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# Rivalries

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**Abstract**

Rivalries are a key aspect of sports, but one with few counterparts elsewhere in economic theory. In this paper rivalries are modeled as a habitual good, and complementary in fan utility with other trade between residents of team locations. Some implications for optimal team investment in rivalry capital, for league investment in competitive balance, and for the fundamental differences between rivalries in team and individual sports are derived.

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"Now hatred is by far the longest pleasure."

- Lord Byron, *Don Juan*, Ch. 15

"To enjoy the things we ought and hate the things we ought has the greatest bearing on excellence of character."

- Aristotle, *Nicomachean Ethics*, X, 1

Rivalries are the most compelling of recurring athletic competitions. Their drama provokes some of the most distinguished commentary on sports, and some of the most memorable moments of sports contests. They have been little-analyzed from the perspective of economic theory, although they have occasionally entered empirical analysis in an ad hoc way (Owen and Weatherston, 2004; Paul, 2003; Price and Sen, 2003). (One partial exception with respect to theory is Amegashie and Kutosoati (2005), who, in a study of boxing rematches that they argue also applies more permanent rivalries in other sports, take rivalries as given but explore ways to motivate greater effort.) But it seems likely that sports consumers treat rivalry and non-rivalry contests differently, even though the outcomes in each contest type are produced by the same firm. Rivalries can thus be viewed as a problem in joint production.

Rivalries are also different from a preference-modeling perspective from non-rivalry contests in their intertemporal nature. Rivalry results are closely monitored and often called up years after the fact to enhance (or detract from) fan utility. This suggests that rivalries are a form of the habitual good pioneered in various work by Gary S. Becker and others (Becker, 1996; Becker and Murphy, 1988). This paper merges the joint-product and habitual-good approaches to turn the analysis of rivalries into a

standard price-theory problem. In doing so it generates several empirical implications about the circumstances under which rivalries will be more or less important to consumers and producers, and indeed what it means economically for a rivalry to be "important," beyond the obvious empirical implication that rivalry contests should generate higher demand, ceteris paribus. Two models are developed, one in which the identity of the rivalry contest is exogenous, the other in which a degree of rivalry develops endogenously from other exogenous factors. Sections 1 and present the two models, and Sections 3-6 derive some empirical implications, some of which can be productively combined with other strands in the theoretical literature on athletic competition.

## 1. Model 1 – Rivalry and non-rivalry contests as distinct goods

I first propose that rivalry games and non-rivalry games are simply separate goods, jointly produced by the same single firm. In particular, assume that each fan possesses preferences defined by a strictly concave, time-separable utility function over three goods, $x_t$, $y_t$ and $z_t$. $y$ is investment by the team in the rivalry game. "Investment" can be anything that will raise demand – an improvement in team success or any other increase in the appeal of the rivalry to consumers through, for example, persuading them of its value. $X$ is similar investment in the composite non-rivalry schedule, and $z$ is a composite market good. $T$ is a time subscript.

The key assumptions are those regarding the relation between demands for the various goods. In particular, let $y$ be a habitual good in the sense of, for example, Becker

and Murphy (1988). Its value to a consumer depends on his consumption in the past. It is reasonable to suppose that a rivalry that has been one-sided for an extended period of time is less attractive for consumers in period *t* than a rivalry that has been more competitive. Define firm demand faced for $y_t$ as

$$y_t\left(p_{yt}, x_t, \delta y_{-t}, z_t\right). \qquad \textbf{(1)}$$

$p_{yt}$ and $p_{xt}$ are prices charged by the firm. $y_{-t}$ is consumption of $y$ in periods prior to $t$. Following Becker (1996), let the effect of past consumption on current demand be given by $\sum_{s=1}^{t} \delta^s y_{t-s}$ , where $0 < \delta < 1$. Note that this will also be the equivalent of the effect on future demand of a unit of $y_t$ produced in $t$. Thus, rivalry demand depends not just on the price set for rivalry investment in the current period but on the price set for non-rivalry investment and on past rivalry success, but less so in the latter case as the period of comparison recedes farther into the past. In addition, it depends in ways later to be specified on $z_t$, output of the non-market good in the current period, although the quantity of this good available is beyond the firm's control.

Demand for $x_t$ is given by

$$x_t\left(p_{xt}, y_t, z_t\right). \qquad \textbf{(2)}$$

Thus, consumer demand for rivalry and non-rivalry success will depend on the other good's price (and hence output). But what distinguished rivalry from non-rivalry

success is the time interdependence of the former. The value of rivalry success to consumers, and hence demand for it, is inextricably bound up with past output of rivalry success. Indeed, this interdependence – preferences defined around the time path of rivalry success – is arguably the very definition of a rivalry. Non-rivalry success, on the other hand, can influence rivalry success within the same period, but has no impact on demand for either rivalry or non-rivalry success in periods other than *t*.

The firm is a price-searcher, and must solve, via optimization over $y_t$ and $x_t$, the problem

$$\max \pi = \sum_{t=0}^{\infty} \left[ p_{yt} y_t \left( p_{yt}, x_t(.), \delta y_{-t}, z_t \right) + p_{xt} x_t \left( y_t(.), p_{xt}, z_t \right) - C\left( x_t, y_t \right) \right] \qquad \textbf{(3)}$$

$C(x_t, y_t)$ is the cost function for production of *x* and *y* in period *t*, and is assumed to be constant across periods. The first-order conditions in any period *t* are

$$\frac{d\pi}{dy_t} = p_{yt} + y_t \frac{dp_{yt}}{dy_t} + p_{xt} \frac{dx_t}{dy_t} + p_{yt} \frac{\delta}{1-\delta} = y_t \frac{dp_{yt}}{dy_t} + p_{xt} \frac{dx_t}{dy_t} + p \frac{1}{1-\delta} = \frac{dC}{dy_t} \qquad \textbf{(4a)}$$

$$\frac{d\pi}{dx_t} = \frac{dy_t}{dx_t} + x_t \frac{dp_{xt}}{dx_t} = \frac{dC}{dx_t}. \qquad \textbf{(4b)}$$

It is further assumed that $x_t$ and $y_t$ are substitutes, so that

$$\frac{dx_t}{dy_t} = \frac{dx_t}{dp_{yt}} \frac{dp_{yt}}{dy_t} < 0 . \quad \textbf{(5)}$$

$z_t$ also enters into the demand for $y_t$. The sign effect of changes in $z_t$ on the demand for $y_t$ depends on whether they are substitutes or complements. I will assume, for consistency's sake with respect to Model 2 below, that they are complements. This assumption also seems the more reasonable one. Evidence of its importance can be derived from the international-relations literature, where Beck (2003) finds, essentially, that geopolitical rivalry (an example of a non-sports but complementary good) over time acts in a complementary way with soccer competition in the rivalry between the national teams of Germany and the U.K. In particular, as the intensity of that geopolitical rivalry rises and falls so too does the intensity of fan interest in World Cup matches between the teams. Such matches also interact with behavior of and attitudes by British nationals toward Germany and Germans more generally. This effect is also obvious in within-city rivalries, where people trade with one another even as they split allegiances among the Chicago Cubs and White Sox, the New York Yankees and Mets, or the athletic teams of the University of Southern California and UCLA.

What drives rivalry demand is thus in part the nature of the intertemporal dependence of consumption of it in one period on demand in another. Just as with any other habit, when there are significant spillovers between periods (i.e., $\delta$ is higher), the demand for the full intertemporal stream of rivalry goods is higher and a rational firm should invest more in it.

## 2. Model 2 – Degrees of rivalry

It is also possible to think about rivalry as differing among all teams within a league, and as continuous rather than binary, an approach with implications for optimal league structure. Suppose that preferences are now defined around $Y$ and $Z$ where $Y$ is sports competition and $Z$ is as before a composite non-sports good. In this instance the unit of analysis is not an individual team but cities, which trade with one another. Define $Y_{ij}$ and $Z_{ij}$ as the stock of sports competition (produced by a league) and composite-good trade (taken as exogenous by a league) between cities $i$ and $j$, where $i, j = 1,\ldots,n$. Following the iceberg model of Krugman (1991) and Samuelson (1952), let the demand function for $Y_{ij}$, the demand by all residents in city $i$ for sports competition against the team from city $j$, be given by

$$Y_{ijt}\left[P_{ijt}, \delta Y_{-t}, A_{ij} Z_{ij}\left(1 - t_{ij}\right)\right]. \qquad \textbf{(7)}$$

$P_{ijt}$ is the price for a unit of investment in quality for competition between cities $i$ and $j$ in period $t$. $Z_{ij}$ is a base measure of (exogenous, to a team or a league) composite-good trade between cities $i$ and $j$ (assumed constant across periods). $t_{ij}$ is a rate of depreciation of base output, and is an increasing function of distance between the two cities. $A_{ij}$ is the combined buying power (e.g., income times population) in cities $i$ and $j$. Demand is increasing in $A_{ij}$ and decreasing in $t_{ij}$. Cities farther apart, in other words, trade less in the composite good, while cities with more joint population and income trade more. Links between cities – the degree of complementarity between $Y_{ijt}$ and the cities' trade in the composite good $Z_{ijt}$, itself a negative function of distance and a positive

function of joint income and population and the intrinsic complemetarity of sports consumption and $Z_{ijt}$ in isolation – drive investment in contests against each opponent.

The theory is a complement to older theories of league structure, which ordinarily rely on entry restriction and optimal spacing of retail outlets – i.e., franchises – in the manner of the traditional Hotelling class of retail-location models. Here, the analysis takes team location as exogenous, and rivalry becomes a degree of investment corresponding to the factors that drive gravity models of international trade. The amount of potential rivalry will be greater the greater are the forces of economic gravity (in the sense of distance and buying power, e.g. gross jurisdictional product) between cities and the greater the degree of complementarity in fan preferences between *Y* and *Z*. Such an approach is supported by the work of Leonard (2003), who demonstrates that the distance component of gravity helps determine college-football attendance. Rivalry investment in a particular periodic contest between teams of an *i-j* pair will vary with these gravity factors in the model here.

This gravity effect can explain the idea of the one-sided rivalry. Many leagues have teams with vastly disproportionate (before accounting for wealth or population) numbers of fans who both love and hate the teams – the New York Yankees in MLB, the Yomiuri Giants (located in Tokyo) in Japanese professional baseball, the Los Angeles Lakers in the NBA. Often these teams engage in competitions with teams from smaller markets for whom these games are extremely important events, while for the larger-market teams they are non-rivalry games. If the relative proportion of complementary composite-consumption ties is (as seems likely) much higher for the smaller-market teams, their fans, fueled by investment by teams, might emphasize these games much

more than fans and teams in the large markets. This effect is particularly pronounced in Japanese baseball. In that country Tokyo dominates the culture and politics to a much greater extent than any city does in the U.S. (Tokyo has two teams, but one, the Yomiuri Giants, has a much more successful history.) Such a large gravity deficit between two markets suggests that the rivalry is far more lucrative to the small than the large market; since the large market is likely to have many such one-way rivalries, it cannot simultaneously invest a great amount in all of them. No accommodation can or should be made to any particular one-sided rivalry in scheduling, but such rivalries will flow in one direction – from the smaller to the larger market – anyway.

A similar effect is suggested by rivalries between teams with much and little at stake in competitive terms. Many college football rivalries are very one-sided, matching long-time powerhouses against teams with little recent general success. So too in professional sports, late in the season one rival may have a postseason berth at stake while the other may already be eliminated from contention. The theory suggests that the opportunity cost of rivalry investment for the team with more at stake in non-rivalry contests is higher (given that every remaining game counts the same in the playoff chase), hence the weaker team may invest a great deal more in the rivalry, increasing its chances of success. Sports lore has it that in rivalry contests "anything can happen," and the approach here suggests that rivalry underdogs should win more often than their relative team strength and the possession of home-field advantage suggests, although little empirical evidence exists.

Critically, in both this and the prior model the very idea of rivalry is exogenously constrained. Whether seen as directly given (Model 1) or limited by the absence of other

economic ties (Model 2), other games will inevitably trade off in firms' optimization problems against contests involving greater rivalry potential. While certain contests may temporarily, over a period of several seasons, yield intense consumer interest because of current competitive conditions, the difference between an anticipated game and a rivalry is that the latter requires at least an inherent habitual effect and perhaps other economic linkages between teams' jurisdictions. Rivalries, in other words, cannot be created out of thin air, and competitions with high fan interest purely generated by current competitive conditions (a series of seasons in which two teams compete for a divisional or league title, for example), do not have this quality.[1]

**3. Investment in rivalries**

This habitual-goods approach, in either model, also provides motivation for the notion of investment in rivalries by athletic firms. College football rivalries in particular are notable for the extra investments made by team pairs to make the rivalry more attractive to fans. Some games have paraphernalia that go to the winners. The winner of the annual football game between the University of California and Stanford University, for example, obtains a commemorative item known as The Axe because it contains an axe head mounted on a trophy. The axe head was itself once mounted to an actual ax, and used by Stanford yell leaders to decapitate a straw man during the annual football game in 1899. According to legend, in a baseball game soon after, California students

1. One thinks of the rivalry between the Boston Celtics and the Philadelphia 76ers in the late 1970s and early 1980s, as fierce as any for a few years but largely forgotten now, in contrast to the timeless rivalry between the Boston Red Sox and the New York Yankees.

grabbed the ax away from Stanford fans. Over the years, it changed hands several times before the teams agreed to permanently declare it the temporary property of whichever team won the game most recently. The trophy, and the emotional lore surrounding it[2], is a classic example of investment in a habitual good, and indeed bears some resemblance to the account of college or university investment in current sports-team quality to promote the consumption value of past university attendance proposed by Goff and Tollison (1990).

Firms sometimes even make these investments to improve the "rivalry capital" not of fans but of athletes. We might expect that for professional and some major-college programs the players themselves would have no particular initial propensity to value a traditional rivalry, coming as they do from all over the country. (An exception would be a college athletic rivalry where most players come from within the state and have long exposure to the rivalry and its intensity.) There is no particular reason for draftees of the Celtics or the Lakers to enter the NBA hating the Lakers or the Celtics. But such hatred, and greater effort in rivalry contests, can be cultivated. Bradley (2006) reports the example of Notre Dame and the University of Southern California, teams united merely by competitive history rather than any close economic ties. In the early years of the rivalry, just after the death of Knute Rockne, USC coach Howard Jones took the team to visit Rockne's grave *after* a major victory at Notre Dame, obviously not to motivate the team for that game but presumably as an investment in the future intensity of the rivalry.

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2. Including the habit of Stanford changing the score of the 1982 game, which ended on a famously controversial kickoff return, when it possesses the trophy and California changing it back when it recovers it.

More concretely, Russell (1983) finds that hockey players (most of them presumably from elsewhere than their team's city) behave more aggressively, measured by aggression penalties received, in intradivisional rivalry games.

Another form of investment in rivalries is branding. College rivalries often possess informal names ("The Civil War," etc.). Increasingly even broadcast networks, who have an obvious interest in increasing rivalry attractiveness, officially invoke such terminology, such as the christening in television broadcasts and elsewhere of the University of Texas-Oklahoma University football game by its long-time unofficial name, "The Red River Shootout." Such investments presumably serve to separate such rivalries not just from the other games for those teams but from other rivalries involving other teams, promoting a particular rivalry's sense of uniqueness and thus increasing its desirability to fans.

Such tactics – the employment of paraphernalia, the investment in player appreciation for the rivalry that is of a piece with other sorts of human-capital investments, the adoption of a brand name – make little sense in periodic contests not likely to yield big future payoffs from such investments. Indeed, given the way in which they increase utility across time in ways not possible for contests with little if any cross-good complementarities or intertemporal persistence, the rough equivalent in a non-rivalry contest to these investments is perhaps to a simple cash discount or other direct compensation. American sports teams frequently employ promotional tactics involving giveaways of merchandise, and these tactics are generally employed in contests against non-rivalry opponents.

This model also implies that there can be an optimal division of a sports league into groups that will compete against one another more often in a particular season, with economic closeness (taking into account not just actual geographic distance, but income and population as well) driving the formation of divisions. Indeed the formation of such units in professional leagues, along with conferences in college athletics, is a way to subsidize the formation of rivalries. There are of course other theories of divisions, including the control of moral hazard and the enabling of postseason competition (Krakel, 2006) and the ability to increase uncertainty and hence demand by increasing the number of steps needed to win a championship (Noll, 2003). The motivation here is not mutually exclusive with these motivations, but an additional consideration. The greater the division of leagues into regions that are compact internally but far apart from one another, the greater the ability to use a divisional structure and unbalanced scheduling to promote rivalry.

Table 1 depicts combined populations and geographic distances for each pair of cities in each division of the National Football League. Ignoring income differences across cities, this is a crude measure of $A_{ij}(1 - t_{ij})$. The two divisions with the least combined distance, the NFC North and the AFC Central, are those where traditional divisional rivalries are often thought to have the greatest force. (When the NFL reorganized into eight four-team divisions substantial effort was made to retain these rivalries, at the expense of the expelled teams, the Tampa Bay Buccaneers and the Tennessee Titans.) There are also few if any opportunities to switch any pair of teams among divisions in a way that decreases both intradivisional distances. This is presumably partly because of transportation-cost considerations for road teams, but

before reorganization the NFL had several unusual divisional allocations for teams new to the league – e.g., the location of the Jacksonville Jaguars in the NFC West. This suggests that distance considerations loomed large in the 2002 reorganization.

Thus, in this argument rivalry can be thought of as (endogenously) emanating from two forces. We may speak of rivalry driven by intertemporal complementarity, the habitual-consumption motivation constructed earlier, as well as rivalry driven by cross-product complementarity with non-sports output, that deriving from other economic ties between team locations. Neither is obviously the single dominant contributor. Notre Dame and USC have one of college football's most compelling rivalries (in which many not connected with either school take an active rooting interest) despite an almost complete absence of economic ties between South Bend, Indiana and Los Angeles. And it is sometimes argued that Cleveland and Pittsburgh have a more natural baseball rivalry than Cleveland and Cincinnati despite their near-equidistance, based on their other ties (including a compelling rivalry between their NFL teams). But equilibrium rivalry investment can and frequently is driven by both.

## 4. Scheduling

In addition to firm location, another variable over which a league has control is scheduling, in particular the amount of scheduling devoted to rivalry games. Concavity of preferences in either specification indicates that there will be diminishing returns to scheduling more rivalry games. While not explicitly modeled, the tradeoffs that might enter into fan preferences to be balances against rivalry scheduling include diversity of

opponents (fans might wish to see more teams over the course of a season, other things equal) and competitive balance. (Competitive balance in a rivalry environment is discussed further below.)

Table 2 depicts the number and percentage of games against each divisional opponent, where rivalry games are traditionally most likely to be found and in any event, in Major League Baseball, the National Football League, the National Basketball Association, the National Hockey League and Major League Soccer. In MLB, extra, specially scheduled interleague rivalry games are also included. The immediate thing to notice is the relatively small proportion of rivalry games in the NBA at the level of either an individual opponent or the total number of potential rivalry games, combined with the unusually large proportion in MLB. (MLS has a large percentage, but that is because they have only 13 teams spread across the country and two conferences rather than divisions. Whether much intraconference competition is potentially rivalrous is very debatable here, although MLS does schedule extra games for closer geographic neighbors.) The reasons for the smaller proportion of games against divisional opponents in basketball is not clear, although it is possible that the star effects in this sport, because of smaller numbers of players on the court at a time, is greater and hence so is demand for opponent variety. (Hockey has only six players on the ice at a time on each team, but in short shifts. Any one player's share of total minutes played will thus still be small.) In the other sports, where there are many more players so that the marginal product and therefore marginal utility, other things equal, of each is (arguably) lower, the utility of a particular team as an opponent, as opposed to the desire to watch a particular player on that team, may thus be greater. Attempts to capitalize on rivalry utility are clearly

identifiable in the extra game (in one conference) devoted to specific potential geographic rivals in MLS and the aforementioned interleague rival preference in MLB and the very large intradivisional scheduling in the NHL. Neither the NBA, NHL or NFL shows this preference for added rivalry games outside the divisional structure, although the NFL does in preseason, where many teams have annual games (often in the final week) against natural geographic rivals. (Preseason of course is a considerably weaker effect than a regular-season opponent.)

So too some college conferences clearly invest more in rivalry opponents. The Atlantic Coast Conference now consists of twelve teams, having added three in recent years. In football, the conference explicitly has each team play an annual game against one opponent in the other division every year, in addition to its annual intradivisional games. Some of these games have little historical content (Virginia Tech vs. the most recent addition to the conference, Boston College, for example), but most clearly show high levels of historical or geographic consumption capital – Miami vs. Florida State and Duke vs. Wake Forest, e.g.

Investment in rivalries through scheduling is conspicuously missing in some national soccer leagues outside the U.S., where all opponents are frequently scheduled the same number of times. The lack of playoffs in these leagues mean there is little reason to have a divisional structure, and so there is no occasion to differentiate with respect to scheduling frequency on divisional grounds among opponents. There is, in other words, no investment by the league in rivalry promotion through the schedule. In the English Premier League, for example, each team is an opponent two out of 38 games, constituting 5.3 percent of all games. There is no apparent reason other than scheduling

symmetry for this principle, and as indicated, in the U.S. MLS devotes considerably more effort to scheduling so as to promote rivalry. The use of relegation in non-U.S. leagues is a complicating factor because it raises the possibility of fan dissatisfaction through unequal scheduling affecting relegation outcomes. A team that must play rivalry games against an opponent at the top of the standings is handicapped by an unbalanced schedule, and a team playing its rivalry games against an opponent at the bottom is aided by this approach. Major-league baseball carries out such unbalanced scheduling, particularly against interleague rivals, without much permanent complaint (although fans of particular teams who miss the playoffs in a particular year sometimes complain of such lack of balance being responsible for rank-order finishes in the standings).

Unless the consequences of relegation are significantly worse than those for missing the playoffs in a league that has them (and perhaps despite this), it appears that soccer leagues outside the U.S. miss a significant opportunity to enhance revenue through greater use of unbalanced schedules. Indeed, the lack of a playoff structure deprives teams of a chance to play to either make or advance in the playoffs. Presumably such contests significantly increase rivalry capital, at least temporarily. (If the teams did not continue to meet in high-stakes contests rivalry capital might depreciate more rapidly.) While the presence of contests over relegation offset this to some extent, if soccer leagues are characterized by several large-market or historically dominant teams who have dominated competition and who have large numbers of fans and anti-fans outside their home market, the absence of a postseason structure, which involves contests for championships at the top rather than relegation at the bottom, may inhibit the development of rivalries and hence lower profits, other things equal.

## 5. Turnover, competitive balance and rivalry

It is well-known that, particularly in the U.S., sports leagues take steps to increase competitive balance below what free competition among teams for player services might yield. The usual explanations for this are that it enhances both demand for franchises otherwise not well-positioned to contend for championships and that champion diversity is (perhaps offset by love of dynasties) appealing in its own right. The list of measures taken to improve competitive balance is long and differs, because of the legal constraints on nonprofit groups and historical/institutional reasons, between collegiate and professional sports. Some of these measures will trade off against the courting of rivalry intensity.

A habitual-goods approach suggests that some measures to improve competitive balance will increase the rate of turnover on team rosters. This will have the effect of lowering the intertemporal dependency of rivalry consumption, $\delta$, and hence the amount of investment teams make in rivalry production or quality. A salary cap that lowers the average duration of players with teams will mean that next year's team bears less relation to this year's, making last year's rivalry game less complementary with this year's. If a star player (either because of his success or failure) is a key factor in a particular team winning this year, his absence next year makes next year's game less appealing, other things equal. Free agency is (assuming the Coase theorem does not hold) one way in which rivalry intensity is diminished, but in all likelihood salary caps are even more so. Any salary cap that increases roster turnover will have a similar effect on rivalry-based

demand, which is accentuated if it increases search costs for fans seeking to make their own investments in rivalry appreciation, analogous to the music appreciation investments (which enhance desire for classical-music consumption) of Stigler and Becker (1977). In the NFL, with its unique combination of a salary cap, less guaranteed compensation and frequent substantial injuries that motivate teams to release players, this rivalry-retarding effect may be particularly high. Of course, this is an argument that can be applied to anything that restricts player movement. The *Bosman* decision by the European Court of Justice and the advent of free agency in most North American sports have also lowered $\delta$, lowering the appeal of rivalries, as would league expansion. In no sense does this effect make these events economically unwise, but it is an unaccounted-for cost.

Not all measures to enhance competitive balance are subject to this effect. Responses that do not significantly increase the rate of roster turnover will have no rivalry cost. The reverse-order draft has only the most marginal effects – all teams are granted the same number of draft picks, although a weaker team may have a draft set in a given year with more members likely to make the team. Reverse-order scheduling, of the sort once extensively employed by the NFL, would have no effect on rivalry value (assuming rivalries are games scheduled in fixed amounts annually). Income-redistribution schemes such as luxury taxes and salary caps would redistribute rivalry opportunities from richer franchises to poorer ones, allowing the latter to invest more in rivalry cultivation but requiring the former to invest less.

## 6. Individual vs. team rivalries

Rivalries between individual athletes, either in individual sports such as tennis or golf, or between particular athletes in team sports, such as Wilt Chamberlain and Bill Russell, can also be examined using the approach here. In each case, the models suggest that the incentive for individual athletes to make investments specifically in rivalry capital for the sake of greater public interest are less than the corresponding incentives for team owners in team rivalries. Individuals are not systematically connected through potentially complementary trade in the same way as team-hosting jurisdictions are, although there may still be a habitual component in consumption. The absence of such complementary effects between *Y* and *Z* means that the marginal returns to rivalry-specific investments are lower. While fans may derive some utility from specific contests between, say, Chris Evert and Martina Navratilova or Phil Mickelson and Tiger Woods, the incentives for the athletes themselves to embellish the rivalry or to invest in tactics specifically to counter the other opponent are somewhat smaller. In a team sport, much of the increased benefit of investments by an individual player in a particular rivalry will leak out to other players (on both teams), suggesting a possible under-investment problem.

Consequently, such rivalries should generally be less compelling for fans than team-based rivalries. The examples offered above indicate that they are not unknown, but are perhaps less memorable than longstanding team rivalries. The fact that individual athletes retire while teams can in principle live forever further accentuates this distinction. The Red Sox and the Yankees may still be fierce rivals in twenty years' time, but any pair of athletes who are rivals now will not be playing then. Often in team sports individual rivalries are subsumed into the larger team rivalries. When such individual rivalries exist,

they tend to be defined by highly particular circumstances. That they might involve such players as star basketball centers, who possess rare physical attributes (Berri, et al., 2004) in a sport in which a single player can dominate indicates that they are likely candidates for such rivalries. On the other hand, the relatively limited role of rivalry scheduling in the NBA, discussed above, mitigates this tendency.

## 7. Conclusion

This approach to rivalry intensity as an outcome of optimal investment decisions is the merest first step. Many other strategic considerations could be introduced. It is possible that both sides of a rivalry might behave in predictable ways if their choices are mutually dependent. The incentives for athletes operating in a rivalry context, or of fans' desire to create rivalries themselves, are also ripe for further exploration. Perhaps most importantly, optimal and actual team and league behavior in the presence of potential rivalry profits is a topic that merits more attention.

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Table 1
Divisional gravity, National Football League

| | Population | Distance | | Population | Distance |
|---|---|---|---|---|---|
| NFC East | | | AFC East | | |
| *Dallas*-New York | 5,221,801 | 1560 | *Buffalo*-Miami | 1,170,111 | 1400 |
| *Dallas*-Philadelphia | | 1440 | *Buffalo*-NY | | 370 |
| *Dallas*-Washington | | 1310 | *Buffalo*-NE | | 470 |
| *NY*-Philadelphia | 9,314,235 | 110 | *Miami*-NY | 2,253,362 | 1330 |
| *NY*-Washington | | 240 | *Miami*-NE | | 1520 |
| *Philadelphia*-Wash. | 6,188,463 | 130 | *NY*-NE | 9,314,235 | 210 |
| *Washington* | 4,923,153 | | *New England* | 3,406,829 | |
| Total | 25,647,652 | 4790 | Total | 16,144,537 | 5300 |
| | | | | | |
| NFC South | | | AFC South | | |
| *Atlanta*-Carolina | 4,112,198 | 240 | *Houston*-Ind. | 4,177,646 | 1000 |
| *Atlanta*-New Orleans | | 480 | *Houston*-Jack. | | 890 |
| *Atlanta*-Tampa | | 416 | *Houston*-Tenn. | | 780 |
| *Carolina*-NO | 1,499,293 | 720 | *Ind.*-Jack. | 1,607,486 | 840 |
| *Carolina*-Tampa | | 508 | *Ind.*-Tenn. | | 280 |
| *New Orleans*-Tampa | 1,337,726 | 474 | *Jack.*-Tenn. | 1,100,491 | 560 |
| *Tampa* | 2,395,997 | | *Tennessee* | 1,231,331 | |
| Total | 9,345,214 | 2838 | Total | 8,116,954 | 4350 |
| | | | | | |
| NFC North | | | AFC North | | |
| *Chicago*-Detroit | 9,157,450 | 280 | *Baltimore*-Cin. | 7,608,070 | 424 |
| *Chicago*-Green Bay | | 186 | *Balt.*-Cleve. | | 360 |
| *Chicago*-Minnesota | | 410 | *Balt.*-Pitt. | | 250 |
| *Detroit*-Green Bay | 4,456,428 | 287 | *Cin.*-Cleveland | 1,646,395 | 220 |
| *Detroit*-Minnesota | | 690 | *Cin.*-Pittsburgh | | 257 |
| *Green Bay*-Minnesota | 226,178 | 261 | *Cle.*-Pittsburgh | 2,250,871 | 130 |
| *Minnesota* | 4,919,492 | | *Pittsburgh* | 2,358,695 | |
| Total | 18,759,548 | 2114 | Total | 13,864,031 | 1641 |
| | | | | | |
| NFC West | | | AFC West | | |
| *Arizona*-St. Louis | 5,130,632 | 1480 | *Denver*-KC | 2,109,282 | 610 |
| *Arizona*-San Fran. | | 760 | *Denver*-Oak. | | 946 |
| *Arizona*-Seattle | | 1470 | *Denver*-SD | | 1100 |
| *St. Louis*-San Fran. | 2,796,368 | 2120 | *KC*-Oakland | 1,766,062 | 1498 |
| *St. Louis*-Seattle | | 2140 | *KC*-San Diego | | 1590 |
| *San Fran.*-Seattle | 776,733 | 810 | *Oakland*-SD | 2,392,557 | 446 |
| *Seattle* | 2,414,616 | | *San Diego* | 2,813,833 | |
| Total | 11,118,349 | 8780 | Total | 9,091,734 | 6190 |

Note: Populations are of metro areas, from http://www.city-data.com; city distances are from http://www.travelnotes.org/NorthAmerica/distances.htm.

Table 2

Intradivisional and specified rivalry games

| | Intradivisional (max. per team) | Other rivalry | Total (all rivalry games) |
|---|---|---|---|
| NFL | | | |
| | 0.125 | 0 | 0.375 |
| MLB[1] | | | |
| | 0.105-0.117 | 0.037 | 0.352-0.562 |
| NBA | | | |
| | 0.049 | 0 | 0.195 |
| NHL | | | |
| | 0.098 | 0 | 0.390 |
| MLS[2] | | | |
| East | 0.100 | 0 | 0.600 |
| West | 0.133 | 0 | 0.533 |

Notes

1. MLB does not apply same scheduling rules to all teams or team pairs.
2. MLS has conferences, not divisions. Scheduling rules are different and number of teams are different in the two conferences.