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Organizational Forms in Professional Cycling: An Examination of the Efficiency of the UCI Pro Tour

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Abstract

This paper analyzes the changes induced by the newly introduced UCI Pro Tour on the behavior of racing teams. We develop an oligopolistic model starting from the well-known Cournot framework to analyze why the UCI Pro Tour fails to reach its primary aim, namely to increase overall competition among professional cycling teams. In particular we show that the pattern of non-competitive behavior displayed by race teams is the result of a poorly designed Pro Tour licensing assignment procedure. Empirical findings confirm that teams put forth low effort in a high percentage of tour events, reserving their greatest effort for races organized in their home countries. This less-than-optimal performance pattern is the result of an organizational design that focuses solely on financial requirements and does not include incentives related to race performance. The study concludes with the recommendation that the current "closed league" organizational structure be replaced with a relegation system.

Keywords: sport economics, professional cycling, oligopolistic competition

Introduction

Although cycling was one of the first sports to be practiced professionally, until very recently, it has received almost no attention from sports economists.[1] The minimal attention academics have paid to professional cycling is somewhat surprising, given the popularity and financial dimensions of major cycling events like the *Tour de France* and the *Giro d'Italia.*

The Union Cyclist Internationale (UCI) has been essential to the development of cycling. Established in 1900, the UCI has grown into the preeminent administrative and regulatory body in international cycling. In 2005, the UCI Pro Tour was established to provide a well-organized racing circuit that would bring together the best riders and best teams in the world for major one-day and stage races.

The objective of this paper is to investigate the changes induced by the establishment of this new racing series using a theoretical model and empirical findings observed during the 2005 and the 2006 season. With a simple microeconomic approach, we study the behavior of the racing teams before and after the introduction of the UCI Pro Tour. We develop an oligopolistic model starting from the well-known Cournot framework to determine why the actual setting of the UCI Pro Tour fails to reach its main aim, namely to increase overall competition among professional cycling teams. In particular, we show that the blamed regional concentration of their race participation, which we detect empirically even for the 2005 and 2006 seasons, depends on a lack of incentives stemming from the Pro Tour license assignation procedure. As we will illustrate, this is based only on financial requirements and does not consider any race performance results. Therefore, teams still concentrate their effort on a few, mostly nearby races, as they did before the Pro Tour, and do not contribute to an active competition over the whole season. The validity of our theoretical approach is confirmed by the analysis of empirical data concerning the racing teams' race results in 2005 and 2006. As a recommendation for future improvements, we derive from the model the need for a relegation system for the Pro Tour teams. The "American" team sports model of a closed league seems inappropriate for the European sociocultural environment.

This paper is one of the first academic approaches to professional cycling in economics. Although sports economics in general has developed into an important branch of economic science (see Andreff, 2006, for a recent overview), most of the effort is devoted to team sports. There are a large number of papers and books that focus on European professional football (e.g., Dobson & Goddard, 2001, and the special issue of the *Journal of Sports Economics* in February, 2006), as well as major league sports in the U.S. (e.g., Fort, 2003; Schmidt & Berri, 2005).

Among individual sports, professional golf has probably been the most intensively examined (see Shmanske, 2004, for a comprehensive survey). In contrast only a relatively few papers have focused on other individual sports at the professional level, such as tennis (e.g., Magnus & Klaassen, 1999), triathlon (Sowell & Mounts, 2005), and road running (e.g., Lynch & Zax, 2000). Very few attempts have been made to study cycling: Tondani (2005) examined the role of rankings in professional cycling, while Prinz (2005) and Torgler (2007) analyzed the determinants of success at a specific race, the *Tour de France*.[2] Another recent paper, by Cherchye and Vermeulen (2006), studied an alternative ranking methodology, applying it to *Tour de France* cyclists. Finally, Desbordes (2006) provided an overview of the commercial structure of pro cycling with a particular focus on France. Because of the lack of economic research, one has to rely on other disciplines, like sociology (Jutel, 2002; Brewer, 2002) and history (Rabenstein, 1996) for relevant work on professional cycling.

An Economic Spotlight on Professional Cycling

Historical overview

Cycling was one of the first sports practiced professionally. A few years after the bicycle was patented in 1817,[3] races offering prize money were organized across Europe. One of the earliest official races, with 1,000 marks prize money, was arranged by the *Münchener Bicycle-Club* in May 1886, with participants from Germany, England, and France. During the first decades, road cycling was run mainly by full-time professionals employed by bicycle firms, which used the competitions as promotion events (Rabenstein, 1996; Schröder, 2002). Besides prize money, riders received (not opulent) fixed salaries and technical equipment, and, in exchange, the sponsors' names were displayed on their jerseys. The first "non-cyclistic" sponsors appeared in 1953 (*Nivea*) and 1954 (*St-Raphael* – alcoholic beverages), causing considerable controversy (Brewer, 2000, p. 282).

Beside road races, indoor competitions were staged. In 1896, Madison Square Garden in New York City hosted a six-day race. In the 1890s, technical innovations like the pneumatic tire allowed the establishment of the first long-distance competitions, like the *Paris-Bordeaux* (577 km) in 1891. Some races still in existence on the UCI Pro Tour, like the *Liege-Bastogne-Liege*, *Paris-Roubaix*, and *Milano-Sanremo* came into existence around the end of the 19th century. Stage races play a predominant role in

cycling, particularly three major three-week stage events. The *Tour de France* was first organized in 1903. Sixty cyclists took part in the six stages, competing for 6,075 francs prize money. The first *Giro d'Italia* took place in 1909, offering 5,325 lire prize money. Finally, the *Vuelta a España* was established in 1935.

The history of cycling is also accompanied by the history of cycling organizations. The first national federations were founded in the late 19th century (e.g., the *Bund Deutscher Radfahrer* 1884 in Germany). In 1900 the federations of Belgium, France, Italy, Switzerland, and the USA founded the *Union Cycliste Internationale* (UCI) in Paris, which was intended to be the superordinate entity for regulating, administering, and promoting the sport. In 1965, under pressure from the International Olympic Committee, the UCI established two subsidiary branches: the Federation Internationale Amateur de Cyclisme (FIAC) and the Federation Internationale de Cyclisme Professional (FICP). The FIAC was dominated by Eastern Bloc nations whose cyclists were wholly amateur competitors. The FIAC controlled access to the Olympic Games and allowed FIAC cyclists to compete against FICP members only on rare occasions. After the admission of professional athletes to the Olympic Games in 1990, FIAC and FICP were reunified within the UCI in 1992.

In 1984, a ranking system was implemented and a few years later, in 1989, the 10 major one-day races were grouped together to form the World Cup.[4] The introduction of rankings had a profound impact on professional cycling. Invitations to single events were made according to the UCI ranking points, which led to major changes in racing behavior and increased the level of overall competition. Because collecting points was essential for participating in major events like the *Tour*, which were of high public interest and, therefore, important for the sponsors, teams began to abandon the traditional strategy with one captain surrounded by water-carriers. They assumed a more aggressive race behavior, with more team members entitled to pursue their own winning chances.[5]

The UCI Pro Tour

In 2005, the UCI ranking and the World Cup were replaced by the new UCI Pro Tour. The Pro Tour is a race series including the 27 most important races of all types (stage races, one-day races, a team time trial, and the World Championship). Cyclists collect points throughout the year on the basis of their performance. The points are accumulated over the course of the World Cup events to determine the season's best racer.[6] Although establishing an overall ranking is one the major aims of the Pro Tour, other objectives include:

- to force teams and cyclists into a more homogeneous race participation in a temporal and geographic sense. This serves to avoid the historical phenomenon of racers concentrating on competitions in their home countries (or in the sponsor's home country). In some cases, as in the case of Lance Armstrong, there has even been a tendency to restrict one's season around one big event, reducing the competition time to two or three months. This trend has risen during the last years, probably because of increased competition.
- to reduce the planning and financial uncertainty of the teams by guaranteeing participation in each major event. Before the Pro Tour, the organizers of the three major three-week stage races had almost complete discretion over what teams were invited to participate in their events. Being excluded from the Tour de France could cause serious repercussions with sponsors. Under the UCI's system, every Pro Tour team has considerable incentive to participate in every race of the series.

The teams must apply for a Pro Tour license, which is limited to 20 teams and is in effect for four years, costing EUR 100.000 (UCI, 2006). Additional fees are to be paid for each race. Each Pro Tour Team must participate in all Pro Tour races and must employ 25 riders. Also, race organizers are required to apply for a Pro Tour license, with a maximum of 30 events being licensed per year. The UCI system comprehends two lower categories, the *Continental Pro Teams*, which can be invited to Pro Tour races, and *Continental UCI-Teams*. No promotions or relegations are allowed for.

Economic structure of professional cycling

An empirical assessment about the economics of professional cycling is hampered by the fact that there is almost no data available about cyclists' salaries or even team

budgets. The absence of economic information is particularly pronounced in professional cycling, where corporate sponsors are not subject to disclosure requirements as in European professional football. Prize money available from race organizers does not play the same role as in tennis or golf (Ehrenberg & Bognanno, 1990), because instead of the prize monies going to individual winners, in cycling prize monies are distributed equally among all team members. Nevertheless, we will briefly review revenues and expenditures of a professional cycling team to illustrate the economic dimension of modern pro cycling.

Cycling revenues are derived almost entirely from corporate sponsors. This takes mainly the form of team sponsoring with the teams adopting their sponsors' names. The enterprises involved are of various kinds. There have been international corporations (*Motorola, Panasonic*) as well as small enterprises (*Mapei, Fassa Bortolo*) engaged in professional cycling. In recent years, a growing interest from the financial sector is observable.[7] Individual sponsoring contracts are often limited to equipment support, with a few exceptions for superstars like Lance Armstrong, whose sponsor revenues in 2005 were estimated to reach USD 10 to 12 million (Whittle, 2005), or Jan Ullrich, whose endorsements were likely to bring him EUR 4 to 6 million in the same year.

Generally, prize money associated with pro cycling tour events is considerably lower than in other professional sports. Only the major events provide noticeable sums. In 2006, the *Giro d'Italia* offered a total purse of EUR 1.4 million in prize money, while the *Tour* reached slightly more than EUR 2 million, with EUR 450,000 going to the overall winner. The amounts decrease sharply in competitions of medium importance like the *Deutschlandtour*, for which the overall winner in 2006 received only EUR 14,000.[8] A tradition in cycle racing is for the prize money to be distributed equally among team members after each race. By doing so, the captain thanks his teammates for their assistance and teamwork.

Broadcasting revenues play a crucial role in financing modern sports. In professional European football, revenues from selling TV rights have become the most important source for the clubs (Deloitte, 2006). Professional cycling has a long tradition as a TV sport, although it suffers from its non-telegenic, long events and disadvantageous competition times in the afternoon. The broadcasting interest in traditional cycling countries like Italy, Spain, France, and the Benelux is high and stable for major events.[9] It decreases dramatically in other European countries like the United Kingdom, where pro cycling receives very little media coverage. Outside Western Europe, pro cycling is at the margin of public interest. In the United States, Lance Armstrong contributed with his compelling biography and outstanding success to gain considerable individual popularity. But, Armstrong's celebrity status had very little impact on cycling in general. Cycling is still almost absent from major TV sport channels.[10]

Unfortunately, no reliable data on broadcasting revenues for cycling events are available. These revenues are usually not distributed among the teams but are retained by the organizers. This is a highly controversial point, with many team managers hoping to establish a new sharing system, possibly with the help of the new Pro Tour.

The teams' expenses consist of participation fees, operating costs, which are not negligible in pro cycling, and salaries. Racers are usually employed directly by the team manager (e.g., Olaf Ludwig for *Team T-Mobile* or Bjarne Riis for *Team CSC*), who sets up a company (e.g., the *Olaf Ludwig Cycling GmbH*) financed by the team sponsor and pays the racers' wages.[11] In Germany, drivers are usually self-employed, whereas in other countries (France, Italy, and Spain) they have regular salaried positions with the teams.

Because salary data are not available from the teams, one has to rely on estimates to provide some empirical evidence. Up until the '80s, only team leaders were relatively well paid, while "servants" (*gregari*) often had to rely on prize money to cover their living expenses. The signing of the first million-dollar contract by Greg LeMond[12] in 1985 induced a sharp rise in riders remuneration, which affected even the water-carriers' wages. Today, a good sprinter like Oscar Freire, who is supposed to ensure his team prestigious victories at one-day races during a season, earns around EUR 1 million a year. Potential stage-race winners like Andreas Klöden, Ivan Basso, and Roberto Heras range between EUR 1.2 million (Klöden) and 2 million (Heras). The wages can even be higher in cases of top stars like Jan Ullrich or Lance

Armstrong. Salaries for *gregari* vary in Pro Tour teams between EUR 100,000 and 300,000 and are highly dependent on their previous experience and results, as well as on the teams' budgets. To protect lower categories riders and new professionals, the UCI has established a minimum wage (UCI, 2006). This has to be equal to the minimum wage of the country of employment or be not less than EUR 30,000 a year (EUR 24,000 for a new pro).

Overall, the annual team budget for a Pro Tour team varies from EUR 3.3 million to EUR 18 million. The team budgets for the 20 Pro Tour teams are reported in Table 1. On one hand, we observe significant differences between "rich" (*T-Mobile, Rabobank*) and "poor" teams (*Liquigas, Saunier Duval*). On the other hand we notice a significant rise in the absolute budgets amount and in the gap between rich and poor from 2004 to 2005, coinciding with the introduction of the Pro Tour. However, one should not draw too far-reaching conclusions. For a substantiated assessment of whether this growing financial basis is due to the changed institutional setting, we need further details about the teams' budget structures.

Table 1. Pro Tour Team Budgets from 2003 through 2006

Teams*	Budget 2003 (Mill. EUR)	Budget 2004 (Mill. EUR)	Budget 2005 (Mill. EUR)	Change 04-05 in %	Budget 2006 (Mill. EUR)
Ag2r Prevoyance					7,3
Astana					7,5
Bouygues Telecom		n.a	7		7
Cofidis	6	8	8	0	8
Crédit Agricole	5	5.5	6	+9.1	6
Team CSC	4.5	6	6	0	7
Davitamon-Lotto	6	6	6	0	6
Discovery Channel	6.5	7	8.4	+20	8,4
Domina Vacanze	2.5	7	6	-14.3	
Euskaltel-Euskadi	5	6	6	0	5
Fassa Bortolo	5.5	6	9	+50	
Francaise des Jeux	6	5.5	6.5	+18.2	6,5
Gerolsteiner	6	8	12	+50	7
(Caisse d'Epargne –)					
Illes Baleares	6	5.5	6.5	+18.2	6,5
Lampre-Caffita/Fondital		5	n.a.		6
Liberty Seguros	6	6	8	+ 33.3	
Liquigas-Bianchi			5		5
Milram					6
Phonak	n.a.	7.7	10.5	+36.4	8
Quick Step	7.5	8	9.3	+16.3	9,3
Rabobank	6	9	15	+66.7	10
Saunier Duval-Prodir		3.5	3.3	-5.7	3,8
T-Mobile Team	9	12	18	+50	15

* In some cases, the main team sponsor changed over time (e.g., from *US Postal* to *Discovery Channel*).

Source: A.S.O. 2002-2006, various media releases.

Peculiarities of professional cycling

Prior to providing a theoretical analysis of professional cycling, one has to bear in mind peculiarities that distinguish this sport from others:

- The most distinctive feature of professional cycling is that although it is an individual sport, racing events are conducted in a team context. It is neither a pure single sport, like golf, tennis, or athletics, which can be analyzed using tournament models, nor a classical team sport like football or basketball. The professional cyclist acts as a single racer but is highly dependent on his team. This is obvious in special team contests like team time trials, but concerns every race situation, especially during a stage race. Every squad consists of one or a few captains and a number of "servants," called domestiques or gregari. The single members of the squad have well specified duties: tactical ones like avoiding breakaways or starting sprints, and even very simple ones like delivering food and water to the captains. Without a strong team, even superstars can hardly win a major event.[13] This particular social organization has characterized cycling from the beginning, creating the rather unique figure of the gregari: professional sportsmen who spend their whole careers not pursuing their own personal success but helping their team leaders to win.[14]
- Cycling events are unique, with significant differences between single races and types of races (stage and one-day races, time trials, mountain stages). These differences are much more pronounced than for other sports. A 100-meter sprinter does more or less the same act his or her entire career. In the case of tennis and golf, the surface and the shape of the course, respectively, may change. In cycling, however, winning a stage race is something completely different from succeeding in a "classic" one-day event like the Milano-Sanremo, and time trials require different skills than a mountain stage does.[15] A great finisseur like 2005 world-champion Tom Boonen does not have a ghost of a chance during mountain stages and ends such races often beyond the 100th position. Although they can specialize, during their careers cyclists have to compete in every kind of race. The search for the "overall best racer" is an old dispute among cycling fans and is one of the intentions of the new UCI Pro Tour.
- Professional cycling is considered the most physically demanding sport. The three-week stage races, especially, require almost super-human efforts from the riders. A portion of the stages, normally about one third, are held in the mountains. During such a mountain stage a rider burns 8,000-10,000 calories (Prinz, 2005) and often has to repeat a similar effort the next day because mountain legs are often grouped together . In total, a major three-week stage-race like the Tour or the Giro consists of 21 sequential stages with only two days of rest. Athletes also face a high number of competition days, up to 100 in one season, unlike in other endurance sports such as a triathlon or marathon. During a year, a professional cyclist covers a distance of 35,000-40,000 km in training and competitions. These exertions have a positive externality in generating high incentives for technical and medical research. There is nevertheless also a negative externality in form of high incentives for doping.[16]
- Although in most team sports the major aim of the participants is to win the whole series (e.g., a Bundesliga season or the FIFA World Championship in football), the newly established Pro Tour does not have a similar importance. Prevailing in the overall Pro Tour does still not constitute the main goal of the teams and cyclists. Winning single races, especially the major three-week stage races, is the primary goal of race teams and their corporate sponsors.
- An empirical/financial peculiarity is the fact that road cycling is an outdoor sport practiced on public ground. This implies that no gate revenues can be taken into account for organizers to finance themselves and distribute them among the racing teams. Although mega-events like the Tour de France attract millions of spectators along the streets every year, this does not lead to any revenues for the organizers.[17] They take in revenues from selling broadcasting rights, merchandising activities, and direct sponsor-

ing.[18] The major stage races demand furthermore a fee from cities willing to host a stage. London, for example, paid £ 3.6m to host the 2007 prologue of the Tour.

Starting from these preliminary observations, our leading question will be: Is the newly introduced UCI Pro Tour the best organizational setting, ensuring optimal incentives for cyclists and teams, or does it need to be reformed?

The New UCI Pro Tour – A Theoretical Analysis

Establishing the new Pro Tour in 2005, the UCI opted for the constitution of a closed league. Two controversial topics arise from this choice, which need a theoretical justification: (a) the optimal number of teams in the Pro Tour league, and (b) the preference for a closed league rather than for a system of promotions and relegations. We discuss these controversial issues in the next two sections.

The optimal number of teams

The choice of the optimal number of teams should take into account mainly the congestion problem: this number cannot be infinite in a single race, as the number of firms should be, in a theoretically perfect competitive market. The UCI rules limit the total number of cyclists in a race to 200, including racers from teams outside the Pro Tour, which can be invited by local organizers. Of course, the number of teams could be increased by lowering the number of teammates. But, as stated above, the "production function" incorporates a strong labor division inside the teams, which makes it quite difficult to follow this option.[19]

Moreover, in choosing the optimal size of the league, it is necessary to preserve the homogeneity of the product offered on the market. As in other sports, the competitors produce an indivisible joint product (Neale, 1964). Introducing more teams that are not able to supply a product of a level adequate to the expected standards leads to a lower competitive balance. In professional cycling, those considerations matter much more than theories like those of, among others, Vrooman (1997). He suggested—following James Buchanan's theory of clubs (Buchanan, 1965)—that members have a joint interest in total revenues generated by the club. Hence, the individual optimum is to set the league at the number of teams such that the average revenue per member is maximized.[20]

Determining the optimal size of the Pro Tour league exactly would require a different theoretical approach and is not the main aim of this paper. Nevertheless, we can observe that, in professional cycling, teams seek to win single competitions rather than the top ranking of the overall Pro Tour. Hence, joining the Pro Tour league is not an objective but a means for the teams to participate in the main races, in order to try to win the ones that their sponsors regard as "strategic" for their brand. This implies a differentiation of teams' effort in the single races, which takes into account that only a small number of Pro Tour teams are actually interested in winning a specific race. The main consequence of this behavior is an undesirable decrease of the competitive balance, leading some commentators to the opinion that a twenty-team league is over-dimensioned.

Many specialized sport magazines (e.g., *La Gazzetta dello Sport*) have commented that in competitions like the *Giro d'Italia* or the *Vuelta a España* the effort spent by several teams had been significantly lower than possible, so that enrolling minor league teams, more motivated and interested to perform well, would have raised the competitive balance.[21] The trade-off between limiting race entries strictly to Pro Tour teams interested in spending effort only in selected races and the inclusion of smaller teams who would relish the opportunity to compete leads us to the other issue: the closed league.

The choice of the closed league

The structure of a closed league seems at first glance to be inconsistent with the peculiarities and the tradition of professional cycling, a sport that was born and practiced mainly in Europe and never largely developed in the United States. However, the league setting of the Pro Tour seems to reflect American closed leagues like the NBA or NFL.[22] Why this choice? Several "political" reasons have been mentioned under the earlier section, "The UCI Pro Tour." A theoretical support could be that a system with promotions and relegations may generally not be profitable for pro cycling teams: like other sport teams, they

operate in a local market (e.g., for sponsorships) and in a larger market (e.g., for broadcasting rights). As argued by Noll (2002), in both cases the demand for the team's products depends on their quality, the quality of the team's opponents, and the team's tradition. Moreover, demographic characteristics and the economic framework of the hometown are relevant especially for local products. This means that teams in better markets will have *ceteris paribus*, a higher marginal revenue product of increments to the team quality, because the improved squad will generate a higher demand than it would in a less populous or wealthy market. Hence, teams operating in the good locations generally have a higher optimal quality than teams in bad ones. A system of closed leagues ensures the most uniform distribution of teams, in terms of their markets, among the divisions, guaranteeing the highest competitive balance in each of them.

However, we regard this theory as not adoptable to professional cycling for several reasons. First of all, pro cycling is not properly a team sport but an individual sport practiced in a team context. The center of interest is the single racer, not the team, as shown by the fact that cycling racing squads do not have the same characteristics of football or basketball teams, like a long history linked to a name, a headquarters (or a stadium) that identifies the team with a specific town, and so on. Hence, the importance of the local market is marginal, at least at the professional level, while the national market loses the great part of its importance when the main sponsor is a multinational firm.[23] Supporters are usually linked to the nationality of the single rider, not to the team; in some cases fan support can even cross national borders, making riders markedly appreciated abroad. Moreover, as stated previously, gate revenues, which constitute the primary source of local revenues in many team sports, do not exist in pro cycling, and the broadcasting rights are in many cases completely retained by the race organizers.

The absence of a local market rules out the question of whether the relegation of a team from a big town (or country) and the promotion of a team from a small market represent a net decrease of social welfare, as supposed by Szymanski (2003). The guarantee that in every season the best teams compete in the most important races and that every team should avoid relegation rather increases competition and disincentives opportunistic behavior and position-rents.

The individual nature of cycling also diminishes the extent to which promotions and relegations reduce the outcome uncertainty (competitive balance), thereby lowering the demand for other teams of the league. This follows from the assumption that the relegated teams are of a relatively higher quality than the average quality of teams in the lower league. In pro cycling this phenomenon should not arise: good racers will not compete in a league lower than the Pro Tour, even if their teams get relegated. Since the teams' strength is almost exclusively due to individual quality, the free cyclists' market would allow maintaining an optimal allocation of talents in the leagues, even if teams are relegated or promoted.

Hence, most of the reasons that support the choice of a closed league do not apply to professional cycling. In this framework, the Pro Tour assumes the form (and the undesirable characteristics) of an oligopoly.

Rents and competitive balance in an oligopolistic setting

In order to describe the oligopolistic structure of the UCI Pro Tour, we focus on a static model in which:

1. There is only one period of competitive interaction.
2. Teams perform their actions simultaneously.
3. Competition is limited to the case of only two teams.
4. Exogenous factors, like weather conditions or other circumstances, which are not under control of the teams, do not affect the final outcome.

In particular, we are interested in exploring the outcome produced by an oligopolistic setting like the one introduced by the UCI and to propose eventual corrections. The standard oligopoly theory[24] provides different results. We first take into account the Cournot approach (Cournot, 1838).

Readapting this model to the framework of professional cycling, we consider two teams, A and B. Each of them decides *ex-ante* (before the start of the season) on the effort q they will produce during the competition. The aggregate output $Q = q_A + q_B$ represents a measure of the competitive balance of the Pro Tour: the higher each

single , the higher will be the intensity of the cycling competition.

To produce a unit of effort q, a team sustains a cost $c(Q) \equiv c(q_A + q_B)$, where c is increasing both in q_A and q_B, because a higher effort of the opposing team B would force team A to increase its own endeavor to compete for the victory. The teams have a positive revenue r per unit of q, which represents the positive return for each team in terms of sponsors' reputation, brand visibility in the media, popularity obtained by hiring famous cyclists, etc. Therefore, the difference between r and $c(q)$ corresponds to a rent for the team, consisting in the net return for the sponsorship by competing in Pro-Tour races.

Under this assumption, team A's maximization problem given team B's expected effort is:

$$\underset{q_A>0}{Max}\ r \cdot q_A - c(q_A + q^*_B)q_A. \quad (1)$$

The first order condition will be:

$$r = c'(q_A + q^*_B)q_A + c(q_A + q^*_B). \quad (2)$$

In equilibrium, the best-response correspondence of the two teams will be

$$r'(q^*_A) = c'(q^*_A + q^*_B)q^*_A + c(q^*_A + q^*_B)$$
$$r'(q^*_B) = c'(q^*_A + q^*_B)q^*_B + c(q^*_B + q^*_B) \quad (3)$$

Generalizing to the case of n teams, for the i-th team we obtain:

$$r = c'(Q)q_i + c(Q). \quad (4)$$

The first order condition now reads:

$$r = c(Q)\left[1 - \frac{1}{\varepsilon(Q)/s_i}\right]. \quad (5)$$

where $s_i = q_i/Q$ is the fraction of the total competitive effort produced by the i-th team and $\varepsilon(Q)$ is the elasticity of the cost c to an increase of the total competitive effort Q. In a perfectly competitive framework s_i tends to zero, while in the (theoretical) presence of only one team holds $s_i = 1$. Hence, in an oligopolistic framework the presence of a finite and fixed number of teams does not ensure a competitive outcome, since the revenue r is always bigger than the cost c sustained for producing effort. A gradual reduction of the teams' rents is observable when their number increases, but the size problems discussed previously (under "The optimal number of teams") do not allow for a league that enrolls an infinite number of teams. We discuss this problem under "Empirical Verication." Before doing so, it is useful to investigate the factors that affect the effort decisions in an environment that is not purely competitive.

Disutility and differentiation

Up to now we were interested in determining the optimal choice of the effort level q for each team. This choice concerns the races included in the Pro Tour calendar as a whole. The next step of the analysis is to investigate the distribution of competitive effort among the single competitions. It is unlikely to assume that the teams spend the same level of effort in each of the races. More likely, once having planned the overall level of q, they distribute it according to different preferences on the single races. Notice that the main objective for the teams is to win the single races, while the participation to the Pro Tour is the only way to access these events. The Pro Tour races, as discussed above, are different concerning the skills and the abilities they require to compete for the victory. Because the teams must participate in all races, we can expect that the management of each team will concentrate the effort on particular kinds of races, while attending the other competitions without any substantial aim of victory or good performance. The management depends strongly on the sponsor, from which the team receives almost its entire budget. Therefore, even the specific skills of the hired cyclists will reflect the sponsors' interests. The management will prefer riders able to compete in races regarded as important by the sponsors (e.g., because of their prestige or their location in their home markets).[25]

To formalize this idea, we readapt the classic model of product differentiation of Harold Hotelling (1929), including an additional assumption to the four listed under "Rents and competitive balance": The teams spend different efforts across single races.

This assumption implies that every team's performance is affected by a certain disutility $t>0$ per unit of distance d from the race location to the center of business of the team. The distance d can be interpreted in several ways. The main interpretation can be the geographic distance: for instance, a Spanish team may show little interest in competing in the *Tour of Poland*. Otherwise, distance

may also be interpreted as an hierarchy of objectives. Again, a Spanish team will evaluate the *Tour of Poland* as less interesting for the sponsor than the *Vuelta a España*, which starts only few days after the Polish competition. Or it will decide to present its best cyclists at the *Tour of Basque Countries* rather than at the *Tour of Flanders*, events that are contemporaneous on the cycling calendar.

In this framework the net effort spent by a team will be q-td. Moreover, we take as indicator of the effort spent the amount of points P available in every race for the first n cyclists ranked at the arrival. Implicitly, this means that points are allocated according to the function $P(q)$: the higher the effort spent, the higher will be the number of points earned. The function $P(q)$ is continuous and has a positive slope such that $P'(q)>0$ and there exists a $q^*<\infty$ such that $P(q)=max$ for each $q>q^*$. The presence of the disutility introduces a differentiation between the behavior of two teams because they may now strictly spend more effort in one race than in another.

Readapting the model developed by Hotelling (1929), we assume the races and teams are located on a market structured as a linear segment, with the teams lying at the two extremes and the race located at the point x. The points available will be won by team A if its location holds $q_A-tx>q_B-(1-tx)$. The location of the race in which the two teams present the same level of effort is the point x^*, where $q_A-tx^*=q_B-(1-tx^*)$ or

$$x^*=\frac{t-q_B+q_A}{2t} \tag{6}$$

In every race team A's points at the end of the race will equal:

$$P(q_A, q_B)=\begin{cases} P(q_A) \text{ if } q_A>q_B-t \\ (t-q_B+q_A) \text{ if } q_A \in [q_B-t;q_B+t] \\ 0 \text{ if } q_A<q_B-t \end{cases} \tag{7}$$

Thus, because each team searches for its best response to any effort choice of the other team, team A restricts its effort to the range $q_B-t;q_B+t$ because any effort $q_A>q_B+t$ yields the same number of points as setting $q_A=q_B+t$ and any effort $q_A<q_B-t$ yields zero. Thus, if the second equation of (7) is the stable solution, team A's best response solves

$$\underset{q_A}{Max}\ (r-q_A)\cdot(t-q_A+\bar{q}_B)\cdot\frac{q}{2t}\ s.t.\ q_A \in [\bar{q}_B-t;\bar{q}_B+t] \tag{8}$$

Omitting the proofs, the equilibrium that arises is then $q_A+t=q_B+t=r$.

In this equilibrium, if the disutility t tends to zero, we obtain a competitive outcome, while in the other direction, when disutility increases, a departure from it is observable. Hence, the simple micro-economic model captures the particular behavior of pro cycling teams varying their effort accordingly to their preferences and shows that even under such a (realistic) assumption the model moves toward an equilibrium. Remember that avoiding this behavior was one of the main goals of the UCI Pro Tour. The formalization helps us also to set up an empirical analysis to test whether this goal was achieved or not. This will follow in the next section.

Empirical Verification

The main result of the preceding material is that even in the case of the UCI Pro Tour an oligopoly does not provide a competitive market outcome. We found that a higher aggregate effort and a higher competitive outcome could be achieved only with a very high number of teams, which is not feasible due to the issues discussed under "The optimal number of teams." Moreover, we expanded the model including the aspect that the teams must participate in all Pro Tour races, which causes them a certain disutility resulting from the (geographical and reputational) distance from the sponsorship's aims.

In this section we present some proxy of competitive balance in the Pro Tour and an empirical investigation aimed at validating these theoretical findings. We do it by focusing on the two first editions of UCI Pro Tour (2005 and 2006) and examining the points collected by each rider in every race. The points scale for the single races are reported in the appendix. Then, we aggregate the individual points by team for each race. The races are aggregated by the host nation (with the exclusion of the *Tour de France* from French races) and, in some cases, also by kind of events. For instance, we aggregate all the "Northern Classics"[26] independently of the nation. Points have been normalized such that the figures in every box represent the percentage of the total point achieved by the specific team in the specific country.

Although there is well-developed literature for team sports,[27] a measure of competitive balance for professional cycling has not been developed yet in sports economics. In this paper we make a first attempt and set up some simple indicators that can work as proxy for competitive balance. First, we quantify it with a simple measure of entropy, which is

$$H = -\sum_{j=1}^{N} \frac{q_j}{Q} \log \left[\frac{q_j}{Q} \right] \quad (9)$$

where N is the number of teams, q_j are the points obtained by team j, and Q are the total points assigned. Such an index can vary in a range between 0 (no heterogeneity at all, hence perfect equilibrium among the teams) and $\log(N)$, which stands for maximum heterogeneity. In order to normalize the index in a range between 0 and 1, we can compute an index of relative entropy:

$$RH = \frac{H}{\log(N)} \quad (10)$$

In 2005, RH was equal to 0.9585; in 2006, it reached the value of 0.9592. Hence, the competitive balance in the Pro Tour has been very low in the two first editions of this challenge. Using other common inequality measures like the Q4/Q1-ratio reveals a slight rise in this competitive balance. The ratio between the points obtained by the top five teams and those of the last five decreased from 4.27 in 2005 to 3.93 in 2006. This means that from 2005 to 2006 inequality between the sub-groups of the weakest and the best teams slightly decreased. Of course, the changes are very small and the time period too short to draw further conclusions. Nonetheless, the result is somewhat disappointing because it does not indicate a clear tendency toward a strong and equal competition in the Pro Tour, which one might have expected after a closed league was established, with common financial rules and guaranteed race participation.

An analysis of the teams' behavior over time (Tables 2 and 3) shows that the idea that teams decide *ex-ante* the effort to spend in Pro Tour is in some way valid. Table 2 illustrates the percentage of races in which the teams did not obtain any points. Our starting point is the fact that in each race at least ten cyclists score at least one point; in stage races this number is even higher because of the points awarded in the single stages and the higher number of athletes awarded with points in the final classification.[28] Therefore, the percentage of competitions in which a team gets zero points is a good indicator for lower effort. Table 2 shows that the percentage of these "zero-points competitions" was on average 55.93% in 2005 and 45.74% in 2006. Even if the average decreased over time, it is observable that in 2005 the percentage varied from 85% to 29% and in 2006 from 66% to 26%, indicating different levels of effort. The comparison with Table 1 enforces our hypothesis, since the divergences between the teams' financial budgets are far lower than those shown in Table 2. Structural differences between richer and poorer teams can therefore not be seen as the only cause for the diverging results.

Moreover, the percentage of the points obtained by every team varies from 2005 to 2006 in the range of ±3%. Even if the mobility in the ranking, which varies in the range of ±6 ranking positions is slightly higher, Table 3 shows that the effort decisions are invariant over time, confirming the idea of an oligopolistic structure of the Pro Tour.

Tables 4 and 5 document the teams' behavior in the single races. In both, the third column shows the percentage of the total points obtained by every team, while the fourth one shows the Gini-index of the concentration of the points collected by the teams grouped by nations. The normalized points are displayed from the fifth column onwards.

We can observe from Table 4 that in 2005 nine teams out of 18 achieved the relative majority of their points in the race hosted in the country with which the team is affiliated (arrow).[29] Four other teams achieved the second-highest number of points in their home country (dot). Moreover, a concentration of effort on some particular events or groups of homogeneous events is observable (square). Furthermore, also in 2006 nine teams spent the main part of their effort in the races organized in their home countries (Table 4).

This is a first validation of the hypothesis that behaviors far from pure competition are encouraged by the current structure of the Pro Tour. In particular, teams put a larger effort in races organized in their home countries. It is possible to argue that the different effort can be explained

by the different kinds of races. For instance, one-day races organized in Belgium and the Netherlands require different skills than those needed to be competitive in the *Vuelta a España*. But if one considers that already the formation of the racing squads follows the particular national preferences for special kinds of competitions (one-day races in Benelux, stage races in Spain), the problem remains the same.

Moreover, the non-competitive behavior is stronger for the weakest teams. The scatter plots in Figures 1 and 2 show how these teams concentrate their effort in remarkably few races. The *x*-axis represents the percentage of the points achievable in the Pro Tour scored by every team. The *y*-axis represents a Gini-index that measures how concentrated are the points obtained by every team in few or more races. It emerges clearly that those teams that achieved more points relative to the total possible amount of points show a smaller concentration index concerning their race participation. The correlation index (equal to 0.73 in 2005 and to 0.54 in 2006) confirms the close connection between the two variables.

By aggregating the 20 teams by nationality (Tables 7 and 8), we can observe that in 2005, in five nations out of the seven that hosted at least one Pro Tour race, the local teams, in aggregate, achieved the relative majority of their points in local races (arrow). Again, a concentration of effort on some particular events is observable (square). The number of nations in which the local teams collected the relative majority of their points in local races decreased to two (Italy and Spain) in 2006, but this reduction is attributable to a larger mobility of the single cyclists outside the national borders.

This analysis is a first empirical attempt and bears significant shortcomings. First of all, basing the analysis exclusively on points, even if they are the best (and only available) effort proxy, does not consider the whole uncertainty of a sport competition, and in particular of cycling, like mechanical accidents, cyclists performance variability, etc.

The possibility of collusions, a typical element of oligopoly and a fundamental variable in cycling (Caruso, 2005), both in the weak form of the "tacit alliance" and in the strong form of money compensation, is not considered here. But this omission does not invalidate our findings. Collusion is a rational strategy when there is a strong asymmetry in the prize evaluation by the two colluders, for instance, when in a stage there are two riders in front and one of them is sure to wear the overall leader's jersey after the stage. In this case the rider has a low evaluation of the stage victory and renounces to dispute the final sprint. Another kind of collusion concerns the tacit decision of the main teams of not competing for the less important prizes (such as intermediate sprints, special rankings) with an implicit advantage for small teams. Both cases affect only marginally the outcome of final Pro Tour rankings that we used for our verification[30]

Table 2: Participation in UCI Pro Tour races scoring zero points

Teams	Races in which teams did not score any point (in % of all the races)	
	2005	*2006*
Ag2r Prevoyance	-	66,67
Bouygues Telecom	85,19	66,67
Cofidis, Le Credit Par Telephone	59,26	59,26
Credit Agricole	59,26	48,15
Davitamon-Lotto	59,26	48,15
Discovery Channel	55,56	29,63
Domina Vacanze	74,07	-
Euskaltel – Euskadi	74,07	59,26
Fassa Bortolo	40,74	-
Française Des Jeux	74,07	66,67
Gerolsteiner	33,33	37,04
Illes Balears - Caisse D'Epargne	66,67	48,15
Lampre – Caffita	55,56	25,93
Liberty Seguros (Astana)	40,74	48,15
Liquigas-Bianchi	48,15	44,44
Milram	-	51,85
Phonak Hearing Systems	44,44	51,85
Quick Step	29,63	25,93
Rabobank	51,85	29,63
Saunier Duval – Prodir	66,67	48,15
Team Csc	48,15	18,52
T-Mobile Team	51,85	40,74
AVERAGE	**55,93**	**45,74**

because it is very improbable to face cases of collusion for what concerns the final victory of the *Tour de France* or the *Milano-Sanremo*.

Neither is the effect of doping, a factor that can strongly affect sport contest outcomes, taken into account in this paper. This is an important limit and is the reason we did not extend our analysis to the results of 2007; a season in which doping scandals strongly interfered in races results through several suspension and disqualifications of involved cyclists.

Finally, single riders and their personal effort are supposed here to be ex ante homogeneous. But the cycling tradition of one country itself shapes, through the training methods and the selection in junior teams, particular kinds of riders. Cyclists from some countries have a better performance in one-day races rather than in stage races, while others perform well in stage races.[31] When they are grouped in teams homogeneous in nationality, this factor plays an important role, inducing some teams more likely to be successful in certain races than in others. Moreover, more sophisticated models could consider and tolerate an at least slightly major propensity to spend more effort in home races, independent of the team nationality, which would capture the long-lasting tradition of cycling events better.

Nevertheless, we conclude that the empirical investigation does not reject our theoretical results. It backs our intuition that the UCI Pro Tour needs some corrections in order to achieve a larger degree of efficiency without offsetting the peculiarities of professional cycling.

Table 3: Teams' points and rankings in the 2005 and 2006 UCI Pro Tour

Teams	Points (in % of total points)			Ranking		
	2005	*2006*	*diff*	*2005*	*2006*	*Diff*
Fassa Bortolo	6,14	-	-	8	-	-
Domina Vacanze	1,62	-	-	18	-	-
Team Csc	8,06	11,02	2,95	2	1	1
Discovery Channel Pro Cycling Team	7,89	7,72	-0,17	3	2	1
Liberty Seguros - Würth Team	6,92	7,63	0,70	7	3	4
Lampre - Caffita	5,09	7,12	2,03	10	4	6
Illes Balears - Caisse D'Epargne	4,65	7,11	2,46	13	5	8
Rabobank	7,68	6,96	-0,72	4	6	-2
Quick Step	8,06	6,60	-1,46	1	7	-6
Gerolsteiner	7,12	6,00	-1,12	5	8	-3
T-Mobile Team	7,11	5,20	-1,91	6	9	-3
Saunier Duval - Prodir	4,05	4,90	0,86	14	10	4
Davitamon-Lotto	4,91	4,33	-0,58	12	11	1
Liquigas-Bianchi	4,99	4,18	-0,81	11	12	-1
Euskaltel - Euskadi	2,45	3,79	1,34	16	13	3
Ag2r Prevoyance	-	3,65	-	-	14	-
Phonak Hearing Systems	5,80	3,47	-2,33	9	15	-6
Credit Agricole	2,94	2,79	-0,15	15	16	-1
Française Des Jeux	1,35	2,34	0,99	19	17	2
Milram	-	2,21	-	-	18	-
Cofidis, Le Credit Par Telephone	2,11	2,08	-0,02	17	19	-2
Bouygues Telecom	1,06	0,90	-0,16	20	20	0

Table 4: Points per team in the 2005 UCI Pro Tour

Teams		% of Total Points	GINI Index	Italy	France (without TOUR)	Switzerland	Poland	Spain	Germany	Benelux	World Championship	Tour de France	Giro d'Italia	Vuelta A Espana	Northern Classics
b	Quick Step	8.06	.410	12.79	12.21	7.63	0.00	17.37	13.55	25.38	9.54	1.53	1.15	4.01	22.52
dk	Team Csc	8.06	.562	9.54	23.66	5.73	0.00	15.46	0.95	28.44	0.00	6.22	2.67	10.69	4.96
us	Discovery Channel Pro Cycling Team	7.89	.550	21.44	21.83	1.95	5.07	10.53	0.00	12.09	0.00	27.10	17.54	0.78	10.72
n	Rabobank	7.68	.559	15.63	0.20	7.01	19.44	18.04	0.00	30.26	0.00	9.42	0.00	14.83	9.22
d	Gerolsteiner	7.12	.494	23.11	19.87	1.51	0.22	9.50	21.81	13.17	0.00	10.80	3.24	0.86	9.94
d	T-Mobile Team	7.11	.661	1.08	14.29	2.38	0.00	8.44	8.87	36.58	0.00	28.35	0.87	8.44	16.88
e	Liberty Seguros - Würth Team	6.92	.576	11.56	11.33	6.89	0.00	36.00	12.22	20.22	0.00	1.78	1.33	28.00	8.00
i	Fassa Bortolo	6.14	.588	19.05	17.79	6.27	12.78	0.25	8.52	34.59	0.00	0.75	6.52	0.25	41.60
s	Phonak Hearing Systems	5.80	.402	14.85	14.85	23.34	0.00	12.73	8.49	9.28	0.00	6.45	2.65	2.12	3.98
i	Lampre - Caffita	5.09	.439	35.65	12.69	12.39	9.06	9.06	8.16	8.16	0.00	4.83	22.96	0.00	6.04
i	Liquigas-Bianchi	4.99	.549	22.22	15.43	6.48	7.72	22.53	0.00	25.00	0.00	0.62	20.68	0.31	33.95
b	Davitamon-Lotto	4.91	.618	20.38	15.36	0.00	0.00	19.44	0.00	32.92	0.00	11.91	20.38	11.60	39.18
e	Illes Balears - Caisse D'Epargne	4.65	.622	13.25	14.24	0.00	0.00	37.09	0.00	1.99	13.25	20.20	13.25	18.21	1.66
e	Saunier Duval - Prodir	4.05	.735	16.35	20.91	0.00	0.00	47.15	5.70	9.89	0.00	0.00	15.97	0.76	0.00
f	Credit Agricole	2.94	.759	45.03	32.46	0.00	0.52	2.62	2.62	3.66	0.00	13.09	18.85	0.00	0.00
e	Euskaltel - Euskadi	2.45	.674	2.52	31.45	9.43	0.00	20.13	0.00	32.08	0.00	4.40	2.52	15.72	0.00
f	Cofidis, Le Credit Par Telephone	2.11	.721	31.39	0.73	11.68	0.00	10.95	0.00	40.15	0.00	5.11	8.76	8.76	26.28
i	Domina Vacanze	1.62	.774	34.29	0.00	26.67	0.00	0.00	0.95	38.10	0.00	0.00	34.29	0.00	28.57
f	Française Des Jeux	1.35	.670	22.73	0.00	5.68	35.23	3.41	0.00	26.14	0.00	6.82	0.00	3.41	12.50
f	Bouygues Telecom	1.06	.833	36.23	0.00	0.00	0.00	8.70	0.00	4.35	50.72	0.00	0.00	0.00	4.35

Table 5: Points per team in the 2006 UCI Pro Tour

Teams		% of Total Points	GINI Index	Italy	France (without TOUR)	Switzerland	Poland	Spain	Germany	Benelux	Tour de France	Giro d'Italia	Vuelta A Espana	Northern Classics
dk	Team Csc	11.02	.264	20.15	19.16	9.02	0.00	8.16	9.15	20.27	14.09	15.45	7.54	26.45
us	Discovery Channel Pro Cycling Team	7.72	.350	19.58	14.11	6.53	0.71	24.16	7.58	24.16	3.17	0.88	4.59	11.82
e	Astana - Würth Team	7.63	.567	10.36	2.14	33.21	0.18	44.82	7.50	1.79	0.00	17.86	0.36	3.21
i	Lampre - Caffita	7.12	.331	34.23	16.44	1.91	9.18	5.35	10.90	13.38	8.60	0.57	0.57	16.63
e	Illes Balears Caisse d'Epargne	7.11	.471	3.45	10.54	9.00	0.00	42.53	0.38	17.24	16.86	8.05	3.45	3.45
n	Rabobank	6.96	.299	21.53	19.57	4.70	4.89	1.96	9.00	17.81	20.55	0.00	0.98	0.00
b	Quick Step Innergetic	6.60	.502	40.41	12.58	1.44	0.62	2.06	9.28	28.87	4.74	0.00	0.00	12.37
d	Gerolsteiner	6.00	.257	19.95	15.42	5.67	13.15	4.08	11.56	23.13	7.03	0.00	0.45	6.35
d	T-Mobile Team	5.20	.440	4.19	15.71	4.45	0.00	14.14	2.09	26.70	32.72	0.00	5.24	4.19
i	Saunier Duval - Prodir	4.90	.572	26.67	10.00	11.94	0.56	48.61	0.28	1.94	0.00	0.00	13.89	26.11
b	Davitamon-Lotto	4.33	.379	9.43	4.72	25.47	13.21	4.72	0.00	12.58	29.87	23.90	0.00	8.81
i	Liquigas-Bianchi	4.18	.410	28.99	13.03	7.49	3.91	17.26	0.00	26.71	2.61	6.51	1.30	11.07
e	Euskaltel - Euskadi	3.79	.353	14.39	12.95	15.83	0.36	32.73	0.00	10.79	12.95	0.00	0.00	0.00
f	Ag2r Prevoyance	3.65	.531	3.73	33.96	0.00	0.00	23.13	2.61	1.87	34.70	0.00	19.40	3.73
ch	Phonak Hearing Systems	3.47	.525	39.22	1.18	6.27	2.75	35.69	4.31	10.59	0.00	5.10	28.24	37.25
f	Credit Agricole	2.79	.376	6.34	18.54	0.00	9.76	28.29	0.98	20.49	15.61	0.00	2.93	4.39
f	Française Des Jeux	2.34	.620	22.67	52.91	0.58	0.00	0.00	0.00	23.84	0.00	0.58	0.00	22.67
d	Milram	2.21	.432	31.48	0.00	5.56	0.00	18.52	22.22	18.52	3.70	4.32	0.62	0.00
f	Cofidis, Le Credit Par Telephone	2.08	.499	43.14	2.61	7.19	13.07	22.22	0.00	0.00	11.76	0.00	0.00	8.50
f	Bouygues Telecom	0.90	.667	0.00	15.15	0.00	1.52	68.18	0.00	0.00	15.15	0.00	0.00	0.00

Table 6: Points per nation in the 2005 UCI Pro Tour

Teams	% of Total Points	GINI Index	Italy	France (without TOUR)	Switzerland	Poland	Spain	Germany	Benelux	World Championship	Tour de France	Giro d'Italia	Vuelta A Espana	Northern Classics
Belgium	12.97	.453	15.66	13.40	4.74	0.00	18.15	8.42	28.23	5.93	5.46	8.42	6.88	28.83
Denmark	8.06	.562	9.54	23.66	5.73	0.00	15.46	0.95	28.44	0.00	16.22	2.67	10.69	12.79
France	7.46	.490	35.88	12.99	4.33	6.60	5.98	1.03	18.14	7.22	7.84	9.90	3.09	14.43
Germany	14.23	.486	12.11	17.08	1.95	0.11	8.97	15.35	24.86	0.00	19.57	2.05	4.65	18.81
Italy	17.83	.478	26.06	14.06	9.92	9.15	8.97	5.35	24.68	0.00	1.81	17.69	0.17	29.42
The Netherlands	7.68	.559	15.63	0.20	7.01	19.44	18.04	0.00	30.26	0.00	9.42	0.00	14.83	16.23
Spain	18.06	.537	11.84	16.95	3.92	0.00	36.63	5.96	14.82	3.41	6.47	7.84	17.72	5.20
Switzerland	5.80	.402	14.85	14.85	23.34	0.00	12.73	8.49	9.28	0.00	16.45	2.65	2.12	7.96
United States	7.89	.550	21.44	21.83	1.95	5.07	10.53	0.00	12.09	0.00	27.10	17.54	0.78	10.72

Table 7: Points per nation in the 2006 UCI Pro Tour

Teams	% of Total Points	GINI Index	Italy	France (without TOUR)	Switzerland	Poland	Spain	Germany	Benelux	Tour de France	Giro d'Italia	Vuelta A Espana	Northern Classics
Belgium	10.93	.297	24.92	8.65	13.46	6.91	3.39	4.64	20.72	17.31	11.95	0.00	10.59
Denmark	11.02	.264	20.15	19.16	9.02	0.00	8.16	9.15	20.27	14.09	15.45	7.54	26.45
France	11.76	.385	15.18	24.63	1.55	4.87	28.37	0.72	9.24	15.45	0.12	4.47	7.86
Germany	13.41	.231	18.54	10.38	5.22	4.38	12.25	11.96	22.78	14.49	1.44	2.10	3.51
Italy	11.30	.326	31.61	14.74	4.70	6.54	11.31	5.45	20.05	5.61	3.54	0.94	13.85
The Netherlands	6.96	.299	21.53	19.57	4.70	4.89	1.96	9.00	17.81	20.55	0.00	0.98	0.00
Spain	23.42	.434	13.72	8.91	17.50	0.27	42.17	2.04	7.94	7.45	6.48	4.42	8.19
Switzerland	3.47	.525	39.22	1.18	6.27	2.75	35.69	4.31	10.59	0.00	5.10	28.24	37.25
United States	7.72	.350	19.58	14.11	6.53	0.71	24.16	7.58	24.16	3.17	0.88	4.59	11.82

Figure 1: Concentration of the teams' participation, 2005

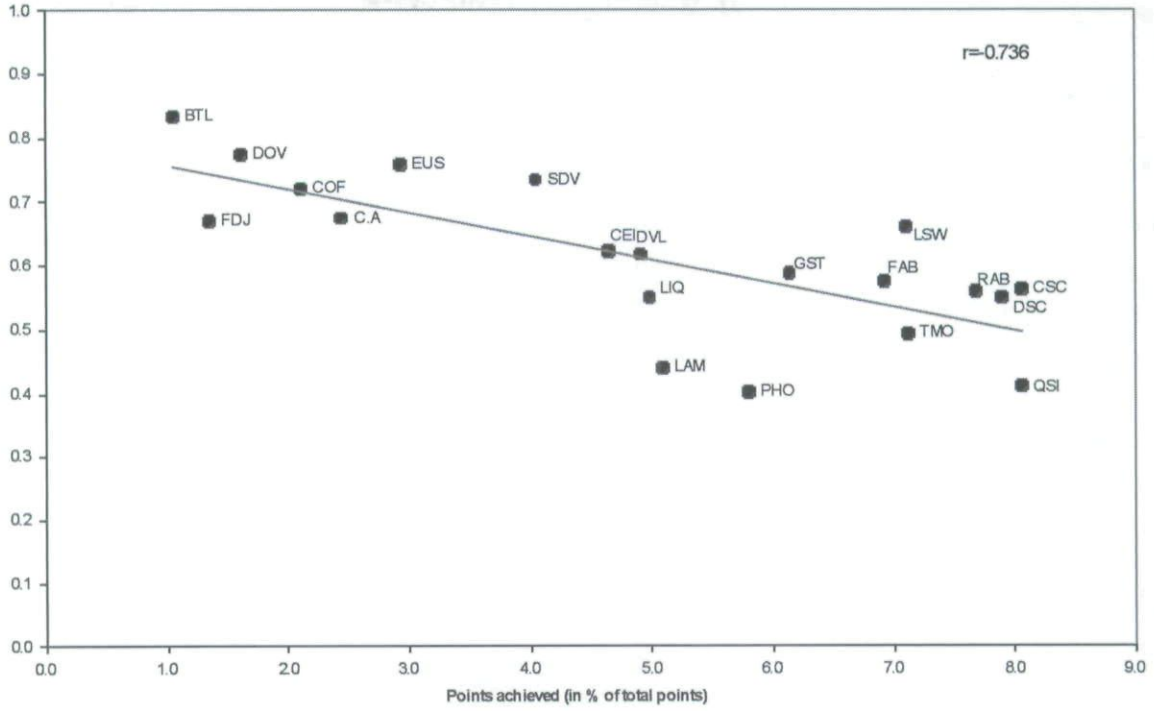
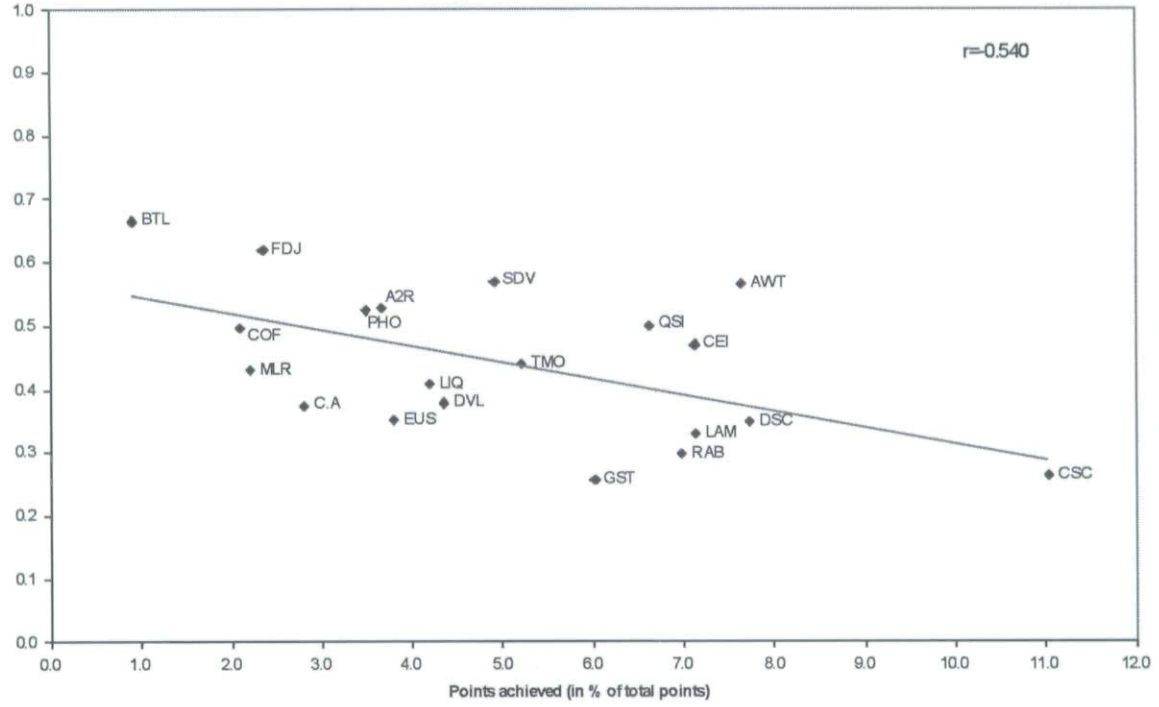


Figure 2: Concentration of the teams' participation, 2006



Efficiency Improvements

The introduction of a promotion/relegation system

The findings of the previous sections can be summed up in the conclusion that the current structure of the UCI Pro Tour suffers from typical competitiveness problems of oligopolistic markets. We will now discuss some possible improvements, developing them in the light of the theoretical framework developed earlier in the paper. As already shown, the most immediate solution would be to increase the number of teams in the league, but the problems of congestion and of the qualitative level of the collective good produced rule out this possibility.

A second-best strategy to avoid behaviors such as those depicted above, by reducing the rents and increasing competitiveness of the Pro Tour, could be the introduction of penalties. In particular, we propose that at the end of the season n teams should be dropped off the competition and substituted by an equal number of promoted ones that will compete in the new season.

Other studies mark the positive effect on effort caused by a promotion/relegation system. Szymanski and Valletti (2005) showed that such a system tends to enhance effort incentives, even if it diminishes the incentive to share income. The lower propension for redistribution is not a problem in our context, since up to now professional cycling teams did not have any revenue from the selling of broadcasting rights or other kinds of collective revenues to share. Noll (2002) also argued that the effect of this system is an increase of competitive balance in the top league among the member teams.

In our theoretical framework, the introduction of relegations induces the teams to maximize an objective function that includes not only one period of competition, as in equation 1, but also an evaluation of the outcome of the second period. This means that in season 1 a team will maximize its effort, taking into account the possibility of being relegated to the Continental circuit in season 2 with probability β, or in the Pro Tour with the probability $1-\beta$, with $\beta'<0$. The maximization problem for a team will be then:

$$Max\ rq_A - c(q_A+q^*_B)q_A + (1-i)\{\beta \cdot (Lr) + (1-\beta)[rq^2 - c(q^2_A+q^2_B)q^2_A]\} \quad (11)$$

where q^2_A represents the expected optimal effort in season 2 if the team remains in the Pro Tour, while i represents a rate of team preference. L_r stands for the loss occurring to the team in case it is relegated. L_r is not equal for all teams; it is rather a subjective parameter depending on the overall ability level. In a promotion/relegation system the loss incurred in case of relegation will be higher for those teams with a low ability. This is because in the closed league they could get a positive rent even if their overall ability was low, and now they must put more (costly) effort into competitions to avoid relegation. On the other side, teams with a high ability have a smaller L because changing over from a closed league to the relegation system does not lead to a need of augmenting effort to remain in the Pro Tour.

Hence, rearranging the first order condition for team A, the optimal level of points will be

$$q_A = \frac{r-c(q_A+q_B)}{c'(q_A+q_B)} + (1-i)$$

$$\frac{\beta'\cdot[L_r - rq^2_A - c(\cdot)q^2_A] + \beta[c(\cdot)+c'(\cdot)q^2_A - r] + r - c(\cdot)q^2_A - c(\cdot)}{c'(q_A+q_B)} \quad (12)$$

Note that from rearranging equation (3) we get

$$q_A = \frac{r-c(q_A+q_B)}{c'(q_A+q_B)} \quad (13)$$

Comparing (12) and (13), the optimal level of effort in the closed league will be lower than in a system with promotions and relegations. Equation (12) holds, if the second term of the right-hand side of (12) is positive. This constraint holds for a level of the loss such that

$$L_r > r\cdot q^2_A - c(\cdot)q^2_A + \frac{1-\beta}{\beta'}\cdot[(r-c'(\cdot)q^2_A - c(\cdot))] \quad (14)$$

Equation (14) provides a result of the introduction of relegation. The right-hand side of (14) represents the total revenues plus. If L_r is larger than the expected best-response correspondence in season 2, the team will increase its effort after the introduction of the relegation system. If not, the team will decrease its q. Hence, if the teams take into account the loss caused by possible relegation, the competitive balance of the Pro Tour will increase.

The implementation of an open league in UCI Pro Tour

From an operative point of view, we propose the relegation of three or four teams out of the 20 actually enrolled in Pro Tour.[32] Since the UCI did not implement a "second division" under the top league, but instead implemented a series of continental challenges, the promoted teams could be selected between the winners of those competitions.

Some secondary advantages could also arise from this reform. In particular, a broader recruitment of the promoted teams from various continental circuits could support the internationalization of professional cycling—a scope actually pursued by UCI—through the upgrade of non-European teams in the Pro Tour. Moreover, spon-

sors interested in financing a Pro Tour team could even "step in" earlier, investing money and time by supporting squads in continental challenges, thus trying to push them into the top league. This solution would be an indirect support for rising competition and interest toward smaller races, which since the introduction of the Pro Tour in 2005 have suffered from a lower presence of the main teams as well as of media and sponsors.

Nevertheless, several problems should be taken into account before introducing such an open league. First of all, the increased uncertainty would also be an obstacle for sponsors to engage, a problem well known from European football, where relegations are often accompanied by the loss of financial supporters. Furthermore, the severe financial requirements of the UCI for obtaining a Pro Tour license could constitute an obstacle for teams to accept a promotion. This issue is also well known from minor sports in Europe, like table tennis, volleyball, or in some cases even basketball, where successful teams refuse a promotion due to the impossibility of matching the increased costs in the top league. The UCI should therefore develop a more flexible license assignation procedure, also taking into account possible financial troubles of relegated teams. Shaping an optimal open league would be thus a challenging but worthwhile exercise that goes, however, beyond the scope of the present paper.

Conclusion

This paper has provided the first economic analysis of professional cycling and examined the effects of the newly introduced UCI Pro Tour on teams' and racers' behavior. We derived the need for some changes, especially the opening of the Pro Tour "closed league" by introducing a relegation system.

Because this is one of the first academic approaches to the topic, much work remains to be done. On the theoretical side, more complex models should be developed, starting from the peculiarities of professional cycling listed previously. One could study alternative organizational forms, or even the behavior of cyclists in contests, using game-theoretic models, for example. A good framework could be the model recently set up by Gershkov et al. (2007). Another interesting field is the application of the existing studies on doping to the particular case of pro cycling, as done in Strulik (2007).

Concerning empirical research, cycling offers good possibilities for effort/success studies (Prinz, 2005; Torgler, 2007), as the competitions' results have been well documented for decades, but there is almost no basis for financial and organizational analysis. Such an investigation of pro cycling requires at least some financial statistics to start from. Although salary data will probably remain difficult to access, at least the publication of detailed budget data of racing teams and race organizers should be possible. Here the transparency induced by the academic attention has contributed, in our opinion, to a greater financial discipline of the football clubs during the last years. Similar positive externalities could result from cycling studies, so the UCI should enhance the publication of financial data as well as other economic and organizational information.

Current developments indicate that the existing organizational structure of the Pro Tour is in fact perceived as not entirely satisfactory by teams and race organizers (e.g., see RSN, 2006). Organizers of the three major stage races have threatened a couple of times to abandon the Pro Tour, mainly because they fear losing control of their own events, particularly relating to the collection and distribution of broadcast revenues.

Therefore, several changes are expected to take place in the next few years. Evaluating

the impact of these changes presents academics with many exciting research opportunities. In a recent interview, T-Mobile team manager, Bob Stapleton, pointed out how underdeveloped pro cycling is in an economic sense. Despite the organizational difficulties and the doping scandals, there still seems to be plenty of room for improvements in order to make the physically hardest sport also a commercially successful one.

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Appendix

Pro Tour 2005: Points scale for individual rankings

	Tour de France	*Vuelta a España, Giro d'Italia*	*Paris-Nice, Tirreno-Adriatico, Milano-Sanremo, Ronde van Vlaanderen, Vuelta Ciclista al Pais Vasco, Paris-Roubaix, Liège-Bastogne-Liège, Tour de Romandie, Volta Ciclista a Catalunya, Critérium du Dauphiné Libéré, Tour de Suisse, Deutschlandtour, Eneco Tour, Tour de Pologne, Giro di Lombardia*	*Gent-Wevelgem, Amstel Gold Race, La Flèche Wallonne, Vattenfall Cyclassics, Clasica Ciclista San Sebastian-San Sebastian, GP Ouest France-Plouay, Züri Metzgete, Paris-Tours*
Final classification of the races				
1	100	85	50	40
2	75	65	40	30
3	60	55	35	25
4	55	45	30	20
5	50	40	25	15
6	45	35	20	11
7	40	30	15	7
8	35	26	10	5
9	30	22	5	3
10	25	19	2	1
11	20	16		
12	15	13		
13	12	11		
14	10	9		
15	8	7		
16	6	5		
17	5	4		
18	4	3		
19	3	2		
20	2	1		
Stages and prologues (in parentheses, the points scale for the 2006 season)				
1	5 (10)	3 (8)	1 (3)	
2	3 (5)	2 (4)	(2)	
3	1 (3)	1 (2)	(1)	

Riders belonging to an UCI Professional Continental Team do not score any points. The points corresponding to the place obtained by those cyclists are not awarded. The team time-trial does not award points to single riders.

Endnotes

[1] This paper was presented at the 8th IASE Conference in Bochum (D), 2006 and at the 3rd Bata's Conference in Zlin (CZ). We are grateful to Wladimir Andreff, Joachim Prinz, and Stephan Szymanski for first helpful remarks and to three anonymous reviewers for their comments. All remaining errors are our own.

[2] In both, the importance of a low Body-Mass-Index (BMI) for succeeding in the Tour is pointed out. Prinz (2005) provides a detailed description of the physical peculiarities in road cycling. Similarly, a shorter paper by Dilger (2002) studies the dynamics of slipstreaming using physical equations. There are several other investigations about physical and medical topics in cycling. Some of them are cited and discussed in Prinz (2005).

[3] The first bicycle was constructed by Baron Karl Drais in Mannheim and therefore later called Draisine. Alleged earlier drafts have been proven to be fakes. For a detailed description of the early years, see Lessing (2003).

[4] A World Cup for racing teams has existed since 1986. There had been several previous attempts to establish such an event series, such as the Challenge Desgrange Colombo (1948-1958) or the Super Prestige Pernod Trophy (1958-1988). The composition of the UCI World Cup varied over time and included even newly established, non-European races (e.g., the Japan Cup 1996) in order to promote cycling outside its original countries (Schröder, 2005, pp. 404-405).

[5] This aspect is extensively discussed in Brewer (2002), pp. 290-296.

[6] A list of the races included, together with the distribution of points, is reported in the appendix.

[7] Several banks (Banesto, Rabobank, Cofidis, Credit Agricole, Caisse d'Epargne) as well as insurance companies (Liberty Seguros, Ag2r) have engaged as sponsors in professional cycling during the last decade.

[8] For a detailed description of the prize moneys see A.S.O. (2006) [Tour], RCS Sport 2006 [Giro] and ARD 2006 [deutschlandtour].

[9] For instance, the 2005 Giro d'Italia had an average share of 17.23% in Italian TV, with an audience of about 2 million every day. The decisive mountain stage in Sestriere attracted up to 5 million TV viewers (47.62% share). In Germany there has been a growing interest since the mid-'90s, highly dependent on national hero Jan Ullrich's performance. This interest is mainly concentrated on the Tour: In 2005, the average TV share was about 24% (2.8 million audience). Other big events like the Giro or the deutschlandtour attract on average 1-1.5 million viewers. For comparison, the football European Championships 2004 averaged an audience of 12 million in German TV (35% share). Top events like the semi-final between Germany and Italy during the World Championship 2006 attracted approximately 30 million viewers (91% share) in Germany and 24 million (98%) in Italy.

[10] Even the Tour has live coverage only by the cable station Outdoor Life Network.

[11] The team manager has to employ the technical and medical staff as well. A Pro Tour racing squad requires 15-20 physiotherapists, mechanics, cooks, and physicians. Altogether, a Pro Tour team is therefore made up of 40-45 members.

[12] The later Tour de France-winner Greg LeMond signed a three-year contract with the French team La Vie Claire, totalling $1 million. A few years later, in 1989, he negotiated with the Z-Team the first contract endowed with more than $1 million per season (Brewer, 2002).

[13] A first econometric support for this (quite undoubted) thesis is provided by Torgler (2007), who included variables measuring the team effect in multiple regressions explaining riders' performances in the 2004 Tour de France.

[14] This need for teamwork is determined mainly by physical peculiarities of cycling: The major obstacle in cycling is wind resistance. By riding behind another rider, one can save up to 30% energy. Shading the captains from wind is therefore an essential tactical need, whereto much of the effort of the gregari is devoted, especially during flat stages (Brewer, 2002; Prinz, 2005).

[15] Top climbers are normally lightweights, like the legendary 56kg-rider Marco Pantani; time trial specialists are muscular athletes (e.g., Michael Rich or Serhiy Honchar), being able to generate more than 500 watts. This aspect is indirectly confirmed by Torgler's analysis of the 2004 Tour in which the BMI doesn't matter for time trial, but is highly significant as effort determinant in mountain stages (Torgler, 2007).

[16] The doping problem has been studied extensively in the last years in sports economics. See among others, Berentsen (2002), Dilger and Tonsdorf (2004), Haugen (2004), and Maennig (2002). Some studies even postulate a liberalization of doping in professional sports (Savulescu et al., 2004). Actually, cycling is experiencing again a doping scandal of huge proportions after the revelations of the so-called Operacion Puerto in Spain, which led to the exclusion of some of the favorites from the 2006 Tour the France, like Jan Ullrich and Ivan Basso. At the end of the Tour, the overall winner, Floyd Landis, also tested positive. The 2007 edition of the Tour was completely overshadowed by doping scandals.

[17] A first attempt to modify this peculiarity was undertaken during the 2006 World Championships in Salzburg, when the organizers set up two video screen-equipped "visitor centers" along the track, as well as 1,800 VIP and 500 "guest" seats in the start and finish areas. The "visitor centers" were planned to offer 20,000 seats. The aim of the organizers was to generate 10% of the expected total revenues (Hohenauer, 2006).

[18] The French bank Credit Lyonnais pays $4.5 milliom a year for its logo to be displayed on the famous yellow jersey, worn by the Tour de France leader (Whittle, 2006).

[19] In 2005, the UCI rules limited to nine the number of cyclists per team in stage races and eight in one-day races.

[20] Adopting this theory means in general a smaller number of teams than in the social welfare optimum.

[21] ASO, RCS, and Unipublic, the organizers of, respectively, the Tour de France, Giro d'Italia, and Vuelta a España and other one-day races, had a serious contention with the UCI during the winter of 2006-07, not only because of the TV royalties

division, but also for their refusal to adopt the Pro Tour invitation policy, which stipulates that all Pro Tour teams must be invited to each race.

[22] There are only a few examples of closed leagues in European sports. The only prominent and still-existing one is the Six Nations event in rugby, which indeed could also be seen as a tournament. Other recent attempts to establish such leagues, like the Deutsche Eishockey Liga (DEL) in Germany, faced serious problems and were mostly modified or abandoned.

[23] There are cases in which multinational companies finance teams belonging to small federations. An example is Biarne Riis' Team CSC, enrolled in the Danish federation, financed by the multinational CSC, and having its headquarter in a small village in Tuscany.

[24] For a survey, see e.g., Mas-Colell et al. (1995), pp. 383-398.

[25] Take as an example the Belgian squad Quick Step, which is traditionally set up to be competitive in one-day races, according to the Belgian preferences. On the contrary, Spanish teams are mainly constituted by mountain and time trial specialists in order to prevail in stage races. The most extreme example was the American team Discovery Channel: Because the Tour de France is the only cycling event that has some popularity in the U.S., the squad was hired exclusively to support Lance Armstrong in winning the Tour.

[26] Cycling fans refer to the traditional Belgian, Dutch, and Northern-French races, which take place in spring, as the "Northern Classics."

[27] See Fort/Maxcy (2003) for a survey of measuring issues.

[28] Some examples: In the 2006 Tour de France, 48 riders collected at least one Pro Tour point. The same was obtained by 36 cyclists in the Giro d'Italia and by 19 in the Vuelta a Catalunya during the same season.

[29] We take into account only 18 teams out of 20 because two of them (the Danish CSC and the US-American Discovery Channel) represent countries in which no Pro Tour races are organized.

[30] A collusion between two riders for the victory in a single stage has an infinitesimal impact on the whole UCI Pro Tour point ranking. See the point scale in the appendix.

[31] This is, for example, the case of Belgian cyclists, who have not been able to win a three-week race since the 1970s with Eddy Merckx. On the other side, the first Spanish winner of a Northern Classic has been Igor Astarloa, in the 2003 edition of Fleche Wallonne.

[32] Although we cannot provide a theoretically supported "optimal" number, we rely on the experience of European team sports leagues, in which normally 10-15% of the league is replaced every year by relegation/promotion.