Tournament theory: can we guarantee an athlete's best performance?

Principles

For labour economists, the employer-employee contract seems to escape more and more from market rules and is being replaced by organisational doctrines. A firm is now seen as an organisation in which relations between employers and employees are marked by the private possession of informational rents and by strategic interactions. In reality, the adjustment and formation of wages are not the results of a trial-and-error mechanism between labour demand and supply, but incentive mechanisms.

Tournament theory, developed by Edward Lazear and Sherwin Rosen [1981] and Rosen [1986], is based on the idea that the employer puts his employees in competition by promising them prizes specified in advance and, by indicating to them that the attribution of these prizes will not depend on the absolute value of an employee's production but on the position that this production occupies in comparison to that of the other employees. In situations of imperfect control of individual work in complex organisations, pay-for-performance can reduce a dual problem of moral hazard and adverse selection: the uncertainty of the environment and the privacy of some information about workers' actions and performance.

In sport, there are many examples of working relationships in which the actions of the athletes are not verifiable, but the results are. Tournament theory, a variant of game theory, is therefore a frequently used analytical framework for studying competitions in individual sports. It establishes a central relationship between the winners' payoffs and the effort they expend during the competition. Competition organisers use a financial incentive to perform to make their event the most interesting for the public and consequently the most economically profitable.

Tournament theory is based on the postulate that the athletes' results during competitions are a function of the gains they expect to make. The non-linear distribution of prizes will have a positive impact on the level of performance and the individual effort made by each competitor; this effort being an increasing function of the endowment gap. The structure of the endowments distorted towards the top of the Professional Golfers' Association (PGA) Tour is an example of this: the winner receives 18% of all prizes, second place 10.8%, third place 6.8% and last place 0.2%.

An optimal tournament contract should have a double effect: an increase in the participation of the best available talent and an improvement in the performance achieved by each of them. The

principle of a sports tournament includes explicit and verifiable clauses: the remuneration at each level of competition, the overall prize money for the competition, the number of competitors and the elimination process. The remuneration for each level of qualification is completely disconnected from labour productivity. In other words, receiving twice the amount of prize money as your final opponent when winning a tennis tournament does not imply that the winner is twice as productive, but is merely intended to induce the two contenders to work hard to win [Lazear and Rosen, 1981].

Sporting performance and financial incentives

The existence of such a correlation has often been tested in sport: athletics, boxing, running, cycling, golf, motorcycling, figure skating, skiing, motorsports, and tennis. If the tournament model is correct, the increase in prize money should be accompanied by an improvement in performance. The opposite assumption is that players always play to their full potential and their performance is not conditioned by financial considerations.

The relevance of the first hypothesis as chosen by golf tournament organisers seems to be validated. Players become more accurate when the following two variables evolve: the progression of prize levels and the concentration of prize differentials offered for first place. To identify the incentive effect of individual performance, Ronald Ehrenberg and Michael Bognanno [1990] analysed all 40 of the 1984 PGA Tour tournaments. They showed that an increase in prize money of $100,000 resulted in an average of 1.1 fewer strokes per round. They also found that the greater the fluctuation in marginal revenue that would result from one place change in the rankings the smaller the score differences between players and the better the performance of the competitors.

When Tiger Woods won the 1999 US PGA, he received $630,000, while the runner-up, Sergio Garcia, received $378,000. However, their productivity is similar: the average score over the four courses of 67.75 strokes for Woods and 69.50 strokes for Garcia (2.5% difference), yet there is an inequality of earnings between them of 252,000 dollars (40% difference). Rafael Nadal defeated Roger Federer in the 2008 edition of Wimbledon with a very close score: 6-4, 6-4, 6-7 (5/7), 6-7 (8/10), 9-7. It took the two finalists 4 hours and 48 minutes and five sets that ended in the smallest difference (2 games), with the addition of two tiebreaks at the end of the third and fourth sets, which also ended in the smallest difference (2 points). Nadal earned 1.1 million euros (compared to 550,000 euros for Federer), 2,000 points in the ATP rankings (compared to 1,200 for Federer) and the number one world ranking at the expense of Federer. This hierarchical compensation model is designed to motivate both Woods and Nadal to put forth the maximum effort once

they have decided to participate in these tournaments [Lazear & Rosen, 1981].

The results of the application of tournament theory to the thirty best tennis players in the world (2007 ATP ranking) do indeed support, in accordance with one of its predictions, the existence of an incentive effect associated with sports performance, namely that a highly unequal prize structure between the tournament rounds increases the probability of the 'best player victory'. But, the participatory effect is not confirmed, i.e., the overall monetary prize of the tournament does not significantly influence the performance level of the players [Barget, Llorca and Teste, 2011].

Heterogeneity of athletes and competition intensity: the *superstar* effect?

A growing body of literature examines the role that heterogeneity amongst participants in a sporting competition may have on individual effort, which is captured by the variation in performance [Babington, Goerg and Kitchens, 2020]. In the disciplines studied (men's and women's golf and skiing), the presence of a superstar does not discourage the participation of competitors. However, the superstar effect on the level of performance is complex to measure because its calculation is sensitive to the composition of the sample of athletes taken into account, as well as to the assumptions made.

One assumption is that increased rivalry motivates athletes to perform at their best. This seems to be the case for athletes below the superstar's level who, in his presence, improve their results. But too great a difference in talent can reduce the efforts of opponents. If the chances of victory seem very low, the fear of injury or the desire to move on to other tournaments may explain the lack of involvement of other players.

In professional golf tournaments from 1999 to 2006, the participation of the world number one was associated with a lower performance by his opponents, with a negative Woods effect of 0.8 strokes on average per tournament when compared to his non-participation. However, golfers far below Woods in the standings seemed to be much less affected by his presence than the top players, as the stakes are different for these two categories of players. This drop in performance does not appear to be related to risk-taking by outsiders resulting in lost strokes, or to a loss of motivation by other golfers due to the media's disinterest in them, which focused on Woods' performance. Conversely, when Woods' dominance came to an end in 2003-2004, good players improved their performances with and against him [Brown, 2011].

Another study examined whether there is a "Usain Bolt effect" comparable to the "Tiger Woods effect" [Hill, 2014]. Are the compe-

tition and the spectacle better if the level of the competitors is relatively homogeneous? Results from the main 100m sprint events organised between 2007 and 2012 indicate a positive effect of the presence of the world's best sprinter on the times achieved by his rivals.

This apparent contradiction between the "Woods effect", which negatively affects performance, and the "Bolt effect", which positively affects performance, could be explained by the simultaneity of the sprinters' efforts and their extreme briefness (under 10 seconds). In golf, however, players are not directly challenged and have time to modify their behaviour according to the intermediate results of the tournament, which is spread over several days.

Asymmetrical sports tournaments, that is to say, with a dominant competitor in the position of ex-ante favourite, frequently constitute a situation that results in a problem of imbalance in the competition that can alter the interest in the spectacle. The choice of an incentive mechanism is, therefore, a delicate one for the organiser to reconcile sometimes contradictory imperatives: attracting the best and maximising their effort to beat a record by employing a high financial reward, not demotivating weaker competitors by offering prizes that are too unevenly distributed, organising a competition of uncertain outcome with talents of similar abilities, and raising the average effort as much as possible to preserve the quality of the event.

Learnings

What types of athletes should be attracted (of comparable level or heterogeneous level)? What is the impact of the tournament format (number of participants, elimination phases, entry selection, and handicap to balance the competition)? What is the impact of the winner's prize on the incentive for effort? What is the impact of the prize differential?

The tournament model allows sporting organisers to avoid two errors: making a bad decision (choosing mediocre athletes) and not making a good decision (eliminating talented athletes). Tournament theory overcomes some of the shortcomings of the superstar theory and is a complementary approach. In individual sports such as golf and tennis, the tournament is used as a tool to filter out the best talent, promote performance, identify superstar contenders, maintain emulation and, maximise the organisers' revenue through the sporting spectacle.

The concentration of prize money and bonuses on the winners of individual competitions results in monetary earnings that are often higher than those of superstars in team sports. As a result, the superstars of individual sports are widely represented in the rankings of the world's highest-paid athletes. A look at Forbes magazine's annual

ranking from 1990 to 2021 shows that golfers (Tiger Woods, Phil Mickelson), tennis players (Roger Federer, Rafael Nadal), Formula 1 drivers (Michael Schumacher) and boxers (Oscar de la Hoya, Evander Holyfield, Manny Pacquiao) dominate.

However, the share of superstars playing in individual sports has declined significantly and steadily over the decades: 60% on average during the 1990s for the Top 10, 50% during the 2000s and 40% during the 2010s. This trend is confirmed if the field of observation is extended to the Top 50. How can this trend be explained?

Is there a relative weakening of the value of monetary incentives in individual sports compared to the increasing revenues of football superstars? Is there a noticeable change in the economics of some team sports such as football (TV rights, sponsorship, salary overbidding, free movement) that significantly increases the income of these superstars? Is there a decline in the audience of some individual sports, such as Formula 1, tennis, boxing or golf, linked to a lack of charismatic superstars likely to generate phenomena of infatuation and self-reinforcement? Is the imbalance of the competition and the lack of uncertainty of the outcome caused by a lasting hegemony of the same champions at the root of this disinterest?

Extensions

Academic publications on tournament theory certainly provide some answers to the economic questions that any competition organiser asks in order to offer a quality spectacle [Szymanski, 2003]. However, theoretical research and empirical studies need to be further investigated as many questions remain and there is no universal answer to all the issues. For example, a frequent criticism of the payoff function is that it is a black box that does not fully explain how effort translates into chances of winning. There are uncertainties about how tournament theory can be applied. To be accurate and operational, answers to these questions must be based on a better link between assumptions and results. The significance of the parameters and the variables found must also be made explicit to increase the explanatory power of the model.

The measurement of performance in some sports is questionable. The number of strokes required to complete a round of golf or the time to run a certain distance in running objectifies performance. Conversely, winning in a head-to-head competition does not constitute an absolute indicator of individual performance [Barget, Llorca and Teste, 2011]. There is also an element of randomness that reduces the scope of the price/effort/performance relationship in certain disciplines where the ranking of the competition is the result of scores awarded by judges (gymnastics, figure skating, synchronised swimming, etc.).

Empirical studies focus on the monetary gains distributed by tournament organisers. However, these earnings account for only 30 to 40% of the superstars' income, depending on the discipline. The main sources of income are signing bonuses, advertising contracts and fees from exhibition matches. Financial guarantees to ensure the participation of the best talents have a positive impact on participation and a negative impact on the effort made. The effect of the endowment must therefore be put into perspective. Furthermore, superstars seem to be motivated as much or more by the possibility of gaining points in the world ranking to become number 1 than by receiving the financial reward.

Tournament models only shed light on part of the logic of superstars: signals on the quality of athletes, participatory and/or incentive effects. For example, when the average prize money doubles for long-distance races in athletics, the average time decreases. Did the amount of prize money distributed have an impact on the performance of the runners or the participation of the best specialists? As another illustration, it seems that the best performances at the top-funded golf tournaments are due to the fact that they attract the best players (selection bias), rather than the efforts made by the participants.

Moreover, the behaviour of sportsmen and women, and in particular of superstars, can be explained by objectives other than a desire to maximise their financial gains: the spirit of competition, the desire to excel, the cult of the self, the search for glory and the desire to become a legend - all of which are internal motivations within the sporting logic. Finally, several negative externalities alter, from a moral viewpoint, the principles of the tournament model. A distorted upward distribution of prizes, aiming to obtain a maximum effort from participants by overdosing the victory to the detriment of the rest of the cohort, is accompanied by a psychological pressure generating health problems (overtraining, overwork, injuries, doping) and ethical violations (cheating, corruption, violence).

Further information:

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