. In exactly the same way, the thresholds on n and $m_1 - m_2$ for socially optimal investments are given by $\sigma^{l,h}$, $\sigma^{u,l}$ and $\sigma^{u,h}$. Proposition 5 compares the cartel and social thresholds.

Proposition 5 *Small club domination is never optimal, both for the league and from a social perspective. The threshold values $\lambda^{l,h}, \lambda^{u,l}$, $\sigma^{l,h}$ and $\sigma^{u,l}$ are increasing in h, where $\lambda^{l,h} > \sigma^{l,h}$ and $\lambda^{u,l} > \sigma^{u,l}$. The thresholds $\lambda^{u,h}$ and $\sigma^{u,h}$ are increasing in n and decreasing in h, where $\lambda^{u,h} < \sigma^{u,h}$ When $n = \lambda^{l,h} \Rightarrow \lambda^{u,l} = \lambda^{u,h}$ and when $n = \sigma^{l,h} \Rightarrow \sigma^{u,l} = \sigma^{u,h}$.*

Proof. see Appendix. ■

It is neither optimal for the league nor from a social perspective that the competition be dominated by the small market team. This result may easily be understood by pointing out that the potential revenues and consumer surplus of the small club's hard-core fans are always lower than those of the large club's fans. As such, it never pays to raise their utility at the expense of the utility of the large club's fans. Fortunately, small market domination is never a Nash-equilibrium in the investment stage.

The utility of hard-core fans remains unchanged when moving from mutually low to mutually high investments. As such, the costs of high talent investments must be offset by increased revenues/consumer surplus from neutral fans. Therefore the thresholds $\lambda^{l,h}$ and $\sigma^{l,h}$ only imply a restriction on the amount of neutral fans. Evidently, rising investment costs push up the value of these thresholds.

Large club domination involves a trade-off between the utility of the small and the large club's hard-core fans. Therefore it becomes optimal when the difference in the amount of hard-core fans both clubs may reach $(m_1 - m_2)$, attains a certain threshold. Less obvious is the intuition behind the factors impacting on $\lambda^{u,l}, \lambda^{u,h}, \sigma^{u,l}$ and $\lambda^{u,h}$. Crucial to see is that at high values of n (i.e. $n > \lambda^{l,h}$ or $\sigma^{l,h}$), the relevant alternative for large market domination is mutually high investments, while at low values of n (i.e. $n < \lambda^{l,h}$ or $\sigma^{l,h}$) the relevant alternative is mutually low investments. Unbalanced investments involve less talent investments than mutually high investments. Hence, the negative impact of h on $\lambda^{u,h}$ and $\sigma^{u,h}$. Yet, large club domination involves higher talent investments than mutually low investments. Therefore the influence of h turns from negative to positive when n falls. Moving from unbalanced investments to mutually high investments leads to an increase in utility for neutral fans. This explains why $\lambda^{u,h}$ and $\sigma^{u,h}$ are both increasing in n.

Since from proposition 5 $\lambda^{l,h} > \sigma^{l,h}$ and $\lambda^{u,l} > \sigma^{u,l}$, mutually low investments are less likely to be preferable from a social point-of-view than from the league's perspective. Mutually high investments on the contrary are more often the optimal outcome for social welfare than for joint profits. The situation for large club domination is more ambiguous. While this is from a social perspective more easily preferred over mutually low investments, it is less attractive compared to mutually high investments. The driving force behind these results is that for social welfare talent investments are evaluated against the total surplus they deliver, instead of solely against private profits.

Proposition 6 *Under performance-based and equal sharing, mutually high investments always arise when they are optimizing league profits. Sharing based on market size cannot guarantee this outcome. When they occur in equilibrium, mutually low investments are optimal for league profits under all distribution schemes. Under none of the distribution schemes the minimal necessary difference $\theta^u_{d_i}(n)$ stops the unbalanced outcome from arising, when this is optimal.*

Proof. see appendix. ∎

Proposition 6 shows that introducing equal sharing guarantees mutually high investments to arise when this is optimal for league profits. In fact, mutually high investments may even arise under equal sharing, when they are not optimal. It follows that lowering the threshold from $\theta^h_{equal}(h,n)$ to $\theta^h_{win}(h,n)$ is unnecessary and even harmful for league-wide profits, as it widens the range of values of n and m_2, at which suboptimal high investments occur. Performance-based sharing is clearly less effective than equal sharing in matching the leagues' optimum with club behavior here. Since the threshold value $\theta^h_{market}(h,n)$ is higher than $\theta^h_{equal}(h,n)$, the same cannot be said of sharing based on market size. On the one hand the league cannot guarantee mutually high investments to arise whenever this is optimal, but on the other hand, there is less chance of them occurring when they should not. Consequently, it is indeterminate whether equal sharing or sharing based on market size, is preferable for the league.

The second part of proposition 6 implies that clubs only make mutually low investments when this is optimal for league profits. The league should never bother to prevent this outcome. On the other hand, the league cannot guarantee that mutually low investments arise whenever this is desirable. She should therefore simply strive to minimize the range of values at which low investments fail to occur in equilibrium. It follows that the league's optimal strategy is to choose the scheme that most encourages them. As proposition 4 shows that $\theta^j_{equal}(h) = \theta^l_{market}(h) > \theta^l_{win}(h,n)$, this is clearly not performance-based sharing, while both other schemes perform exactly the same in this respect.

Finally, proposition 6 shows that under each scheme the difference in hard-core fans which is minimally necessary for the unbalanced outcome to appear, is smaller than the necessary difference for it to be optimal. In other words this necessary difference never stands in the way of the occurrence of an optimal outcome. No scheme is outperformed by any other in this regard.

The previous analysis shows why performance-based sharing only has disadvantages for the league compared to equal sharing. The league would therefore best ignore this sharing mechanism and combine equal sharing with sharing based on market size. It is not possible to show that the results of proposition 6 also apply to the social optima. So, none of the distribution schemes dominates from a social welfare point-of-view. As such, performance-based sharing may induce talent investments that destroy private profits, but deliver more social welfare.

5 Bargaining on a sharing rule

An evident question is why numerous sports leagues have been implementing performance-based sharing, when it is not an efficient way to maximize joint profits. In the context of the present model I propose that performance-based sharing may be the result of bargaining between teams in a league cartel. Leagues cannot impose all decisions on their members, but have to reach them through collective agreements. It therefore makes sense to model the decision on a sharing rule as a bargaining game between clubs, rather than as the result of efficient profit-maximizing. An alternative explanation for performance-based sharing is given by Palomino and Sakovics (2004), who suggest that it induces clubs to attract star players when rival leagues compete in a bidding game to attract talent.

In the present model clubs negotiate on the share of broadcast revenues they should be entitled to have. Their fall-back position is the revenue they could obtain when negotiations break down and they have to sell individually. The revenues they may divide are given by the model as:

$$R_{b,\text{col}} = n\frac{b\left(t_1(d_i), t_2(d_i)\right)}{2} \tag{14}$$

The equilibrium of the bargaining game is then a set of positive revenues $(R^1_{b,\text{col}}, R^2_{b,\text{col}})$, given as:

$$\begin{aligned} R^1_{b,\text{col}} &= d_i^1 n\frac{b\left(t_1(d_i), t_2(d_i)\right)}{2} \\ R^2_{b,\text{col}} &= (1-d_i^1)n\frac{b\left(t_1(d_i), t_2(d_i)\right)}{2} \end{aligned}$$

where d_i^1 is the share club 1 under sharing rule d_i.

Experience in Spain and Italy suggests that the earnings potential of clubs under individual sales is strongly related to the size of their local market[2]. I presume therefore that the distribution of revenues under individual sales is similar to that under sharing based on market sizes. The fall-back position of both clubs is then

[2] In Spain earnings by the top clubs, FC Barcelona and Real Madrid amounted to 65 million euro, compared to 8 million euro for the lowest earning club, Racing Santander in the 2005/2006 season. In Italy the difference between AC Milan (66 million euro) and Siena (10 million euro) was almost identical in the 2006/2007 season. The correlation between dp, a local market size measure (see Peeters, 2009) and broadcast revenues ammounted to 0.88 in Spain and 0.96 in Italy. Sources: Gratton and Solberg (2007) and European Football Statistics.

given as:

$$R_{b,ind}^{1} = \alpha n \frac{m_1}{m_1 + m_2} \frac{b\,(t_1(market), t_2(market))}{2} \tag{15}$$

$$R_{b,ind}^{2} = \alpha n \frac{m_2}{m_1 + m_2} \frac{b\,(t_1(market), t_2(market))}{2} \tag{16}$$

where $\alpha \leq 1$ indicates a fall in club revenues when teams have to compete and lose (part of) their monopoly rents. The Nash-bargaining equilibrium of this game is the solution of the well-known equations:

$$\begin{aligned} R_{b,\mathrm{col}}^{1} + R_{b,\mathrm{col}}^{2} &= R_{b,\mathrm{col}} \\ R_{b,\mathrm{col}}^{1} - R_{b,ind}^{1} &= R_{b,\mathrm{col}}^{2} - R_{b,ind}^{2} \end{aligned}$$

which solves as:

$$\begin{aligned} R_{b,\mathrm{col}}^{1*} &= \frac{1}{2}(R_{b,\mathrm{col}} + R_{b,ind}^{1} - R_{b,ind}^{2}) \\ R_{b,\mathrm{col}}^{2*} &= \frac{1}{2}(R_{b,\mathrm{col}} + R_{b,ind}^{2} - R_{b,ind}^{1}) \end{aligned}$$

After filling in (14), (15) and (16), this may be rewritten to find:

$$R_{b,\mathrm{col}}^{1*} = \frac{n}{4(m_1 + m_2)} \left\{ \begin{array}{l} m_1 \left[b\,(t_1(d_i), t_2(d_i)) + \alpha b\,(t_1(market), t_2(market))\right] \\ +m_2 \left[b\,(t_1(d_i), t_2(d_i)) - \alpha b\,(t_1(market), t_2(market))\right] \end{array} \right\} \tag{17}$$

$$R_{b,\mathrm{col}}^{2*} = \frac{n}{4(m_1 + m_2)} \left\{ \begin{array}{l} m_2 \left[b\,(t_1(d_i), t_2(d_i)) + \alpha b\,(t_1(market), t_2(market))\right] \\ +m_1 \left[b\,(t_1(d_i), t_2(d_i)) - \alpha b\,(t_1(market), t_2(market))\right] \end{array} \right\} \tag{18}$$

Observe from (17) and (18) that sharing based on market size is a stable equilibrium when α approaches 1. Equal sharing on the other hand becomes a stable outcome in case α is zero. More importantly perhaps, the equations show that for any positive value of α, the bargained solution should deviate more from equal sharing when the difference in local markets sizes is larger. In other words, when market sizes differ substantially and α is not too low we should not expect to see equal sharing. In those cases, the large teams' outside option is so strong that it permits to negotiate a sharing rule which allocates more revenue to it than equal sharing does. In the present model this may be done in two different ways. First, clubs may introduce sharing based on market sizes. This system has one important setback however. Antitrust authorities permit collective sales to enable leagues to redistribute revenues in a more egalitarian way. They therefore often not approve of a sharing rule, which has a large component of sharing based on market size. A second way to grant more expected revenues to the large teams is performance-based sharing. As proposition 1 shows, small teams never dominate the competition in terms of sporting results. Large teams should then expect to earn at least half of the revenues, which are shared based on performance. In many instances however, they earn more than half of these revenues. Following this line of reasoning, performance-based sharing may arise when local markets are sufficiently different, the loss of monopoly rents is not too high and antitrust authorities prevent having a large portion of sharing based on market size. In extreme cases of asymmetry between teams negotiations may also break down when sharing based on market size is not allowed. In those cases large teams refuse to enter a collective arrangement, as they cannot be rewarded enough through the sharing rule.

<INSERT TABLE 3 ABOUT HERE>

Table 3 presents an overview of some European soccer leagues and American major leagues to illustrate the reasoning I developed in this section. The table first shows the distribution of local market sizes among clubs. The statistic is calculated as the standard deviation of average club attendances over 4 seasons divided by the league average attendance over this period. This procedure aims to avoid overestimating the local market when one time sporting results have driven up attendance. The use of attendance data allows to calculate it for a large amount of leagues, whereas other measures are often poorly comparable between leagues[3]. The table then gives the percentage of revenues that were shared equally, based on market size/TV appearances and performance. Finally the table provides a figure for total broadcast revenues in the league. When comparing leagues across the Atlantic, it is striking that all American leagues have adopted equal sharing, while European leagues only use it partially (France, Germany, England) or not at all (Italy, Spain).[4] In terms of the model, this is explained by the fact that home market sizes are more homogeneously distributed in the USA. The table indicates that this is indeed the case, with figures around 0.1 for all leagues, compared to a minimum of 0.38 in Europe. Within Europe, Spain and Italy show the most heterogeneous distribution

[3] See Peeters (2009) for more information on the use of this measure.

[4] One important remark to add is that American clubs often have retained the right to individually sell their local broadcast rights. As such, they also partially introduce market-based sharing.

of home markets. In line with the predictions of the model, this renders the bargaining on a sharing rule more difficult, which has led these countries to abandon the collective system. In the other European leagues teams have come to negotiated solutions. Their sharing rules partially involve performance-based sharing and sharing based on market size. A final observation from table 3 may be that individual sales apparently have not harmed overall broadcast revenues in Spain and Italy too much in comparison to the collectively selling leagues. This suggests that the value of α in the model may be closer to one than zero for European soccer.

6 Conclusion and final remarks

In this contribution I have built a model of a team sports league which includes two horizontally diversified types of consumers, hard-core and neutral fans. The league operating as a profit-maximizing cartel may use its sharing rule for broadcast revenues to steer talent investments by clubs. The analysis shows that sharing based on performance is an inefficient way to maximize joint profits in the cartel, while not necessarily implying a loss of social welfare. Therefore leagues would do best to avoid using this mechanism. The intuition for the existence of performance-based sharing comes from bargaining on a sharing rule within the league cartel. This can never lead to equal sharing when clubs have highly asymmetric fall-back positions and sharing based on market sizes is impossible for antitrust reasons. Data from European soccer and American major leagues reveal that the American leagues have been able to avoid performance-based sharing, while the more heterogeneous European soccer leagues have in most cases implemented a partly inefficient scheme.

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8 Appendix

In this appendix I provide proof of all propositions.

8.1 Proposition 1

Proof. I show that $t_1 = l, t_2 = h$ can never arise in equilibrium by showing that the necessary conditions for this lead to a contradiction, namely that $m_1 \leq m_2$. $t_1 = l, t_2 = h$ is a Nash equilibrium when $\pi_1(l,h) \geq \pi_1(h,h)$ and $\pi_2(l,l) \leq \pi_2(h,l)$. If $d_i = w_i$ this can be filled out using (10) and (11) to get $\frac{1}{4}m_1 f(l,h) + \frac{1}{2}nw_1(l,h)b(l,h) \geq \frac{1}{4}m_1 f(h,h) + \frac{1}{2}nw_1(h,h)b(h,h) - h$ and $\frac{1}{4}m_2 f(l,l) + \frac{1}{2}nw_2(l,l)b(l,l) \leq \frac{1}{4}m_2 f(h,l) + \frac{1}{2}nw_2(h,l)b(h,l) - h$. Rearranging these terms yields $h \geq \frac{1}{4}m_1\left[f(h,h) - f(l,h)\right] + \frac{1}{2}n\left[\frac{1}{2}b(h,h) - (1-\beta)b(l,h)\right]$ and $h \leq \frac{1}{4}m_2\left[f(h,l) - f(l,l)\right] + \frac{1}{2}n\left[\beta b(h,l) - \frac{1}{2}b(l,l)\right]$. It then follows that

$\frac{1}{4}m_1\left[f(h,h) - f(l,h)\right] + \frac{1}{2}n\left[\frac{1}{2}b(h,h) - (1-\beta)b(l,h)\right] \leq \frac{1}{4}m_2\left[f(h,l) - f(l,l)\right] + \frac{1}{2}n\left[\beta b(h,l) - \frac{1}{2}b(l,l)\right]$, which implies

$m_1\left[f(h,h) - f(l,h)\right] + 2n\left[\frac{1}{2}b(h,h) - b(l,h) + \beta b(l,h) - \beta b(h,l) + \frac{1}{2}b(l,l)\right]$

$\leq m_2\left[f(h,l) - f(l,l)\right]$. Simplifying this expression using (4) and (3) gives

$m_1\left[f(h,h) - f(l,h)\right] + n\left[b(h,h) - b(l,h)\right] \leq m_2\left[f(h,l) - f(l,l)\right]$ or $m_1 + n\frac{b(h,h)-b(l,h)}{f(h,l)-f(l,l)} \leq m_2$. Since $b(h,h) - b(l,h) \geq 0$ and $f(h,h) - f(l,h) \geq 0$ this can only hold if $m_1 \leq m_2$. Therefore $t_1 = l, t_2 = h$ is never an equilibrium under $d_i = w_i$.

Proof for $d_i = \frac{1}{2}$ and $d_i = \frac{m_i}{m_i + m_j}$ is completely analogous. ■

8.2 Proposition 2 & 3

Proof. Since from proposition 1 $t_1 = l, t_2 = h$ is never an equilibrium, unilateral deviation of club 1 from $t_1 = h, t_2 = h$ need not be considered. I therefore define a threshold value $\theta^h_{d_i}$ on the market size of the small club. For the existence of $t_1 = h, t_2 = h$ in Nash equilibrium it is necessary that $\pi_2(h,h) \geq \pi_2(l,h)$. This implies under $d_i = w_i$ that $\frac{1}{4}m_2 f(h,h) + \frac{1}{4}nb(h,h) - h \geq \frac{1}{4}m_2 f(l,h) + \frac{1}{2}n(1-\beta)b(h,l)$. This may be rearranged to get the threshold $\theta^h_{win}(h,n) = \frac{4h - n[b(h,h) - 2(1-\beta)b(h,l)]}{f(h,h) - f(l,h)} \leq m_2$. In a similar way it is straightforward to show $\theta^h_{equal}(h,n) = \frac{4h - n[b(h,h) - b(h,l)]}{f(h,h) - f(l,h)}$ and $\theta^h_{market}(h,n) = \frac{4h - 2\frac{m_2}{m_1+m_2}n[b(h,h) - b(h,l)]}{f(h,h) - f(l,h)}$. Since $\beta > \frac{1}{2} > \frac{m_2}{m_1+m_2}$, it follows that $\theta^h_{market}(h,n) > \theta^h_{equal}(h,n) > \theta^h_{win}(h,n)$.

Unilateral deviation of club 2 from $t_1 = l, t_2 = l$ may also be excluded, because of proposition 1. The threshold for $t_1 = l, t_2 = l$ on the large market club's size is given as $\theta^l_{d_i}$. For a Nash-equilibrium $t_1 = l, t_2 = l$ to exist it should then be the case that $\pi_1(h,l) \leq \pi_1(l,l)$. When $d_i = w_i$ this means $\frac{1}{4}m_1 f(h,l) + \frac{1}{2}\beta n b(h,l) - h \leq \frac{1}{4}m_1 f(l,l) + \frac{1}{4}nb(l,l)$ which may be rearranged using (4) to get $\theta^l_{win}(h,n) = \frac{4h-n(2\beta-1)b(h,l)}{f(h,l)-f(l,l)} \geq m_1$. Under $d_i = 1/2$ and $d_i = \frac{m_j}{m_k+m_j}$ the same reasoning leads to $\theta^l_{equal}(h,n) = \theta^l_{market}(h,n) = \frac{4h}{f(h,l)-f(l,l)} \geq m_1$. Since $\beta > \frac{1}{2}$, it follows that $\theta^l_{market}(h,n) = \theta^l_{equal}(h,n) > \theta^l_{win}(h,n)$

At both thresholds, clubs are indifferent between high and low investments, so multiple equilibria are possible at these values. Uniqueness of the Nash-equilibria at all other values for the model parameters implies that both thresholds should never be met at the same parameter values. This can be ensured by imposing

$$m_1 - m_2 \geq \frac{n(b(h,h) - b(l,l))}{f(h,l) - f(l,l)} \tag{19}$$

To see this under $d_i = w_i$ observe that to have uniqueness $m_1 < \theta^l_{win}(h,n) = \frac{4h-n(2\beta-1)b(h,l)}{f(h,l)-f(l,l)}$ and $\frac{4h}{f(h,h)-f(l,h)} - \frac{n[b(h,h)-2(1-\beta)b(h,l)]}{f(h,h)-f(l,h)} = \theta^h_{win}(h,n) < m_2$ should never hold simultaneously. Plugging (19) into the second condition gives: $\frac{4h-n(2\beta-1)b(h,l)}{f(h,h)-f(l,h)} - (m_1 - m_2) < m_2 \Leftrightarrow \frac{4h-n(2\beta-1)b(h,l)}{f(h,h)-f(l,h)} - (m_1) < 0 \Leftrightarrow \frac{4h-n(2\beta-1)b(h,l)}{f(h,h)-f(l,h)} < m_1$, which violates the first line. This extends straightforward to both other sharing rules. ■

8.3 Proposition 4

Proof. It is clear that $t_1 = h, t_2 = l$ is a Nash-equilibrium when both $\theta^h_{d_i} > m_2$ and $\theta^l_{d_i} < m_1$ are simultaneously not satisfied. The necessary differences between both fan sizes may be calculated by subtracting both thresholds. Under $d_i = w_i$ this means $m_1 - m_2 \geq \theta^l_{win} - \theta^h_{win} \Leftrightarrow m_1 - m_2 \geq \frac{4h-n(2\beta-1)b(h,l)}{f(h,l)-f(l,l)} - \frac{4h-n[b(h,h)-2(1-\beta)b(h,l)]}{f(h,h)-f(l,h)}$. After rearranging this leads to $m_1 - m_2 \geq \theta^u_{win}(n) = \frac{n[b(h,h)-b(h,l)]}{f(h,l)-f(l,l)}$. Likewise under $d_i = 1/2$ this gives $\theta^u_{equal}(n) = \frac{n[b(h,h)-b(h,l)]}{f(h,h)-f(l,h)}$ and under $d_i = \frac{m_j}{m_k+m_j}$ I find $\theta^u_{market}(n) = 2\frac{m_2}{m_1+m_2}\frac{n[b(h,h)-b(h,l)]}{f(h,h)-f(l,h)}$. As $\frac{m_2}{m_1+m_2} < \frac{1}{2}$, it is clear that the necessary difference is smallest under sharing based on market size. ■

8.4 Proposition 5

Proof. League profits in each talent investment situation are given by:

$$\pi^{h,h}_L = \frac{1}{4}\left((m_1 + m_2)f(h,h) + 2nb(h,h)\right) - 2h \tag{20}$$

$$\pi^{h,l}_L = \frac{1}{4}\left(m_1 f(h,l) + m_2 f(l,h) + 2nb(h,l)\right) - h \tag{21}$$

$$\pi^{l,h}_L = \frac{1}{4}\left(m_1 f(l,h) + m_2 f(h,l) + 2nb(l,h)\right) - h \tag{22}$$

$$\pi_L^{l,l} = \frac{1}{4}\left((m_1+m_2)f(l,l) + 2nb(l,l)\right) \tag{23}$$

As before, I establish the conditions on n, m_1, m_2 and h under which each talent investment situation is optimal. Note that small market domination is optimal for league profits, in case: $\pi_L^{l,h} \geq \pi_L^{h,h}$, $\pi_L^{l,h} \geq \pi_L^{h,l}$ and $\pi_L^{l,h} \geq \pi_L^{l,l}$. However, from (21) and (22): $\pi_L^{l,h} \geq \pi_L^{h,l} \Leftrightarrow \frac{1}{4}\left(m_1 f(l,h) + m_2 f(h,l) + 2nb(l,h)\right) - h \geq \frac{1}{4}\left(m_1 f(h,l) + m_2 f(l,h) + 2nb(h,l)\right) - h \Leftrightarrow m_2\left(f(h,l) - f(l,h)\right) \geq m_1\left(f(h,l) - f(l,h)\right)$ $\Leftrightarrow m_2 \geq m_1$ which is a contradiction. Therefore, small market domination is never optimal for league profits and it should not be considered as an alternative. Now I turn to the three other talent investment outcomes.

First, $t_1 = t_2 = h$ is optimal for the league when $\pi_L^{h,h} \geq \pi_L^{h,l}$ and $\pi_L^{h,h} \geq \pi_L^{l,l}$. Filling this out using (20), (21) and (23) gives: $\frac{1}{4}\left((m_1+m_2)f(h,h) + 2nb(h,h)\right) - 2h \geq \frac{1}{4}\left(m_1 f(h,l) + m_2 f(l,h) + 2nb(h,l)\right) - h$ and $\frac{1}{4}\left((m_1+m_2)f(h,h) + 2nb(h,h)\right) - 2h \geq \frac{1}{4}\left((m_1+m_2)f(l,l) + 2nb(l,l)\right)$. This may be simplified to $2n\left(b(h,h) - b(h,l)\right) - 4h \geq m_1\left(f(h,l) - f(h,h)\right) - m_2\left(f(h,h) - f(l,h)\right)$ and $2nb(h,h) - 8h \geq 2nb(l,l)$. Implementing (2) and (3) in the first condition yields $2n\left(b(h,h) - b(h,l)\right) - 4h \geq (m_1 - m_2)\left(f(h,l) - f(h,h)\right)$, so $\lambda^{u,h} = \frac{2n(b(h,h)-b(h,l))-4h}{f(h,l)-f(h,h)} \geq m_1 - m_2$. Rearranging the second condition I find $\lambda^{l,h} = \frac{4h}{b(h,h)-b(l,l)} \leq n$.

Second, $t_1 = t_2 = l$ is optimal when $\pi_L^{l,l} \geq \pi_L^{h,l}$ and $\pi_L^{l,l} \geq \pi_L^{h,h}$. From the previous point, it is clear that the second condition implies $\lambda^{l,h} = \frac{4h}{b(h,h)-b(l,l)} \geq n$. Filling out the first condition using (21) and (23) yields $\frac{1}{4}\left((m_1+m_2)f(l,l) + 2nb(l,l)\right) \geq \frac{1}{4}\left(m_1 f(h,l) + m_2 f(l,h) + 2nb(h,l)\right) - h \Leftrightarrow (m_1+m_2)f(l,l) \geq m_1 f(h,l) + m_2 f(l,h) - 4h$. Again using (2) this gives $4h \geq (m_1 - m_2)\left(f(h,l) + f(h,h)\right)$ and $\lambda^{u,l} = \frac{4h}{f(h,l)+f(h,h)} \geq m_1 - m_2$.

Finally, $t_1 = h, t_2 = l$ is optimal when $\pi_L^{h,l} \geq \pi_L^{h,h}$ and $\pi_L^{h,l} \geq \pi_L^{l,l}$. From the previous derivations it is already clear that this implies $\lambda^{u,h} = \frac{2n(b(h,h)-b(h,l))-4h}{f(h,l)-f(h,h)} \leq m_1 - m_2$ and $\lambda^{u,l} = \frac{4h}{f(h,l)+f(h,h)} \leq m_1 - m_2$. From the observation that when $n = \frac{4h}{b(h,h)-b(l,l)}$ this means $\frac{4h}{f(h,l)+f(h,h)} = \frac{2n(b(h,h)-b(h,l))-4h}{f(h,l)-f(h,h)}$, it follows that these conditions converge at the point where the league is indifferent between mutually high and mutually low investments. Notice as well that the condition $m_1 - m_2 \geq \frac{n(b(h,h)-b(l,l))}{f(h,l)-f(l,l)}$ never prevents a balanced outcome being preferred by the league.

Social welfare in each talent investment outcome is given by:

$SW^{h,h} = \frac{3}{8}\left((m_1+m_2)f(h,h) + 2nb(h,h)\right) - 2h$

$SW^{h,l} = \frac{3}{8}\left(m_1 f(h,l) + m_2 f(l,h) + 2nb(h,l)\right) - h$

$SW^{l,h} = \frac{3}{8}\left(m_1 f(l,h) + m_2 f(h,l) + 2nb(l,h)\right) - h$

$SW^{l,l} = \frac{3}{8}\left((m_1+m_2)f(l,l) + 2nb(l,l)\right)$.

I introduce the notation $\sigma^{l,h}$, $\sigma^{u,l}$ and $\sigma^{u,h}$ for the social welfare thresholds. Following a completely similar logic as before, it is straightforward to show that small club domination is never socially optimal. The thresholds are given by $\sigma^{l,h} = \frac{8}{3}\frac{h}{b(h,h)-b(l,l)}$, $\sigma^{u,l} = \frac{8}{3}\frac{h}{f(h,l)-f(l,l)}$ and $\sigma^{u,h} = \frac{2n[b(h,h)-b(h,l)]-\frac{8}{3}h}{f(h,l)-f(h,h)}$. Comparison with the league's thresholds reveals that $\sigma^{l,h} < \lambda^{l,h}$, $\sigma^{u,l} < \lambda^{u,l}$ and $\sigma^{u,h} > \lambda^{u,h}$. ■

8.5 Proposition 6

Proof. In order to provide evidence for proposition 6 I first investigate the case of equal sharing and then compare both other schemes with this benchmark.

Under $d_i = 1/2$:

- if $t_1 = t_2 = h$ is optimal, it always occurs.

  Suppose $t_1 = t_2 = h$ is optimal, then from proposition 5:

$$n \geq \frac{4h}{b(h,h)-b(l,l)} = \lambda^l(h) \tag{24}$$

  From proposition 2 $t_1 = t_2 = h$ is the unique Nash-equilibrium $\Leftrightarrow \frac{4h-n[b(h,h)-b(h,l)]}{f(h,h)-f(l,h)} = \theta^h_{equal} < m_2$. Implementing (24) into this condition shows $\frac{4h-n[b(h,h)-b(h,l)]}{f(h,h)-f(l,h)} \leq \frac{4h-\frac{4h}{b(h,h)-b(l,l)}[b(h,h)-b(h,l)]}{f(h,h)-f(l,h)} < m_2$ or $\frac{4h-4h}{f(h,h)-f(l,h)} = 0 < m_2$. Since $0 < m_2$, $t_1 = t_2 = h$ is always the unique Nash-equilibrium of the investment stage when this is optimal for league profits.

- if $t_1 = t_2 = l$ occurs, it is optimal.

  Suppose $t_1 = t_2 = l$ occurs, then from proposition 3

$$\Rightarrow m_1 \leq \frac{4h}{f(h,l)-f(l,l)} \tag{25}$$

  From proposition 5, $t_1 = t_2 = l$ is optimal for league profits

$$\Leftrightarrow \left\{ \begin{array}{c} \lambda^{l,h}(h) = \frac{4h}{f(h,l)+f(h,h)} \geq m_1 - m_2 \\ and \\ n \leq \frac{4h}{b(h,h)-b(l,l)} = \lambda^h(h) \end{array} \right\} \tag{26}$$

  Filling in (25) in the right hand-side of the first condition of (26), yields: $m_1 - m_2 \leq \frac{4h}{f(h,l)-f(l,l)} - m_2 < \frac{4h}{f(h,l)+f(h,h)}$, because $0 < m_2$. So the first condition of (26) is satisfied. To see why (25) also implies that the second part of (26) is satisfied, observe that $n > \frac{4h}{b(h,h)-b(l,l)}$ and the second part of (26) can never be satisfied simultaneously. On the contrary, when $n > \frac{4h}{b(h,h)-b(l,l)}$ is not satisfied (26) is always satisfied. On the other hand it is clear that the occurrence of $t_1 = t_2 = l$ and $t_1 = t_2 = h$ also mutually exclude each other. Since $n > \frac{4h}{b(h,h)-b(l,l)}$ is a (more than) sufficient condition for $t_1 = t_2 = h$ to occur, it follows that when $t_1 = t_2 = l$ occurs (and consequently $t_1 = t_2 = h$ fails to occur and (25) is satisfied) $n > \frac{4h}{b(h,h)-b(l,l)}$ can never be satisfied. Therefore in such cases the second part of (26) is always satisfied. In this way, (25) also implies that the second part of (26) is met.

- if $t_1 = h, t_2 = l$ is optimal, $\theta^u_{equal} < m_1 - m_2$.

  Suppose $t_1 = h, t_2 = l$ is optimal, then from proposition 5 it follows that 2 situations might occur. First, it may be that $\frac{4h}{f(h,l)+f(h,h)} \leq m_1 - m_2$ and $n \leq \frac{4h}{b(h,h)-b(l,l)}$. Rewriting the second condition to $n\,(b(h,h) - b(l,l)) \leq 4h$ and plugging it into the first shows $n\frac{(b(h,h)-b(l,l))}{f(h,l)+f(h,h)} (= \theta^u_{equal}) \leq \frac{4h}{f(h,l)+f(h,h)}$. Given the first condition this implies $\theta^u_{equal} \leq m_1 - m_2$. Second, it may also be that $\frac{2n(b(h,h)-b(h,l))-4h}{f(h,l)-f(h,h)} \leq m_1 - m_2$ and $n \geq \frac{4h}{b(h,h)-b(l,l)}$. Again rewriting the second condition to $n\,(b(h,h) - b(l,l)) \geq 4h$ and plugging in the first shows $\theta^u_{equal} = n\frac{(b(h,h)-b(l,l))}{f(h,l)+f(h,h)} \leq n\frac{(b(h,h)-b(l,l))}{f(h,l)+f(h,h)} + \frac{n(b(h,h)-b(h,l))-4h}{f(h,l)-f(h,h)} \leq \frac{2n(b(h,h)-b(h,l))-4h}{f(h,l)-f(h,h)}$ $\leq m_1 - m_2$. $n\,(b(h,h) - b(l,l)) \leq 4h$. So, the minimal necessary difference in market size can never prevent large market domination to arise, when it is optimal.

Secondly, for $d_i = w_i$, the following reasoning applies:

- if $t_1 = t_2 = h$ is optimal, it always occurs

  Proposition 2 has shown that $\theta^h_{win} < \theta^h_{equal}$, while from part 1 of this proof it is clear that if $t_1 = t_2 = h$ is optimal, this implies $\theta^h_{equal} < m_2$. Obviously, this means that if $t_1 = t_2 = h$ is optimal, this implies $\theta^h_{win} < \theta^h_{equal} < m_2$ and consequently $t_1 = t_2 = h$ occurs under $d_i = w_i$ when it is optimal.

- if $t_1 = t_2 = l$ occurs, it is optimal.

  From proposition 3 it is clear that $\theta^l_{win} < \theta^l_{equal}$, while again part 1 of this proof has shown $m_1 \leq \theta^l_{equal}$ implies $t_1 = t_2 = l$ is optimal. Combining these observations yields: $m_1 \leq \theta^l_{win} \Rightarrow m_1 \leq \theta^l_{equal} \Rightarrow t_1 = t_2 = l$ is optimal.

- if $t_1 = h, t_2 = l$ is optimal, $\theta^U_{win} < m_1 - m_2$

  From proposition 4: $\theta^u_{win} = \theta^u_{equal}$, so the reasoning of part 1 applies.

Finally, when $d_i = \frac{m_j}{m_k+m_j}$:

- if $t_1 = t_2 = h$ is optimal, it cannot be guaranteed to occur

  Suppose $t_1 = t_2 = h$ is optimal, then as before from proposition 5:

$$n \geq \frac{4h}{b(h,h) - b(l,l)} = \lambda^l(h) \tag{27}$$

  From proposition 2 $t_1 = t_2 = h$ occurs as an equilibrium under $d_i = \frac{m_j}{m_k+m_j}$ $\Leftrightarrow \frac{4h-2\frac{m_2}{m_1+m_2}n[b(h,h)-b(h,l)]}{f(h,h)-f(l,h)} = \theta^h_{market} < m_2$. As before it is possible to plug (27) into this condition. It leads to: $\frac{4h-2\frac{m_2}{m_1+m_2}n[b(h,h)-b(h,l)]}{f(h,h)-f(l,h)} \leq \frac{4h\left(1-2\frac{m_2}{m_1+m_2}\right)}{f(h,h)-f(l,h)} < m_2$. But since $\frac{1}{2} > \frac{m_2}{m_1+m_2}$, this cannot be guaranteed for all positive values of m_2.

- if $t_1 = t_2 = l$ occurs, it is optimal.

  Proposition 3 has shown $\theta^l_{market} = \theta^l_{equal}$, while from part 1 of this proof it is clear that $m_1 \leq \theta^l_{equal} \Rightarrow t_1 = t_2 = l$ is optimal. Combining both leads to $m_1 \leq \theta^l_{market} \Rightarrow m_1 \leq \theta^l_{equal} \Rightarrow t_1 = t_2 = l$ is optimal

- if $t_1 = h, t_2 = l$ is optimal, $\theta^u_{market} < m_1 - m_2$

  From proposition 4: $\theta^u_{market} < \theta^u_{equal}$, so the reasoning of part 1 applies.

■

9 Tables

Table 1: Sharing systems for broadcast revenue in European soccer

Country	Broadcast Revenue/year[5]	Sharing Mechanism[6]
England	£ 672m	50% equal sharing, 25% based on league position, 25% based on TV appearances
France	€ 668m	50% equal sharing, 30% based on league position, 20% based on TV appearances
Germany	€ 413m	50% equal sharing, 50% based on past three and current season performance
Norway	€ 14.54m	40% equal sharing, 30% based on league position, 30% based on TV appearances
Scotland	€ 63.5m	52% equal sharing, 48% based on league position

[5] Data taken from www.sportsbusiness.com and Gratton & Solberg (2007). All figures for 2008-2009 season, except Scotland (2004) and Norway (2006).

[6] Based on 2005 figures from Solberg and Gratton (2007).

Table 2: Comparison of European Soccer Leagues 2005-2008

League	average competitive balance[7]	average UEFA points	average attendance/ fixture	average bottom 3 attendance[8]	average top 3 attendance	average total attendance/TV households[9]
England	0.39	67.75	34,548	19,961	58,621	3.27
France	0.33	51.64	21,688	8,800	42,467	1.73
Germany	0.41	47.61	39,479	20,178	66,589	2.03
Belgium	0.47	29.44	10,472	4,799	24,415	4.04
Netherlands	0.53	39.69	17,463	5,571	40,763	4.49
Scotland	0.54	31.50	15,896	4,874	40,913	9.00
Austria	0.37	20.36	7,945	4,222	12,396	2.34
Norway	0.35	20.83	9,719	5,275	16,895	6.68
Sweden	0.39	13.22	9,027	4,160	13,207	3.14

Table 3: Revenue sharing and national broadcast revenue in European soccer and US major leagues

[7] Competitive balance is measured by NAMSI, see Peeters (2009) for more information on this. This measure increases when competitive balance decreases. Data were taken from RSSSF. The RSSSF is the Rec. Sport. Soccer Statistics Foundation. More information on this organisation and the full archives can be found at http://www.rsssf.org

[8] This statistic is calculated as the average attendance of the three best attended clubs in each season 2005-2008. Data are taken from European Football Statistics, online retrievable at http://www.european-football-statistics.co.uk/.

[9] Sum of all club average attendances per fixture, divided by the number of TV households, based on European Football Statictics data and World Development Indicators.

League	Local market size distribution	Percentage equal	Percentage market size	Percentage performance	Total Broadcast Revenue (in $1m) [10]
NFL	0.098	100	0	0	3,700
NBA	0.116	100	0	0	930
NHL	0.108	100	0	0	675
Premier League	0.380	50	25	25	1,092
Bundesliga	0.420	50	0	50	578
Ligue 1	0.547	50	20	30	934
Serie A[11]	0.647	0	0	0	645
La Liga	0.625	0	0	0	470

[10] Exchange rates on 28/01/2010. All data from www.sportbusiness.com and Gratton & Solberg (2007). Data from 2008-2009 season, except Serie A (2007) and Liga (2006).

[11] Serie A introduced a collective agreement, which comes into effect from 2010 onwards. They agreed on a 40% equal, 30% performance, 30% TV appearances distribution.