

Chapter 7

The Tour de France: a success story in spite of competitive imbalance

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Abstract The Tour de France is one of the world's largest annual sport events. Although cycling races are usually not lucrative, the Tour de France organizer's balance sheet reveals that the Tour has been profitable since the 1980s. How can this economic success story be explained? Most sports economists are used to turn to tournament theory and a contest's competitive balance and outcome uncertainty as major reasons for success. However, fans of the Tour de France are seldom surprised by the name of the final winner of the race, usually not even by the riders sharing the podium. Thus, explaining the Tour's success by competitive balance must be checked carefully. Following the introduction, this chapter shows how the Tour de France has been a successful managerial and economic model: it is a well-designed and well-managed sport event, with a modern financing model which is founded on TV broadcasting rights, like other mega-sport events. Fundamentally, the quality of the show of the Tour seems well explained by tournament theory. However, if one focuses on competitive balance, it appears that the success of the Tour is likely not due to a high competitive balance, but instead holds *in spite of* static and dynamic competitive imbalance. The conclusion stresses that the increasing economic success of the Tour since the 1980s is likely not caused by more competitive racing, but instead by a better broadcasting of the event.

Keywords

Tournament theory; competitive balance; outcome uncertainty; competitive intensity; Tour de France

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1 Introduction

The Tour de France is one of the world's largest annual sport events. The three-week race includes a publicity caravan, it attracts host cities and sponsors which are willing to pay to be present in the race, and its individual stages (and their landscapes) are watched by a mass of TV viewers. Although cycling races are usually not lucrative, the Tour de France organizer's balance sheet reveals that the Tour has been profitable since the 1980s (Mignot 2016). How can this economic success story be explained? Most sports economists are used to turn to tournament theory and a contest's competitive balance and outcome uncertainty as major reasons for success. However, fans of the Tour de France are seldom surprised by the name of the final winner of the race, usually not even by the riders sharing the podium. Thus, explaining the Tour's success by competitive balance must be checked carefully.

Following the introduction, this chapter shows how the Tour de France has been a successful managerial and economic model (Sect. 2): it is a well-designed and well-managed sport event, with a modern financing model which is founded on TV broadcasting rights, like other mega-sport events. Fundamentally, the quality of the show of the Tour seems well explained by tournament theory (Sect. 3). However, if one focuses on competitive balance, it appears that the success of the Tour is likely not due to a high competitive balance, but instead holds *in spite of* static and dynamic competitive imbalance (Sect. 4). The conclusion stresses that the increasing economic success of the Tour since the 1980s is likely not caused by more competitive racing, but instead by better broadcasting of the event (Sect. 5).

2 The Tour de France: a successful managerial and economic model

A top sport event offered for free will automatically attract a significant demand. Beyond this basic and quite obvious cause of Tour de France attractiveness, its management and design are also explanations of its success. This is partly due to the Tour basically sticking to a modern model of professional sport finance.

2.1 A well-managed and well-designed sport event

The Tour de France is managed by *Amaury Sport Organization (ASO)*. *ASO* also organizes other professional cycling races, such as Paris – Roubaix, Paris - Nice and the Critérium du Dauphiné, as well as golf tournaments, track and field events, car races and horse-riding contests. Professional road cycling accounts for close to 70 % of *ASO*'s revenue, mainly because of the success of the Tour de France (Desbordes 2006, Van Reeth 2019a). Since *ASO* is a privately owned company, it aims at profit maximizing and designs its strategy accordingly.

A first strategic tool consists in multiplying the number of trophies within a race. In the Tour de France, this process started in 1919 with the introduction of the yellow jersey for the leader in the race, and lasted until 1989 when the number of trophies stabilized, respectively, rewarding the best rider overall (yellow jersey), the best climber (polka-dot jersey, created in 1933), the best sprinter (green jersey, created in 1953), the best young rider, i.e. any cyclist less than 26 years of age (white jersey, created in 1975), and the best-ranked team. From time to time, other trophies appeared and vanished again. By creating “different races within the race,” ASO attempted and succeeded in making the Tour de France a more vivid contest with multiple opportunities for duels between riders or teams competing for a given trophy and changes in the tactics adopted by riders or teams during the course of the race. Given that cycling is a strategically complex sport, fans may be interested in who will win and also how (see [Chap. 10 on strategies in road cycling competitions](#)).

Two other factors that attract people to watch riders on the Tour de France roads are linked together. The first one is the riders’ performance, the second one lies in the hardness of the race. Based on the number of racing days and the number of rest days per racing day, the Tour de France became much harder after the 1920s with the number of racing days stabilizing up to about 20, while one rest day per ten racing days became the usual ratio (Mignot 2014). Before the 1920s, the number of stages was usually 15 at most and the riders enjoyed at least one day of rest after each stage. The overall riding distance was 2,428 km in 1903 and rose to a maximum of 5,745 km in 1926. Since then, the distance shortened to about 3,500 km on average. Thus, compared with the initial era of so-called road’s convicts (*‘les forçats de la route’* in French), riders now spend more days on the roads and have less often time to rest. However, this has been made feasible by reducing the average stage length from over 300 km until 1926 to less than 200 km since the 1960s. Consequently, the average duration of a stage, i.e. the daily time actually spent by riders on their bikes, fell from 10 to 16 hours before the 1930s to 4 to 5 hours in the 2000s. The race also became harder due to the introduction of mountain stages. The first mountain ever climbed in the Tour de France was the Ballon d’Alsace in the Vosges region in 1905. A handful of years later, high-mountain stages in the Pyrenees (1910) and the Alps (1911) were introduced. However, the number of passes over 1,000 meter height in a given Tour de France has not increased significantly on average since the 1920s.

Apart from the physical hardness of the Tour de France, it is also the increase in riders’ performances that has made the Tour attractive to spectators. The overall average speed of the yellow jersey winner was between 25 and 30 km per hour (km/h) until the late 1930s. Since World War II, it has steadily increased. From 25.7 km/h in 1903 to 42.3 km/h in 1999 (the

fastest Tour ever) is an improvement of 65 %. Part of this acceleration is due to technical progress affecting riders' bikes such as the introduction of derailleur gears, the increase in the number of gears, lighter bikes, profiled wheels, etc. (Calvet 1981; Andreff 1985). Improvement of the road surface, shorter stages, multiple stakes, and high-effort intensity in the crucial parts of the race have also triggered both higher rider performance and increased attractiveness to spectators. Improved physical and medical preparation, better nutrition, and sometimes doping may have played a role as well. Another index of riders' performance is the withdrawal ratio, the percentage of riders who do not finish the race (Mignot 2014). This ratio decreased from over 70 % in the 1920s to 40 % in the 1930s and about 20 % during the 2000s. The highest withdrawal ratio was reached in 1926 (as mentioned before the longest Tour de France ever held) with 126 withdrawals out of 162 riders (78 %), meaning that year only 36 riders finished the Tour de France. In 2019, the lowest withdrawal ratio was recorded with 155 out of 176 riders finishing the contest, only 21 riders (12 %) abandoned. Before 2019, when 198 riders were enrolled in the peloton, the second lowest withdrawal ratio was witnessed in 2016 with 174 finishing riders and 24 abandoning (12 %).

Last but not least, the Tour de France is a sport event that is supplied for free to millions of spectators along the roads. However, the demand for it is not infinite. The demand is rationed by various constraints such as the date and location of a stage or the hosting capacity of a geographical site (like the slopes of the Mont Ventoux or Alpe d'Huez), limiting the number of spectators. Nevertheless, from an economic point of view, a free sport event is likely to draw a huge attendance. Indeed, 10 to 15 million spectators per year attend the race over the course of three weeks. This is significantly more than the biggest mega-sport event in the world, the FIFA World Cup with a stadium attendance of 3,441,450 people in Brazil in 2014 and 3,031,768 in Russia in 2018. Moreover, since not all spectators can attend the Tour, they also demand a story telling which was first supplied by newspapers, then through radio broadcasts, and eventually through TV broadcasts.

Overall, the proportion of adults in France who claimed they personally liked the Tour de France went from 59 % in 1964 to 44 % in 2010 and then 49 % in 2011–2014 (IFOP 2014). In 2011, the share of adults who claimed they like the Tour de France was close to 50 % not just in France but also in Italy and Spain, but it was much lower in the UK (35 %) and in Germany (28 %) (IFOP 2011).

2.2 A modern financing model

The Tour de France has not always been a profitable business. Until the 1970s, financial deficits

were common (Reed 2003; Mignot 2016). However, the deficits vanished with rising TV broadcasting rights. From the mid-1950s to the mid-2010s, the revenues of the Tour de France were multiplied by more than fifty, and since the 2000s most of these revenues have come from television rights (Fig. 1), dwarfing the revenue sources of host cities, the publicity caravan and other sponsors.

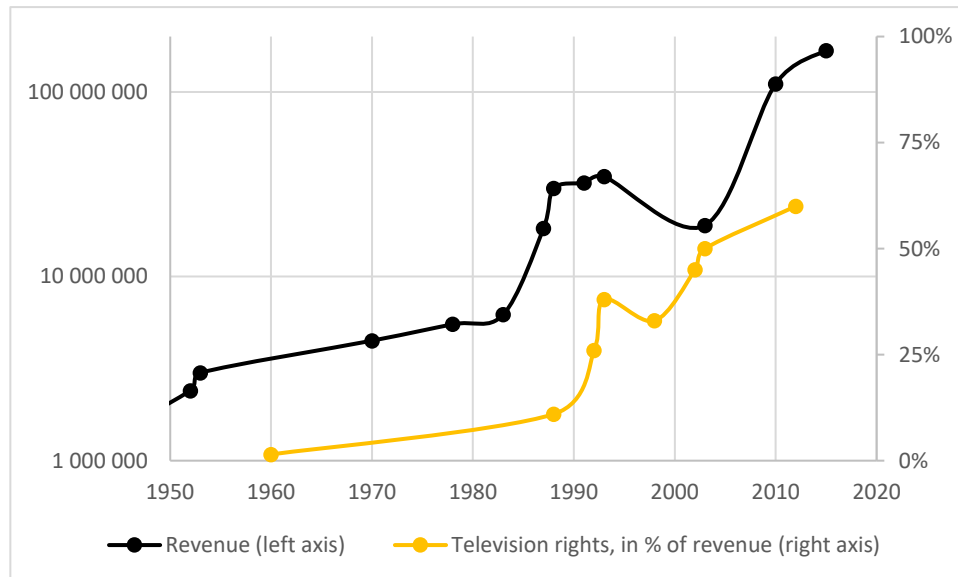


Fig. 1 Tour de France revenues, 1950-2020 (in 2020 euros), *Sources* Mignot (2016), Bačik, Klobučnik and Mignot (2021)

The first Tour de France TV broadcast was the finish of the last stage at the Parc des Princes stadium in Paris in 1948, whereas the first TV broadcast of a mountain pass was at the Aubisque in 1958 (Chap. 6). Nowadays, the Tour is the major sport event in the French broadcasting market with well over 80 hours of broadcast, ahead of the Roland Garros tennis tournament (77 hours), Champions League matches, Formula 1 races and the rugby Six Nations Tournament. In 2019, 35.4 million French TV viewers saw at least one minute of the Tour de France, which is about half of the nation's population (France Télévisions, Médiamétrie data). The average per stage audience in France is between three and four million (Van Reeth 2019b). Consequently, the Tour de France TV rights revenues have increased significantly over the years.

Chap. 6 explained how, from the 1970s on, the Tour de France was broadcast in more and more countries. Today, it is a global mega-sport event. Over 100 TV channels in 190 countries now broadcast the Tour de France, with live broadcast in 60 countries (www.aso.fr). As a result, the budget of the Tour de France has literally skyrocketed since the 1980s. From the early 1980s to the late 2000s, the operational budget of the Tour was multiplied by twenty, primarily due to

the growth of TV rights revenues that multiplied by 65 over the same period of time (Mignot 2014; Fig. 1).

Table 1 illustrates the financing sources of the Tour de France. Basically, three types of income can be distinguished: TV broadcasting rights, marketing (merchandising included) and sponsorship revenue, and income from municipalities. The media success story is the basis for the solid economic foundations of the Tour de France because it provided 44 % of its overall budget in 2010 according to *ASO* accounts. It is all the more so in 2019, when TV rights revenues have reached 55 %. Just like in other professional sports, TV rights are now an important source of revenue, which compares to its share in the English Premier League finance in 2019 (59 %). This is the result of an organizer's strategy of using its monopoly power over the Tour de France to increase these rights. From the 1950s to the 1980s two-thirds of Tour de France revenue originated from marketing and sponsorship. This kind of revenue emerged in 1925–1929 when the Tour transformed from a race opposing individual riders into a race between opponent teams sponsored by commercial companies. Since 1930, additional sponsorship income was generated with the introduction of a publicity caravan, i.e., dozens of vehicles preceding the riders by a few minutes and distributing product samples to spectators. In 2019, a sponsor had to pay €37,000 for its brand exposure on four vehicles of the Caravane du Tour (publicity caravan) and an additional €6,300 for any extra vehicle. The share of advertising and sponsorship revenue has declined in the past two decades to 51 % of the budget in 2010 and 40 % in 2019. Finally, each year over 200 cities are a candidate for hosting a Tour de France stage arrival and/or departure and those which are successful had to pay in 2021 €65,000 for hosting a departure, €110,000 for an arrival, and €160,000 for both. The first stage departure (*Grand Départ*) is much more expensive for a city. Utrecht had paid €4 million in 2015 while Rennes eventually did not accept hosting the *Grand Départ* in 2021 with the excuse of too high a bill to be paid. However, because of the rising overall budget, the share of the contributions from these cities in the total budget of the Tour de France has decreased from 40 % in 1952 to just 5 % in 2010 and 2019 (Table 1). For more on the economic impact of hosting major road cycling events, see Chap 5.

The Tour de France has thus also evolved towards a contemporary model of professional sports finance and developed from a so-called SSSL model (Spectators, Subsidies, Sponsors, Local) to a MCMMG model (Media, Corporations, Merchandising, Markets, Global) with regard to its major sources of finance (Andreff and Staudohar 2000). In the MCMMG model, media, in particular through TV broadcasting rights, have become the most significant source of income for sports. Furthermore, alongside with sponsors and gate receipts (spectators) whose

share in overall finance of sport events has shrunk, new sources of finance have emerged, including corporations (investment funds, big companies, Russian oligarchs, Middle Eastern oil sheiks, etc.), merchandising of non-sporting goods (e.g., T-shirts) under a club's or a player's label, and markets. With respect to the latter, we see that money is channeled into contemporary professional sports from two markets: a labor market for talent in which a club makes money in selling home-educated and trained talented players, and a capital market that enables to trade a club's shares at the stock exchange and collecting money from the fans as shareholders. Most of these new sources of finance are global.

Table 1 Revenue sources Tour de France and professional football leagues, 2010 & 2019

Revenue source (in % of overall finance)	Tour de France		English football Premier League*		French football Ligue 1*	
	2010	2019	2010	2019	2010	2019
TV broadcasting rights	44 %	55 %	51 %	59 %	57 %	47 %
Advertising & sponsorship	51 %	40 %	22 %	27 %	28 %	41 %
Municipalities**	5 %	5 %	0 %	0 %	2 %	1 %
Spectators (gate receipts)	0 %	0 %	27 %	14 %	13 %	11 %

* Revenues from player transfers not included

** Municipal subsidies in football, stage-cities in the Tour de France

Sources Websites national football leagues and ASO (2019)

From Table 1, we also see that although the current Tour de France financing model is in line with big professional sports leagues such as the English Premier League and the French Ligue 1, it remains specific in a way too. For example, its TV dependence in percentage of overall revenue (55 % in 2019) compares with football, while advertising and sponsorship (40 %) is no longer the most important source of income to the Tour de France organizers. This may be interpreted as the Tour de France having moved from the SSSL to the MCMMG model. The absence of gate revenue has been compensated for by sponsorship money but primarily by increased TV revenues. In fact, the lack of gate revenue potentially deprives the Tour de France of up to one-sixth to one quarter of overall revenue (like in English football). The share of public money received from municipalities is more important in the Tour de France than in European football, though it is now reduced to 5 % only. At the end of the day, the profitability of the Tour de France is likely to be guaranteed as long as it will attract the media, advertisers and sponsors, even without any spectatorship income.

3 The Tour's success and tournament theory

There is a more fundamental reason why the Tour de France is such a successful sport contest:

it fits with the recommendations derived from tournament theory. Tournament theory (Tullock 1980) was first conceived to analyze the efforts dedicated by competing job seekers to get a job, and it was then adapted to sporting contests, namely tennis tournaments (Rosen 1986). Each participant is assumed to independently choose the quantity of resources (physical and psychical efforts) he is going to invest in view of winning the tournament and receiving the winner's prize. His winning probability increases with this quantity. Let V stand for the value of the winner's prize. Each participant i dedicates an effort e_i , and his probability of winning p_i depends on his share in the overall effort devoted by all participants, that is:

$$p_i = \frac{e_i}{e_i + e_j}$$

The financial gain of participant i is: $\pi_i = p_i \cdot V - c_i \cdot e_i$ where c_i stands for the marginal cost of each participant i 's effort or investment in the tournament.

The assumption that the organizer of a sport tournament acts to maximize profit implies that the goal is to attract as many spectators as possible by gathering high-quality athletes and by securing that these athletes dedicate maximal efforts to win. Therefore, the organizer must conceive incentives in such a way that athletes maximize their efforts and, consequently, produce a spectacular sport event. From tournament theory, it is mathematically derived that a tournament will be attractive if its incentive mechanism (through its prize structure) fulfils six prerequisites (Szymanski 2003; Andreff 2012). As *ASO* indeed aims at making a profit from organizing the Tour de France, the choice of an appropriate incentive mechanism is crucial and it must be checked whether the Tour fulfills prerequisites (a) to (f) for a sport contest to be successful and attractive.

(a) When one competitor has a very high capacity to win, the tournament practically is without interest for other participants who will dedicate only a minimal effort. The organizer must avoid such competitive imbalance. The Tour de France has always tried to stick to this principle by enrolling several superstar riders every year. Whether the Tour fulfills condition (a) is debatable when one witnesses a rider winning the Tour five times like Jacques Anquetil, Eddy Merckx, Bernard Hinault and Miguel Indurain – or seven times in a row, as in the case of the later disqualified Lance Armstrong. Condition (a) is not valid either when the yellow jersey winner is too much ahead of the second-ranked rider, like in 1952, when the campionissimo Fausto Coppi won the Tour de France with a lead of over 28 minutes. This is why in 1952, when Coppi dominated the race as early as the 10th stage, organizers doubled the second-place cash prize so that riders fight for second if not first place. In fact, condition (a) raises the issue

of competitive balance, which is addressed in detail in Section 4.

(b) Individual effort and aggregated effort of all the participants increase with the value of the winner's prize V . In the long run, the value of V has massively increased in the Tour de France (Chap. 2, Fig. 1). Total prize money in the Tour de France is over €2 million – exactly €2.288 million in 2021 (for a detailed analysis, see Chap. 3), which fulfills prerequisite (b) compared with other cycling races, for instance €1.499 million in the Italian Giro d'Italia 2021 and €1.116 million in the Spanish Vuelta a España 2021.

(c) Individual effort decreases with the number of participants. The size of the Tour de France peloton climaxed at 210 participating riders in 1986, it decreased to between 176 and 198 in the 1990s and 2000s, it stabilised at 198 in 2011-2017, and it has been reduced to 176 since 2018. Reducing the number of participants down to 176 since 2018 must have on average increased individual efforts of each rider. If *ASO* intended to further increase the number of riders, it could deteriorate this condition (c) in terms of riders' individual effort. Anyway, the maximum number of riders engaged in a professional cycling race is regulated by the international cycling federation (UCI). The only trade-off still open to *ASO* is between more teams with fewer riders each and fewer teams with more riders each. At the end of the day, the organizer chooses each year the number of teams and which teams are selected to participate in the Tour. This is not without conflicting interests between the organizers of the *Grand Tours* (*ASO*, *RCS*, and *Unipublic*) and the UCI, which claims that each *Grand Tour* must invite all the WorldTour teams (Rebeggiani and Tondani 2008).

(d) Aggregated effort increases with the number of competitors. Such condition is a trivial by-product of condition (c). In the Tour de France, maximal aggregated effort is constrained by an exogenous factor which is the set of UCI cycling rules.

(e) Participants' efforts are more intense in a tournament with multiple prizes, where there are several prizes or trophies at stake, as soon as the competitors' abilities to win are different. This principle is satisfied in the Tour de France with offering prizes for final ranking trophies such as yellow jersey, green jersey, polka-dot jersey, white jersey, and best team final ranking as well as prize money for the best ranked riders in a stage or the first riders at a mountain pass summit (Table 2). Since the prize money is distributed over multiple trophies, condition (e) is satisfied. In addition, the Tour offers some more specific prizes: the most aggressive rider prize rewarding the rider with the toughest fighting spirit in each stage, and the super-fighter prize at the end of the Tour, the winners of intermediate sprints, a daily rent for the holder of each distinctive jersey, special bonus prizes such as the 'Souvenir Henri Desgrange' (€5,000) awarded to the first rider reaching an ex-ante specified pass. Prizes are diversified in view of

stimulating any rider's effort at some point in the race.

Table 2 Tour de France money prizes in 2021 (in euros)

Position	Final ranking					Individual stage	Mountain pass by category				
	Yellow jersey	Green jersey	Polka-dot jersey	White jersey	Best team		'Hors'	1 st	2 nd	3 rd	4 th
1 st	500,000	25,000	25,000	20,000	50,000	11,000	800	650	500	300	200
2 nd	200,000	15,000	15,000	15,000	30,000	5,500	450	400	250		
3 rd	100,000	10,000	10,000	10,000	20,000	2,800	300	150			
4 th	70,000	4,000	4,000	5,000	12,000	1,500					
5 th	50,000	3,500	3,500		8,000	830					
6 th	23,000	3,000	3,000			780					
7 th	11,000	2,500	2,500			730					
8 th	7,600	2,000	2,000			670					
9 th	4,500					650					
10 th	3,800					600					
11 th	3,000					540					
12 th	2,700					470					
13 th	2,500					440					
14 th	2,100					340					
15 th	2,000					300					
16 th	1,500										
17 th	1,300										
18 th	1,200										
19 th	1,100										
20 th -160 th	1,000										

Source ASO 2021

(f) The effort will be more intense the wider the gap between the winner's prize and the prize rewarding the runner-up, and the wider the gap between the prize for the runner-up and the prize rewarding the third-ranked rider, and so on. This scheme is particularly relevant when the differences between the competitors' winning abilities are small. For instance, in most tennis tournaments, qualifying for the next round usually doubles the player's money prize and the tournament winner earns twice the amount of money the losing finalist gets. It is nearly so with the yellow jersey final ranking in the 2021 Tour de France (Table 2). A rider doubles his money prize when he climbs in the ranking from the 10th to the 8th rank, then from the 7th to the 6th rank, from the 6th to the 5th, from the 5th to the 3rd, from the 3rd to the 2nd rank; the winner more than doubles his gains (times 2.5) compared with the runner-up. Such incentive scheme is in tune with the lessons derived from tournament theory. The prize structure for winning a stage is similar with also approximately a doubling of the monetary reward for each rank improvement among the four best-ranked riders. The prize structure for the other trophies is less in tune with tournament theory. In the race for the green, the white, and the polka-dot jerseys, financial gains are not doubled when a rider improves his rank by one. These trophies

thus clearly have a less incentive prize structure. If one *ASO* objective is to multiply the races within the race this must not go as far as disturbing the contention for the yellow jersey. That is the reason why incentives are significantly lower (€25,000 for the green and polka-dot jersey winners, €20,000 for the white jersey winner) and less structured according to tournament theory for trophies that only appeal to specialized riders like sprinters or climbers.

It should be remarked though that this focus on prize money is not always relevant in the context of cycling races. There are also significant indirect financial and non-financial gains from winning, such as a salary increase, the terms of the next contract to be signed, and fame. Since, as was shown in Chap. 3, salaries are much more important than prize money for cyclists, this incentive could be higher than the pure prize money. Possibly less attractive for riders, the incentive scheme of the Tour de France is basically made to be attractive for spectators and TV viewers through its effect on riders' efforts and fighting spirit. For more on strategic behavior in road cycling competitions, see Chap 10.

4 The Tour's success and competitive balance

One of the fundamental reasons why some sport contests are so successful and attract large audiences is their high competitive balance. Is the Tour's success due to its competitive balance?

4.1 Competitive balance and competitive intensity in road cycling

Competitive balance may contribute to the attractiveness of the Tour in several ways (Bačik, Klobučnik and Mignot 2021). First, it generates 'uncertainty of outcome' (Rottenberg 1956) and spectators' feeling of suspense, which supposedly are at the origin of the demand for most if not all individual or team sport events (Szymanski 2006; Humphreys and Watanabe 2012). Indeed, if spectators knew the Tour winner in advance or when and how he would turn out to win, few people would still be interested. Second, competitive balance may make the Tour attractive indirectly, by increasing competitive intensity. When riders are more equal (high competitive balance), this tends to incentivize them to fight harder and take more risks to win or to gain a better ranking (high competitive intensity). In contrast, when a rider or team clearly dominates the race, riders have no hope of winning and no reason to fight, except perhaps to maintain their ranking.

As cyclists sometimes collude to share prizes instead of fighting for victory (low competitive intensity), Tour organizers have repeatedly tried to improve competition among riders in order to attract more spectators and thus increase the Tour's revenues and profits

(Bačík et al. 2021). This is why they have decided to shorten the race to make it more attractive to attack and counter-attack. As the Tour started being broadcast live on the French radio (1930s) and on French television (1960s) and then around the world, television broadcast rights became the Tour's main source of revenues in the 2000s (Fig. 1). Organizers shortened the race in order to make stages more nervous, livelier and to attract more radio listeners and television viewers. In the same vein, organizers have included short, particularly intensive mountain stages since the 2010s, once again to increase competition. Finally, competition among riders may have increased following the prize pool changes that occurred since the 1980s. Indeed, to intensify competition, since the 1980s the organizers have tripled the total prize pool (Mignot 2016). In addition, the share of the total prize pool that goes to the yellow jersey went from less than 5% in 1980 to close to 25% today, which should give lower-ranked riders more incentives to take risks to take the leader's place.

4.2 The measure of competitive balance in cycling stage races

In league sports, where each team plays one-on-one against each of the other teams, quantifying competitive balance may seem relatively easy. A match's competitive balance is measured by teams' probabilities of winning (the closer to 0.5, the more competitive the match) and the championship's competitive balance is measured by some indicator of the dispersion of teams' probabilities of winning (Andreff 2012; Groot 2008), such as the Noll–Scully index. Attendance at baseball games depends, among other things, on 'the dispersion of percentages of games won by the teams in the league' (Rottenberg 1956; Neale 1964). However, this indicator does not make sense for cycling stage races such as the Tour de France, mainly because winning the maximum number of stages does not amount to winning the whole race. Conversely, a rider may win the Tour without winning a single stage, as shown by Christopher Froome in 2017 and Egan Bernal in 2019.

At the stage level, several indicators of competitive balance or related concepts have been suggested in literature (Bačík et al. 2021). Larson and Maxcy (2014) measure outcome uncertainty at the stage level through the likelihood that the stage winner was part of a breakaway rather than part of the sprinting peloton. They find that in the three *Grand Tours*, the use of two-way radio technology by riders and team directors in 1992–2010 was associated with a higher, not a lower likelihood of breakaway success (especially in mountain stages), compared with the 1985–1991 period. However, the share of stages which are won by a breakaway rider rather than a peloton's sprinter is an indicator of the unpredictability of stages' scenarios, not an indicator of competitive balance among riders or teams. In Chap. 11, Cabaud,

Scelles, François and Morrow review the literature on competitive balance in cycling and they introduce an interesting measure of competitive balance at the stage level called intra-stage ‘competitive intensity’. However, computing this sophisticated indicator requires within-stage data, which are not available in the long or even in the medium term (Cabaud, Scelles, François and Morrow 2015; Scelles, Mignot, Cabaud and François 2017).

At the race level, the level in which we are interested, other indicators have been used. Mignot (2014) computes the number of times the yellow jersey switched from one rider to another (per racing day) and finds that this indicator shows no clear long-term evolution. A second index is the final time difference between the yellow jersey winner and the second-ranked rider. This difference was often over an hour during the 1920s, but it has been reduced in the past decades to some minutes or even only a few seconds. Based on this criterion, we find extremely balanced Tours in 1989 (when Greg LeMond beat Laurent Fignon by 8 seconds only), in 2007 (23 seconds between Alberto Contador and Cadel Evans), in 1968 (38 seconds between Jan Janssen and Herman Van Springel) and in 1987 (40 seconds between Stephen Roche and Pedro Delgado). The same benchmark exhibits very imbalanced Tours in 1952 (28 minutes and 17 seconds between Fausto Coppi and Stan Ockers), in 1948 (26 minutes and 16 seconds between Gino Bartali and Briek Schotte), in 1951 (22 minutes between Hugo Koblet and Raphaël Geminiani) and in 1969 (17 minutes and 54 seconds between Eddy Merckx and Roger Pingeon). However, these indicators are entirely based on the performances of a few race leaders (Andreff 2015). This is why we suggest computing new, more robust measures of competitive balance in the Tour.

Therefore, building indicators of competitive balance in a cycling stage race requires making several choices, for which we rely on the innovative indicators proposed by Andreff (2015), which are inspired by the Noll-Scully index and are based on the standard deviation of the distribution of teams’ average times around the mean. Variants of these indicators were calculated by Bačik et al. (2021) and we report their results in the following paragraphs. First, as cycling has long been a professional sport and most riders have been riding for money, and as the highest cash prize has always been the yellow jersey, Bačik et al. (2021) choose to measure a rider’s performance through his general classification time (in case he was among the finishers). They thus leave aside other – lower – cash prizes such as the king-of-the-mountains jersey and the best sprinter’s jersey, which today earn a rider €25,000 (Table 2), i.e. only 5 % of what the yellow jersey winner gets.

Second, Bačik et al. (2021) choose to compute indicators of competitive balance not only among all riders, but also among the ‘top five riders’ (i.e. the best five finishers) and among

‘team leaders’ (i.e. each team’s best finisher). Indeed, although formally any participant may win the Tour, in reality only a tiny fraction of riders are able to compete for the yellow jersey, which is why they focus on competitive balance among the top five riders. In addition, because of labor division within teams (Cadelon and Dupuy 2015), at most one rider per team usually competes for the yellow jersey (his teammates sacrifice their personal performances to help him win the yellow jersey), which is why they also address competitive balance among team leaders. Overall, these analyses give a relatively complete picture of the evolution of competitive balance.

Third, Bačik et al. (2021) choose to compute indicators of both static and dynamic competitive balance. While ‘static’ competitive balance is the degree of parity among opponents in a single edition of the race, ‘dynamic’ indicators measure to what extent the results of an edition of the Tour may have been predicted by the results of the previous edition. As is well known, several riders such as Jacques Anquetil, Eddy Merckx, Bernard Hinault, Miguel Indurain, Lance Armstrong and Christopher Froome have won the Tour two or more years in a row. What is needed is an indicator based on more than a tiny proportion of riders. A simple indicator of static competitive balance is the share of riders who finished the race. The corresponding indicator of dynamic competitive balance is the share of finishers in year n who had already finished the race in year $n-1$ (given that they had started). They also choose to measure competitive balance regarding race completion as well as final time.

4.3 The evolution of competitive balance in the Tour de France, 1947–2017

ASO made some of the historical statistics of the race available (ASO 2021). Bačik et al. (2021) collected these data along with additional data from www.tourfacts.dk and used them for analyzing competitive balance in the Tour de France. The collected data were organized in a database that is available in the form of a website, www.tdfrance.eu (Bačik and Klobučnik 2013). These data include information on all participants in each Tour from 1947 to 2017, including information on riders such as Lance Armstrong who were disqualified after the official results were published. For each Tour they have the following individual information: the name of each rider who started the race; the name of his team, whether he finished the race, and if so, his final time. Practically, the performance of an individual rider who finished the race is calculated as its delay behind the winner, in percentage of the winner’s time. Below we report the main results of Bačik et al. (2021).

4.3.1 Static competitive balance regarding race completion

Since 1947 the number of riders has increased from 100 to close to 200 and more and more of them, from 50 % in the late 1940s to 80 % now, have been able to finish the race. These changes may have induced more competitive intensity among riders but perhaps not necessarily more competitive balance among them, especially if those additional starters tend to perform less well than the others. Over the same period, teams' finish rates have become more similar to each other, i.e. more concentrated around their mean, which indicates these rates now differ less from one team to another. Teams tend to finish the Tour with more and more similar shares of their riders left, which enables them to compete with each other on a more and more equal footing.

4.3.2 Static competitive balance regarding final time

In the 70 Tours between 1947 and 2017, the top five riders' mean delay has always been inferior to 0.35% of the winner's time. In this sense, one might argue that the Tour includes a fair share of competitive balance – and perhaps also competitive intensity – among top riders. In addition, the top five riders' mean delay slightly decreased from the 1950s (when it was equivalent to 0.17% of the winner's time, on average) to the 2010s (0.08%). This means that competitive balance and intensity have slightly improved over time. However, these improvements have not started or accelerated in the 1980s, which means they most likely are unrelated to the 1980s increase in the number of riders and teams and change in prize structure (Table 2). At the same time, the dispersion (coefficient of variation) of the top five riders' delays has remained at a roughly constant level over the whole period, which means that once the slight decrease in the top five riders' mean delay is taken into account, top riders' performances have remained at the same distance to each other.

In contrast, team leaders' mean delay has tended to increase since the late 1960s, from 0.3% of the winner's time in the second half of the 1960s to 0.8% in the 2010s. This is coherent with the fact that fewer team leaders than before are now able or willing to compete for the yellow jersey – many of them actually compete for other prizes, including stage wins. Team leaders' delays have also remained at a roughly constant level of dispersion over the whole period (around 1 or a bit below), which means team leaders have not become closer to each other.

Overall, these results reflect a slight improvement in static competitive balance among top riders since 1947, but deterioration in static competitive balance among team leaders since the late 1960s.

4.3.3 Dynamic competitive balance regarding race completion

From the late 1940s, more and more riders participated in consecutive Tours. In addition, evermore riders who participated in consecutive Tours were also able to finish both races, from 40 % in the late 1940s to close to 50 % in the 2010s. Thus, it became easier to predict from one year to the next who the Tour finishers would be. More importantly, the correlation between teams' finish rates in consecutive years has mostly been positive, which means that teams with a high finish rate in one year may be expected to also have a high finish rate the following year. However, since the 1950s this indicator has been on a decreasing trend, which means that teams' finish rates tend to be less predictable from one year to the next.

4.3.4 Dynamic competitive balance regarding final time

How predictable are the names of each year's best five riders? To answer this question, one may calculate the correlation between the delays of the best five riders of year n and the delays of the same individual riders in year $n-1$ (if they already participated in the Tour in year $n-1$, whatever their final ranking). This correlation has mostly been strongly positive (0.51 on average), which lends support to Andreff's claim (2015) that 'cycling fans are not often surprised by the name of the final winner of the race, usually not even by the three riders sharing the podium'. In addition, this correlation has not followed a clear trend over time, which means that top riders' performances have remained roughly as easily predictable from one year to the next as before.

How predictable are the names of each year's best teams? One may calculate the correlation between the delays of teams of year n (proxied by the delay of each team's best rider) and the delays of the same teams in year $n-1$ (if they already participated). This correlation has also been mostly positive (0.39 on average) and it has not tended to decrease since the 1970s. In other terms, the performance of a team leader in a given year has remained as predictive of the performance of the leader of the same team the next year. This might not be as much of a problem as one might think though. Buzzacchi, Szymanski and Valletti (2003) have shown about the open soccer leagues of Europe that "*as long as the contest within each season is close (e.g. measured by standard deviation of win percent), fans may be indifferent to dominance by a small number of teams over many seasons.*"

Overall, these results reflect no clear improvement in dynamic competitive balance among top riders or among team leaders. Riders' performances have not become harder (or easier) to predict from one year to the next.

4.4 Discussion

What do the results of Bačik et al. (2021) tell us about the evolution of competitive balance in the Tour de France? In static terms teams have tended to finish the Tour with more similar shares of their riders left, while in dynamic terms, teams' year-to-year finish rates now tend to be less predictable from one year to the next than was the case before. In these respects, competitive balance has improved over time. More importantly, static competitive balance has improved among top riders, which means that top riders have tended to have more and more equal performances. Whatever the causes of this evolution, it is a major trend in Tour history. Static competitive balance among team leaders has deteriorated since the late 1960s, however. Finally, dynamic (year-to-year) competitive balance has not improved over time among top riders or among team leaders, which means riders' performances have remained relatively 'easy' to predict from one year to the next. For the public, however, getting to know the teams and the names, faces and voices of the few contenders who are most likely to perform and win in the coming years may be as much an advantage as a disadvantage. Overall, these findings are mixed: they combine improving competitive balance among top riders and deteriorating competitive balance among team leaders.

A common point of all these findings, however, is that none of the measurable indicators of competitive balance have changed much since the 1980s. This suggests that variations in competitive balance did not play a major role in the increasing economic success of the Tour since the 1980s. These results fit well with other results according to which variations in the success of the Tour de France depend little on the cycling dimension of the show. Poll data concerning French people's reasons for being interested in the Tour stress the importance of landscapes relative to sport matters such as competitive balance. In 2018, among the 27 % of adults in France who declared that they were interested in the Tour, the most common reasons for being interested were that 'the Tour is part of the French heritage' (61 %) and 'the beauty of landscapes crossed' (53 %), more than 'the sporting aspect of the competition' (31 %) and 'riders' efforts' (28 %) (BVA 2018). Similarly, from 1997 to 2012, Flemish Tour de France TV viewership has been shown to depend less on race developments such as competitive balance than on stage characteristics such as mountain stages and weekend stages (Van Reeth 2013).

In an event as complex as the Tour de France, competitive balance is likely difficult to manipulate. Perhaps one of the few ways to increase competitive balance among Tour team leaders would be to reduce the number of riders per team, as has been done since 2018, which may both reduce and equalize resources available to team leaders (Van Reeth 2015a). Similarly, Buzzacchi, Szymanski and Valletti (2003) have demonstrated that the closed leagues of North

America (football, baseball, hockey) are much more balanced than the open leagues of Europe (soccer), in the sense that relatively more teams are likely to experience any given level of success in a given period of time. This is because of the greater extent of resource equalization measures used in North American professional sports, such as draft rules, roster limits, salary caps, gate revenue sharing or collective merchandising.

If competitive balance is not what has driven more spectators to the Tour de France since the 1980s, then what is it? The most likely candidate is better-quality and longer television broadcasting. The proportion of the French population on the roadsides of the Tour decreased from the 1950s and 1960s to the 1970s and 1980s (Mignot 2016), likely because the show has become even better on TV. The creation of additional private television channels in France and other European countries in the 1980s, including networks such as Eurosport, increased competition to get the Tour's TV broadcasting rights. This development also incentivized the channels to improve broadcasting quality in order to increase their ratings and return on investment. On the Tour, motorbikes and helicopters now carried multiple cameras which filmed scenic landscapes as well as close-up images of live race interactions and spectators' reactions (Van Reeth 2015b). The increasing economic success of the Tour since the 1980s is likely not due to more competitive racing, but instead to better broadcasting of the event.

5 Conclusion

Each year, the Tour de France attracts millions of people along the roads and reaches a global TV audience. This results from its nice design, appropriate management and modern model of finance based on TV rights revenue, but also from its good fit with tournament theory. However, the Tour's increasing economic success since the 1980s cannot be related to increasing competitive balance. Quite the contrary, the Tour de France is an economic success story *in spite of* competitive imbalance. The increasing economic success of the Tour since the 1980s is likely not due to better racing, but instead to better broadcasting of them. While the birth of the Tour de France in 1903 was related to the development of French sport newspapers and its interwar success was related to live radio broadcasting of the race finishes, its current economic success seems mostly due to better-quality television broadcasting worldwide – another development in the sphere of the media, rather than in the race itself. In addition, social media might be the next step in bringing the Tour to the fans. Improvements in broadcasting continue to this day, as exemplified by ultra-light on-board cameras that are fixed on some bicycles, enabling spectators to see, hear and experience the same things as champions do.

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